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Cristiano Storni, Keelin Leahy, Muireann McMahon, Peter Lloyd y Erik Bohemia.

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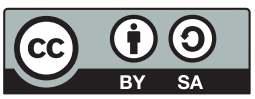

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Cristiano Storni
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Catalyst

Volume 1

Editors
Cristiano Storni, Keelin Leahy, Muireann McMahon
Peter Lloyd and Erik Bohemia

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DRS 2018 Design Research Society 2018 Catalyst

University of Limerick
25th–28th June 2018

Editorial

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DRS2018, hosted by the University of Limerick and the Limerick Institute of Technology is the first international biennial conference of the Design Research Society since the 50th anniversary conference in Brighton. This represented both a challenge and an opportunity; a challenge to meet the high standards set in 2016, but an opportunity to contribute to a growing design research field. The balance between these has translated into the conference theme of *Catalyst*. A catalyst is something that precipitates events; it is the coming together of different entities to generate something new; it is the spark for wider change. Framed by the Catalyst theme, these proceedings explore existing and emergent areas at the intersections of design research, practice, education and policy.

The conference itself built further on innovations from the past two conferences; developing more interactive conversation and debate formats, and providing a forum for practice-based research through the increasingly popular workshops. A *PhD by Design* day, first initiated at DRS2016, provided a platform for PhD researchers to learn new skills, present their work, and network with other researchers. The design of the conference, however, was largely formed around the managed theme tracks which included themes relating to the Special Interest Groups of the DRS. In some cases theme tracks emerged from conversations held at previous conferences, representing a pleasing continuity.

From the initial calls for participation there was a great deal of interest in the conference. Once again we had a truly international range of work presented and published in these proceedings. The original call for theme tracks yielded 46 proposals from which 24 were selected. These formed the backbone of the conference and of these proceedings. The theme tracks represent an increasing engagement with new technologies and data but also reflect contemporary social and political concerns, and the need for different types of design research voices to be heard. In particular, the programme committee were committed to bringing diverse global perspectives into play during the conference.

Following the call for theme tracks, the call for papers resulted in 470 submissions of which, after a rigorous peer-reviewing process, 218 (46%) were finally accepted for presentation and publication. This is a slightly decrease in the acceptance rate from the previous conference indicating a corresponding increase in the quality of the proceedings papers. Although some papers were submitted to an open call, the majority of papers were submitted to theme tracks, with each track being managed through the peer-review process by a track chair and all peer-review overseen by the Programme Committee. In total nearly 1000 paper reviews were written by 330 reviewers. The opportunity for authors to rate and comment on the reviews they received has further helped drive up the quality of peer review for future conferences.

DRS2018 reflects the coming together of many different perspectives and themes. As with previous conferences its design has been emergent, developing over the two years prior to the conference. It has been the result of many discussions and collaborations both within the Limerick team and the DRS more generally. The conference, and the proceedings that have resulted, are an extensive

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collaboration between many people but we would especially like to thank the local organising committee comprising members from the University of Limerick (UL), The Limerick School of Art and Design (LSAD) at the Limerick Institute of Technology, as well as members of other Irish academic institutions all of whom contributed valuable insight and experience. We'd also like to thank the track chairs who worked tirelessly and diligently to organise their tracks, and the reviewers who have ensured the high quality of the papers within those tracks.

Lastly but not least, we need to acknowledge the system that helped shape the way we worked together and made our decisions: the ConfTool conference management system. For the uninitiated ConfTool represents an awkward and mysterious interface. For the initiated it represents an indispensable way to manage the complexity of every stage of the conference process. In a way that echoes the conference theme, ConfTool has been a catalyst for our collective effort in bringing DRS2018 together.

In this sense *Design as a Catalys*t becomes a *thing*; a thing in the Heideggerian sense of a gathering of different entities coming together to deliberate on shared issues and reaffirming the role of DRS as a leading forum for discussing design research from multiple angles. But also a *thing* in the sense of something that escapes a specific definition, reflecting the impossibility and perhaps undesirability of a specific definition of what design research is, and should be.

With this sentiment in mind, we sincerely hope that these proceedings catalyse positive change and that the changes propagate to DRS2020 and beyond.

Go raibh maith agaibh,

Cristiano Storni, Department of Computer Science & Information Systems
Keelin Leahy, School of Education
Muireann Mcmahon, School of Design
Peter Lloyd, Vice Chair of the Design Research Society
Erik Bohemia, Events Secretary for the Design Research Society

Volume 1

Section 1.

Design, Technology and Society

DRS 2018 Design Research Society 2018 Catalyst

University of Limerick
25th–28th June 2018

Editorial: Design, Technology and Society

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doi: 10.21606/dma.2018.002

The Design, Technology and Society track offers new critical perspectives and creative insights into the roles of technological systems and discourses in the design and production of our built environment. As computation, software, simulations, digital fabrication, robotics, 'big data,' artificial intelligence, and machine learning configure new imaginaries of designing and making across fields, this track approaches these subjects critically from enriched socio-material, technical, and historical perspectives —revealing how conceptions of creativity, materiality, and labor have shifted and continue to shift in conjunction with technological change.

The first two papers in the track examine the historical, socio-cultural roles of the 'laboratory' in shaping design education today. In "Olivetti's New Canaan Electronic Laboratory: When Design Meets Computing", João Rocha tells the story of the development of computing in Italy though the seminal work of the Olivetti company, best known for its typewriters. Through meticulous archival research, Rocha uncovers the company's pioneering work at their US research laboratory in developing the precursor of today's 'personal computer', and their unique attention to the aesthetics of their electronic products through alliances with leading architects and designers. In "The Design Laboratory: A Review of Five Design Education Programmes", Gert Hasenhütl examines how the laboratory paradigm in the sciences was appropriated and repurposed in the history of studio education. He reviews five design education programmes from the early 20th century through to the present day, and observes how art, culture, and technology were integrated in these programmes through adaptations of a laboratory model. Highlighting both metaphorical and practical uses of the laboratory paradigm in these design programmes, Hasenhütl sheds light on a key trait of 20th century western design.

Histories of a different kind are the subject of the two following papers —the histories of data as designed artifacts situated in social and material contexts and evolving over time. In "Data Streams, Data Seams: Toward a Seamful Representation of Data Interoperability", Sarah Inman and David Ribes challenge current data gathering and production practices which often obscure the socio-cultural and material choices embedded in the processing of data. Drawing from an ethnographic study of data creation in Alaska's *Salmon and People* project, they propose a 'seamful' approach to data design that takes into account data's constructed, contingent, and negotiated nature. In reflecting on data's own materiality and historicity, they offer important insights for reflective and participatory practices of data creation, curation, and use. The complexities of data are examined, too, in "Digital Quantification Regimes of Cycling Mobility". In this paper, Martin Tironi and Matias Valderrama question the increasing quantification of urban phenomena and social life that accompanies the 'smart city' project to achieve better, more efficient and participatory design and

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planning through data. Like Inman and Ribes, they view data as neither neutral nor objective. They present two case studies of digital quantification strategies or 'regimes' for tracking and quantifying urban cycling patterns in Santiago de Chile. Through a rigorous analysis of the narratives and material technologies employed in the two regimes, the authors unveil the different assumptions, biases, political agendas, and legitimizing tactics that drive them. Their studies reveal that rather than increasing citizen participation, these quantification regimes can create more distance between people and policies.

The last two papers investigate technologies for creative practice through different and complementary methodological lenses. In "Scenes of Writing", Anne Burdick innovatively deploys design fiction both as a method of historical inquiry into writing technologies, and as a medium to speculate into the design of new interfaces for digital scholarship. Through the eyes of a fictional character, the scholar-for-hire Trina, Burdick presents us with a not-so-distant future world where a new form of critical inquiry exists enabled by virtual reality environments. Interwoven with Trina's story is a nuanced reflection on the history of writing interfaces, as well as a suggestive architecture for the future of digital humanities scholarship that evokes and reinterprets the spatiality of the archive. In "Digital, Analog, Discursive: Knowledge Practices and Sense-Making in Design-Build Architecture", Claire Nicholas and Arlene Oak take us from the digital worlds of VR interfaces to the material world of architectural production, and from the speculative key of design fiction to the descriptive key of ethnographic observation and reflection. Nicholas and Oak follow a group of architectural students and faculty as they work across different media in the design and construction of an architectural structure. Placing analytical emphasis on their subjects' engagement with different modes of design, from digital interfaces to drawings and physical models, they study moments of resistance and misalignment that challenge the notion of a seamless translation between digital representations and physical outcomes. In their detailed portrait, they examine the roles that representations, materials, and embodied skills play in design, and observe how the productive disjunctures of transmodal design may be key to both designing and learning.

Through rigorous historic, ethnographic, and design-fictional means, the six papers in this track offer valuable materials to rethink technology in design. They interrogate the influence of scientific paradigms on design education and the transatlantic social histories of modern technology design; they re-specify data as designed artifacts and challenge dominant approaches to their production; and, finally, they shed light on the connective tissues linking creative practices and contemporary socio-technical infrastructures.

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The Design Laboratory. A Review of Five Design Education Programmes

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Five steps in the development of design studio culture are analysed based on a review of the literature: (i) Nikolai Ladovsky´s "Psycho-Technical Research Laboratory", 1921 to 1927, (ii) Gilbert Rohde´s "Design Laboratory", 1935 to 1937, (iii) Frederick Kiesler´s "Laboratory for Design Correlation", 1937 to 1941, (iv) John C. Jones´ "Design Research Laboratory", approx. 1963 to 1974, and (v) Neil Gershenfeld´s "Fab Labs", since 2003. Attention is drawn to the different ways in which art, science and technology are included in the curricula of these educational programmes. Contents and goals of teaching refer to features of laboratories and methods of work. An attempt is made to show how the metaphor of the laboratory was used to establish these programmes. The experimental character of the programmes and the changes from "pseudo-laboratory conditions" to "real-studio conditions" are discussed. The selected programmes can be characterised thematically, methodologically and metaphorically. The issue is to discuss design education not only as a technical but also as a social phenomenon.

design history, design research, design education

1 Preliminary Notes

Modern laboratory work links observation and experimentation and enables an integration of craft and innovation into science (Klein 2008, p. 10). The notion that artistic studios are comparable to laboratories emerged in avantgarde thinking and influenced the development of architectural and design studios. The experiments of these laboratories were not limited to the studio, the museum or the workshop, but were intended to be made available for the general public. Osip Brik called for working in the studio to be carried on into "the laboratories of life" (Brik op. cit. Arvatov 1972, p. 125), and Vladimir Mayakovsky stated that "The streets are our brushes. The squares, our palettes." (Mayakovsky op. cit. Khan-Magomedov 1987, p. 14). Walter Gropius defined the Bauhaus workshops as "laboratories, in which products, suitable for mass production, should be established and improved by working on models" (Gropius 1964, p. 91).

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In social constructivism, knowledge accumulated in a laboratory was not only validated by other laboratories, but the places where knowledge could be generated were made into laboratories themselves. Louis Pasteur set up a laboratory environment in which contagious ferment could be created and regulated (Latour 1993b, pp. 62f.). His laboratory construction for microbes not only guaranteed the quality of milk, but also influenced the construction of dairies designed as laboratories (Farías & Wilkie 2016, pp. 10f). In artistic work, the world appears to be an uncontrollable "outside" where cultural artefacts are evaluated (ibid.). Knorr-Cetina (1992, pp. 127–128) examines construction drawings of the Middle Ages, where the laboratory was a permanently existing room with a pool of materials and tools, and convertible materials or transitional objects were produced.

Comparing scientific with artistic work is questionable because scientists and artists differ from each other in the way they can be regarded as instruments working between the world investigated and the knowledge accumulated (Alpers 1998, 403f). For Rheinberger (2012, n. p.), compared to technical planning, art is similar to science in the way it handles uncertain events. Artistic and scientific research share the features (i) "locality" and (ii) "stability" (Gramelsberger 2013, p. 103): (i) Certain places serve as a basis for the production of art and science. In the future this work will more and more be determined by a kind of "placelessness" and the relocation of research into virtual space (Landbrecht & Straub 2016, p. 40). (ii) As a science art has the problem of stabilisation, e.g. evaluating a piece of art in a social context. Design processes follow the course from mental to material states, i.e. externalisation, and not vice versa (Eekels & Roozenburg, 1991, p. 198), and stabilisation must be located in the realm of materiality.

The question to start with is whether it is possible to define a common foundation for science and art. Stating differences also means searching for relationships and similarities (Rheinberger 2014, p. 50). The five educational programmes discussed here were reform efforts of design education and design research combining science with art (Hasenhütl 2017, p. 149). They have in common that they regarded themselves as "Laboratories". These approaches are chosen because they follow experimental models of natural science and adopt methods of empirical research. The way in which the importance of art, science and technology is emphasised differs from curriculum to curriculum.

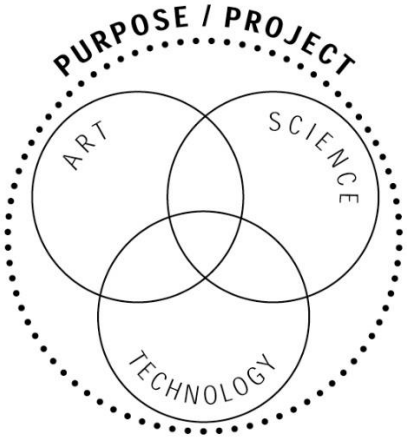

Figure 1 Archetype [Urmodell] of Design Curriculum. Source: (Findeli 2001, p. 8)

At the "Psycho-Technical Research Laboratory", 1927, art was replaced by the use of science and technology; at the "Design Laboratory", 1935, the focus was on art education based on scientific innovation; at the "Laboratory for Design Correlation", 1937, art was regarded as a tool of science and technology; at the "Design Research Laboratory", 1963, the focus was on science and technology including artistic research; and at the "Fab Lab", 2003, art was reintegrated into science and technology as a skill.

The programmes reviewed have in common that they attempted to reform design and research by relying on the metaphor of the laboratory. The question was raised whether art could be regarded as laboratory work. This paper examines the laboratories through a review of the literature. Looking into the programmes of Ladovsky and Jones is difficult because the documentary material is limited or not open to the public. Analysing the laboratories and studios is also affected by the fact that the original work of Ladovsky, Rhode, Kiesler, Jones and Gershenfeld has in the meantime been modified and translated. Knowledge of the original experimental processes is therefore rather hypothetical (Latour & Woolgar 1986, pp. 172–174). The creation of reference by permanently translating between matter and form is a possible method for assessing studio work (Latour 1999, p. 69f). Earlier steps are reconstructed within a reference chain.

2 "Psycho-Technical Research Laboratory", 1927

The "Psycho-Technical Research Laboratory", established by Nikolai Ladovsky, existed from 1927 to 1928 at the Higher Art and Technical Studios (Vkhutemas) in Moscow. The older "psychoanalytical method" (Ladovsky op. cit. Kreis 2009, p. 668) of space research was extended into this programme (Vöhringer 2007, p. 59). "Psychoanalysis" was used to describe spatial effects on the human mind. Mental states were regarded as a result of external influences (ibid., p. 50). It is unclear whether Ladovsky was influenced by Sigmund Freud´s notion of "Psychoanalysis" (ibid., p. 50). The method was used for the design proposal of the "International Red Stadion" in Moscow (Tschepkunowa 2014, p. 7). The laboratory was established in 1927 based on the lecture "A Psycho-Technical Research Laboratory for Architecture" held by Ladovsky in November 1926 (Khan-Magomedov 1987, p. 107; Pistorius 1992, pp. 31–32).

The programme consisted of different research groups, one for the analysis of architectural elements, one for research of psychological effects of colour, form, volume, etc., one for economic organisation, and one for design education. The last group was involved in the design of different experimental devices (Vöhringer 2013, p. 62; Kreis 2009, p. 670). Experiments on the ability to perceive lines, angles and volumes were conducted by "Glazometer" (ibid., p. 59). Devices for testing distances, spatial properties of surfaces, and angles of vision were "Liglazometer", "Ploglazometer" and "Uglazometer" (Khan-Magomedov 1987, p. 136; Vöhringer 2013, pp. 37 and 60–63).

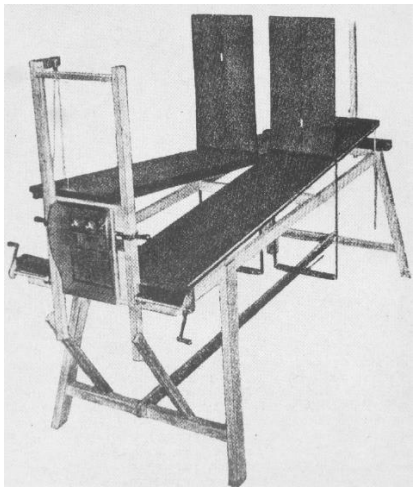

Figure 2 Prostometer. Source: (Khan-Magomedov 1987, p. 136)

The "Prostometer" (meter for space) was an apparatus for testing the ability of perceiving spatial depth. Test subjects were asked to look through two openings from a fixed point of view, while spatial effects were created by tilting two horizontal planes and moving vertically attached figures. By this experiment, also used by Le Corbusier, the ability of stereoscopic perception was tested (Vöhringer 2013, p. 35). In order to prevent test subjects from being distracted, the room in which this apparatus was installed was painted black (ibid., pp. 61f).

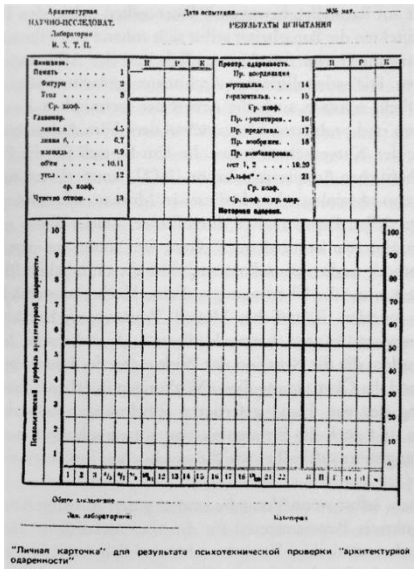

Figure 3 Personal chart. Source: (Vöhringer 2007, p. 65)

Subject´s estimations were recorded on special charts, assessing their technical suitability. The data included attentiveness, memory and spatial skills (ibid., p. 64). The data collected resulted in a personal "psychological profile", applicable for further processes of learning (ibid.). Findings were used (i) for entrance examinations for students of architecture, (ii) for the training and improvement of perception skills and spatial imagination, and (iii) for supporting experiments during design processes (ibid., p. 59).

The curriculum included psychotechnique with the objective of reducing energy and mental effort during the perception of spatial and functional features of forms (Ladovsky 1992a, p. 45). A "rationalist aesthetics" attempted to reduce mental effort in architecture (Ladovsky 1992b, p. 40).

> *An architect have to familiarize with laws of perception. Psychotechnique is one important modern scientific influence, because it is building bridges between pure science and applied sciences. Laboratory work should enhance practical skills. (Ladovsky 1992a, p. 45)*

Design by drawing was given up and replaced by design in space (Ladovsky op. cit. Khan-Magomedov 1987, p. 544). Spatial models were used enhancing spatial cognition and enabling the development of construction plans instead of traditional art teaching starting with drawing (Vöhringer 2013, p. 51). The spatial model or modelling in space was the tool of the "psychoanalytic architect" (ibid., p. 50).

3 "Design Laboratory", 1935

The "Design Laboratory", led by Gilbert Rohde from 1935 to 1937, was a free art school located in New York and financed by the Works Progress Administration. Frances M. Pollak developed the original concept (Bearor 1996, p. 15). The idea of an "American Bauhaus" influenced this programme. Its predecessors were the Bauhaus in Weimar, 1919, and the Carnegie Institute of Technology in Pittsburgh, 1935 (Keyes 1936, p. 5). The curriculum of the Bauhaus in Dessau was also influential due to its focus on machine-oriented design principles (Bearor 1996, p. 19; Clark 2009, p. 47).

Figure 4 Display design students study abstract composition in three dimensions in all materials. This student is working in wood. Source: (Dunne 1937, p. 40)

In contrast to existing schools of art, the programme of this "free art school for underprivileged students" (Keyes 1935, p. 19) intended to coordinate training in aesthetics, machine fabrication and merchandising (Rohde op cit. Keyes 1935, p. 19). For Rohde (1936) the purpose of the laboratory was to develop "various necessary skills" (p. 640) based on the integration of art, handicraft and industrial design. The objective of the programme was to promote this integration.

> *The point is to understand by usage what the machine can and can not do. The work in the design room is coordinated with work in the shop; and the two with study of materials, emphasizing commercially available forms and factory processes, aided by collections of materials at the school and visits to the factories. (Rohde 1936, pp. 642f)*

Postgraduate training emphasised "learning-to-be-practical" (Dunne 1937, p. 41) by practical training, lectures, drawing exercises and field trips. Students were encouraged to work from the outset with equipment, methods and techniques of their core area. The focus was on the field of industrial design, besides drawing, painting, sculpture, visual display and fine arts. This approach stood in opposition to a design driven economy. It appears to be ironic that Gilbert Rohde, with a past in commercial design for business, represented this school (Clark 2009, p. 43).

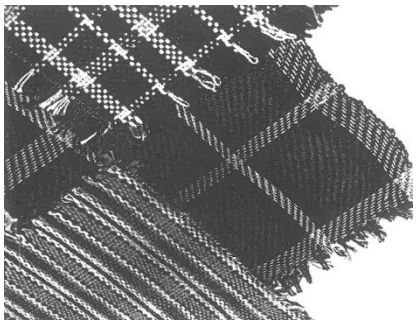

Figure 5 Textiles designed and woven by students of the Design Laboratory. Source: (Rohde 1936, p. 640)

Students all took part in the same practical training, lectures, drawing exercises and field trips. Teaching focused on experimenting with different materials and techniques (Clark 2009, p. 47). "Knowledge of good design was presumed to be the result of direct physical and sensory experience disciplined by an intelligent and sensitive mind." (Bearor 1996, p. 20). Teaching methods were based on "progressive education" (Clark 2009, p. 40) and the method of "learning by doing" (Keyes 1936, p. 5). "For the instructors nearly as much as the students, the daily activities at the Laboratory were a pragmatist exercise in `learning by doing´" (Clark 2009, p. 41).

> *[...] the curriculum is based on the experimental procedure of a research laboratory. [...] Free experimental production in interior architecture, furniture, industrial products and appliances, wood, metal, ceramics, glass, plastics and textiles will figure prominently in shop work. (Rohde, op. cit. Anonymous 1936, p. 117)*

The programme addressed students interested in handicraft, economy and art (Rohde 1936, p. 638). Most of the participants were art students aged between 16 and 60 (Keyes 1936, p. 5). Design was implemented "industrial-design minded" rather than "craft minded" (Rohde 1936, p. 643). In an age of financial repression, industrial design was appreciated for serving American industry. Students educated as prosumers, i.e. people who both produce and consume, could easily be integrated into a modern industrial society as "new-artists" and "artist-technicians" (Rohde, op. cit. Bearor 1996 p. 29).

4 "Laboratory for Design Correlation", 1937

The "Laboratory for Design Correlation", founded in 1937 by Frederick Kiesler, was a graduate programme at the Columbia University in New York. After proposing a "Laboratory for Social Architecture" (Kiesler 1934, n.p.) in the 1930s, Kiesler was involved in establishing a design school influenced by craft schools, e.g. the "Cranbrook Academy of Art" (Benson 1934, p. 308). Kiesler together with E.M. Benson had proposed an "independent research laboratory that would be to art and industrial design what the Rockefeller Institute was to medical research." (Bearor 1996, p. 15). Although it is not clear to what extent Kiesler taught at the school, there is evidence of his participation in the Design Laboratory being established, and of his role as an architect in the advisory board (Keyes 1935, p. 19; Bearor 1996, p. 16 n. 10).

Kiesler (1939, pp. 60–79) was interested in art and science and in biological and physical theories. He can be regarded as a visionary personality metaphorically transferring theories of empirical science into artistic work (Hasenhütl 2014, p. 102f.). Kiesler (1939) established a specific design method by the neologism "Correalism" (p. 77), drawing on the notions "Co-Reality", "Correlation" and "Co-realism", i.e. a reference to Surrealism (ibid., p. 60f; Pessler 2003, p. 3). Kiesler (1939, p. 77) introduced "Correalism" as basic research and "Biotechnique" as applied research. The main objective of the programme was to promote human physical health by the use of design objects (ibid., p. 65).

> *The general objectives of the laboratory are to define an approach to progressive industrial design; to correlate design to the physical and psychological needs of man (control of fatigue and generation)... Kiesler (1937, n.p.)*

Figure 6 File Card: Photostat No. 11. Source: (Austrian Frederick and Lillian Kiesler Private Foundation TXT_5089_0_LDC 1)

The working group consisted of students of architecture and sociology. One of the few proposals realised was the project of a mobile home library, a design process almost entirely documented. The result of the "research into design" (Frayling 1993, p. 5), which was conducted for a period of one year, was a card index box referring to different issues, e.g. ventilation technology, fatigue measurement, energy balance, morphology of architecture (Austrian Frederick and Lillian Kiesler Private Foundation TXT 5176/0). The illustration above shows the front side of the file card "Fatigue Measurement - Bioelectric Methods". On the file cards were text fragments and illustrations taken

from scientific literature. In this example, an experiment on muscle contraction and relaxation conducted by the University of Chicago in 1928 is shown. These file cards were part of a referential system by which the group deduced the design of the mobile home library step by step. These cards were also used for teaching.

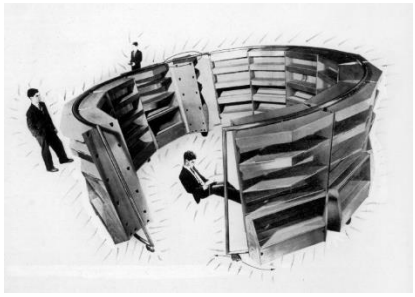

Figure 7 Biotechnique. Source: (Kiesler 1939, p. 72f)

Kiesler (2001, p. 95) developed this design of an ergonomical home library as a result of an experimental procedure. The designed prototype itself was intended to correlate with the problem being tackled, e.g. the book as a media, reading as a cultural technique. The manufactured prototype was the result of a comprehensive literature review of market analysis and of several motion studies, all in the spirit of scientific management. Storage and action space were optimised with regard to functions, dimensions and materials.

The curriculum was dominated by strict scientific methods (Reports on the Laboratory of Design Correlation, Austrian Frederick and Lillian Kiesler Private Foundation TXT 5233/0 Folder 4). Ergonomics, theories of evolution, field theory, strategic corporate planning, nuclear physics, industrial engineering, and the special theory of relativity, delivered source material for theory construction. The work of Frederick Taylor, Frank Bunker Gilbreth and Christine Frederick is very similar to this design method.

5 “Design Research Laboratory”, 1963

The “Design Research Laboratory”, founded in 1963 by Christopher Jones, was a post graduate programme at the University of Manchester, Institute of Science and Technology. Jones (1970a, p. 353) attempted to include applied research in the educational programmes of architects and engineers by integrating computer sciences, ergonomics, operational research and systems engineering. The objective of this programme was to offer technical training enabling students to become “design technologists”, working cross-disciplinary on complex problems (ibid., p. 355).

> *The main objectives of the practical parts of this program in Design Technology are to provide experience of working in groups on preliminary studies of novel design problems and in carrying out design research projects. (ibid., pp. 355f)*

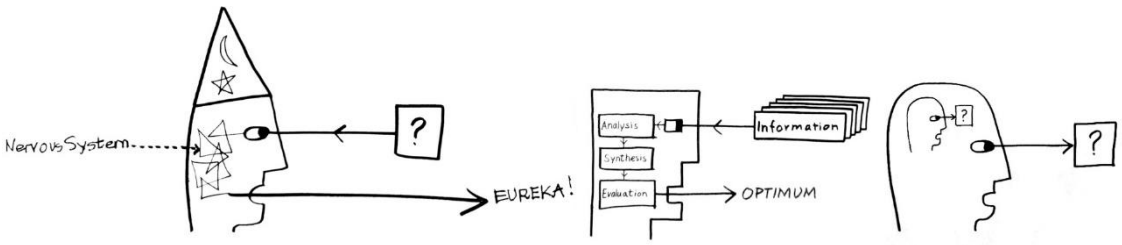

Figure 8 Designer as magician. Designer as computer. Designer as self-organizing system. Source: (Jones 1970b, p. 2)

The illustration shows how the transformation processes of design work were metaphorically interpreted. Jones (1970b, p. 2) wanted to abandon the concept of the designer as a magician without rejecting art. Automation, information technology and human-machine interaction had a massive influence on his work. In the late 1950s, he prophetically described automation as a kind of networked

production where three-dimensional goods could be ordered at “automatic factories” via input and output devices, and design changes could be managed nearly instantly (Jones 2000, pp. 84f).

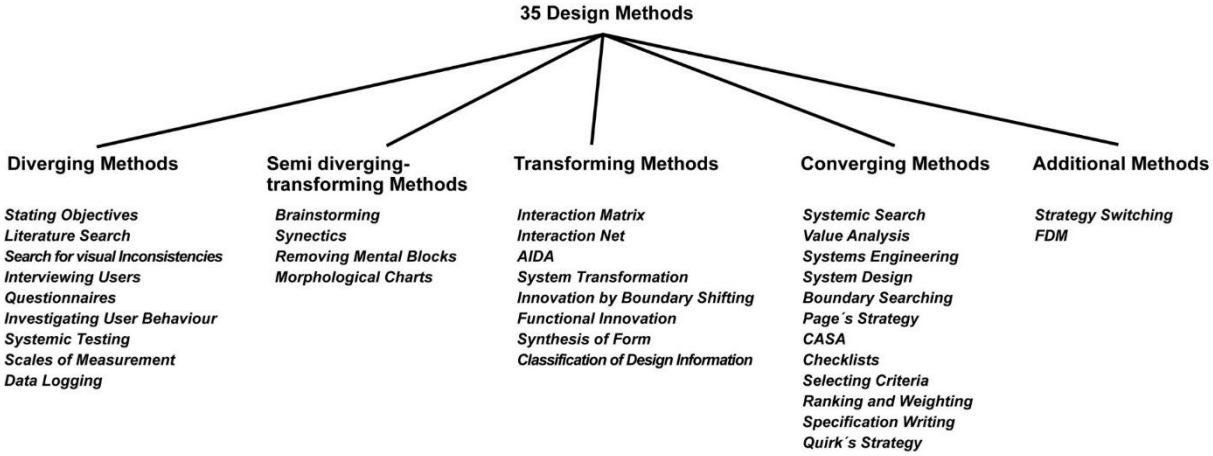

Figure 9 Catalogue of methods. Source: (Author following Jones 1970c, pp. 94–396)

Summed up in the illustration above is the curriculum, published in a seminal book on design methods (Jones 1970, pp. 94–396), which included methods of creativity techniques, of empirical social research and of technical product development. The tasks in teacher-centred instruction and project work dealt with design methods rather than with real-world problems (Jones 1970a, p. 354). Research oriented teaching resulted in an emphasis on theorising and writing. Early studies conducted, e.g. “The Effects of Designing”, “Optimisation using a Computer”, “Car Seating”, “Visual Choice Reaction Times”, and “A Report on the Modular Jointing System of Steel Frame Housing”, were associated with general sections, e.g. “Technological Change”, “Design Methods”, “User Requirements”, “Human Performance”, and “Building Systems” (Jones, Talbot and Goodwin 1967, n. p.). Nigel Cross wrote his M.Sc. Dissertation research project in 1967 on the topic “Simulation of Computer Aided Design” (Cross 2001, p. 44). The aim was to find out what CAD might be like and what the design requirements for CAD systems might be (ibid.). Designers interacted with a simulated CAD-system via television images by following orders which were drawn on little paper charts (Cross 1977, p. 108). As in Wizard-of-Oz-tests, the test subjects were not aware of the simulation of the CAD-system by a group of planners.

The programme began with teaching theory and continued with practical project work. “The course consisted of two semesters: the first (October – April) consisted of lectures and laboratory work, followed by examinations; the second was a 5-month individual dissertation, supervised primarily by Christopher Jones, assisted by the other lecturers. [...] Christopher Jones gave lectures on design methods and technological change, and provided visionary leadership around ideas of the future of society and technology.” (Personal correspondence of the author with Nigel Cross, 24 August 2016). Jones (1970a) regarded his programme as based on experiments. “The purpose of this experiment in design education is to find ways of removing the barriers between arts and sciences and between the many professions that are increasingly relevant to design problems.” (p. 353) He gave up teaching a few years later unhappy with institutional conditions. “In 1970 Christopher Jones was offered the post of Professor of Design at the new UK Open University. I also joined him there as lecturer. The Design Technology course continued at UMIST, with Reg Talbot, for a few years more. Christopher Jones resigned from the Open University in 1974, disillusioned because it did not fit his vision of a more experimental and technologically advanced university.” (Personal correspondence of the author with Nigel Cross, 24 August 2016).

6 “Fab Lab”, 2003

The “Fabulous Laboratory”, “Lab for Fabrication” or “Fab Lab” (Gershenfeld 2005, pp. 11f; Gershenfeld 2012, p. 47) was part of a university programme “How to Make (almost) Anything” established by Neil Gershenfeld and his students at the MIT Media Lab, Cambridge, Massachusetts. Starting in 1998, the objective was to produce a so-called “personal fabricator” within the laboratory setting of MIT´s “Center for Bits and Atoms” (ibid.). It was centred around designing, developing and constructing technical innovations by consumers and first of all by the students.

> *This thought led to the launch of a project to create field `fab labs´ for exploring the implications and applications of personal fabrication in those parts of the planet that don´t get to MIT. As you wish, `fab lab´ can mean a lab for fabrication, or simply a fabulous laboratory. Just as a minicomputer combined components–the processor, the tape drive, the keypunch, and so forth–that were originally housed in separate cabinets, a fab lab is a collection of commercially available machines and parts linked by software and processes we developed for making things. (Gershenfeld 2005. p. 11f)*

Regionalising production facilities and expanding digital fabrication by personal fabrication was an important objective. Consumers were given the opportunity to produce goods not available in department stores (Gershenfeld op. cit. Anderson 2012, p. 77). Students were interested in producing goods different to those on sale. Since the Renaissance, manual skills were excluded from the educational canon. Education focused on the abilities of reading and writing (Gershenfeld 2005, p. 7). Producing goods as “illiberal arts” was no konger included (ibid., p. 34). Illiberal arts, e.g. artistry and skills, were neglected for economic reasons. “We´re still living with the historical division of the liberal from the illiberal arts, with the belief that the only reasons to study fabrication are for pure art or profane commerce, rather than as a fundamental aspect of personal liberation.” (ibid., p. 42)

Figure 10 Fab Lab. Source: (Gershenfeld 2005, p. 25)

Fab Labs consisted of a laser cutter, sign cutter, milling machine and tools for programming tiny micro computers (ibid., pp. 11–12). “This is not a static configuration; the intention over time is to replace parts of the fab lab with parts made in the fab lab, until eventually the labs themselves are self-reproducing.” (ibid.)

The teaching programme was characterised by “peer learning” and “design-based learning” (Koh, Chai, Wong, & Hong 2015, pp. 8 and 59). If students acquired certain skills, e.g. programming or production techniques, they shared their knowledge with other members of the group. This exchange of ideas, skills and experiences developed a momentum boosting the student’s problem solving capacity (Gershenfeld 2005, p. 24). Paradoxically, the majority of the students in the class were reading arts, architecture and engineering, not computational sciences as expected. Curriculum, tutorial material and teaching staff were unable to cover the requirements of such heterogeneous groups (ibid., pp. 6f). The learning process was determined by a demand for and not by a supply of topics of teaching (ibid., p. 7).

> *This process can be thought of as a `just-in-time´ educational model, teaching on demand, rather than the more traditional `just-in-case´ model that covers a curriculum fixed in advance in the hopes that will include something that will later be useful. (ibid., p. 7)*

7 Discussion

The “Psycho-Technical Research Laboratory” attempted to establish industrial psychology as a key technology of social engineering. Psycho-technical architecture was a governmental tool for planning and controlling (Vöhringer 2013, p. 35). The state-funded “Design Laboratory” was institutionalised by the Federal Art Project (FAP) as a means for democratisation of American culture (Clark 2009, p. 41). A letter written by FAP-Director Holger Cahill shows that the purpose of the programme was the recruitment of teachers to carry forward the laboratory´s methods and ideas to young people. Cahill suggested a “program for re-training New England craftsmen” (Clark 2009, p. 42). The “Laboratory for Design Correlation” had a strong influence on transferring Russian and European avantgarde approaches into a design driven economy. “Gesamtkunstwerk”, “Constructivism” and “Psychoanalysis” were commingled with ergonomics and scientific management. European industrial science which “probed a reorganisation of industrial production experimentally” (Felsch 2005, p. 34) had an enormous impact on the reform activities of American industrial design developed by Kiesler. “Psycho-technology” and “mental engineering” as part of the emerging social sciences were tools of “democratic social control” (Lemov 2005, pp. 55–57). The “Design Research Laboratory” intended to integrate applied sciences into the training programmes of professional designers and planers. The objective was to dismantle barriers between different disciplines (Jones 1970a, p. 353). The “Fab Lab” methodology facilitated a massive transfer of knowledge between different disciplines. Anderson (2012) discussed fabbing as part of the maker culture and claimed that “Fab Labs are a special kind of makerspace” (p. 46). Expert knowledge could be disseminated in makerspaces dependent on the technical and social conditions. Rohde and Gershenfeld emphasised the importance of manual skills. Mechanical and digital fabrication brought forward a “technological momentum” (Hughes 1994, pp. 108f) and resulted in reform. The “Design Laboratory” upgraded the value of handicraft and practical work, as opposed to industrialisation downgrading the value of manual abilities. Fab Labs had opened these borders.

Experiments at the “Psycho-Technical Research Laboratory” were about psychological research on spatial effects. The programme was influenced by experimental culture in Russia in the 1920s. Economy, education and art were reorganised with expectations of a great future (Vöhringer 2007, p. 20). Experiments at the “Design Laboratory” were about testing different materials and techniques. John Dewey´s “Laboratory School” (Bearor 1993, pp. 72f) helped to develop the point of view that interests and personal initiatives could serve as a starting point for experiments. Formal teaching was thought to be an enrichment for personal knowledge. Experiments at the “Laboratory for Design Correlation” were about transferring methods from ergonomics and scientific management to designed prototypes. Both Ladovsky and Kiesler were interested in examining psychological processes. But Kiesler didn´t use experimental setups. He regarded the prototype itself as a quasi-experimental setup for corroborating theoretical assumptions. Experiments at the “Laboratory for Design Research” were about testing different methods. Problems were tackled by the use of logical and intuitive methods. Team work and interdisciplinary research were key elements of design education that Jones had established in the spirit of the design-methods movement. Experiments at the “Fab Lab” were about manufacturing, connecting, programming and communicating. Design processes were transferred into technical innovation. The key issue of this type of post-digital literacy was to reintegrate manual skills into the liberal arts model.

The construction of theory in these programmes was influenced by three different types of “scientific references” (Picon 2008, pp. 51–63.): content-related, methodological, and metaphorical. Ladovsky (1992a, p. 45) used methodological references by transferring applied psychology to design research. Referring to Hugo Münsterbergs “Grundzüge der Psychotechnik”, 1914, he proposed an objective foundation of spatial effects. Rohde realised methodological references by focussing on experiences in design education (Clark 2009, p. 43). Kiesler (1939, p. 77) put content-related and metaphorical references into effect by taking up scientific concepts, e.g. biotechniques, nuclear concepts, management, etc. It can be assumed that most of his references were based on poetical

estrangements (Phillips 2017, p. 256). Jones realised content-related and methodological references by adopting qualitative research as a basis for design research. Gershenfeld used methodological references by interlinking different fabrication units. The claim that “studio education is education in making things” (Schon 1985, p. 94) seems to have been achieved in the Fab Lab.

Purification and translation could be aspects of assessing the quality of research processes (Latour 1993a, p. 10f). They both could be involved in the emergence of “quasi-objects” (Serres 1982, p. 233). Artistic work is assumed to consist of experiments where the production of “quasi-objects” (Latour 1993a, p. 89) could occur. Design could be “a kind of experimentation” (Schon 1985, p. 83) where “on-the-spot experiments” (ibid., p. 85) could happen. Bruno Latour´s notes on the Archimedian pulley (Latour 1993a, pp. 109–111) show connection points in the construction of quasi-objects in architecture and design (Hasenhütl 2014, p. 13–27; Van Toorn 2008, p. 76; Randerson 2011, pp. 237–239). Purification can be regarded as separating science from politics. Translation can be regarded as an expansion of political power into a technical mechanism (Latour 1993a, p. 110). Purification in design could be conceived as a discourse on architectural research in “research for design” (Frayling 1993, p. 5; Gethmann 2009, p. 47). e.g. Ladovsky´s and Kiesler´s “scientific” languages. Translation in design could be conceived as the adoption of functionalism and ergonomics in the private household, as a mixture of different techniques through new design tools, and as man-machine interfaces (Gethmann 2009, p. 47), e.g. Ladovsky´s and Kiesler´s use of psychotechniques and Taylorism.

Early laboratories imitated methods of basic research in natural sciences, but did not involve research from other disciplines. Experiments in these programmes were instruments of verification, but not instruments for creating new knowledge. Knowledge was coupled with perceptual patterns or a certain habitus. It can be assumed that in Kiesler´s file card system references to different issues were regarded as given facts and were not constructed in each translation step. Because the origin of the concepts of space-time, continuity, correlation, etc., was not documented, the chain of references was interrupted and could not be backtracked. All programmes referred to technical progress by implementing new methods or technological innovations. Focussing on perceptual patterns, research into design, technical skills, problem solving capacities and prototyping, all programmes were about “design ethics” (Findeli 2001, p. 13) in the broadest sense. The replacement of “design ethics” by “design thinking” (Leifer & Meinel 2016, p. 3) was crucial to the work of the “Design Research Laboratory” and of the “Fab Lab”.

By using advanced simulation techniques and more effective design methods, “`laboratory´ design processes” change into “`real world´ conditions” (Lawson 2004, p. 47). The “studio-laboratory” can serve as a place where such a shift can take place (Century 2013, p. 3 and pp. 6–9). Artistic and technical production are combined by bringing artists, scientists and technicians together. “Studio-laboratories” provide new opportunities in design education, regarding “design problems as intricate systems [...] that might be defined through both rationality and creativity” (Wang 2010, p. 181). Jones (1970a, pp. 355f) assumes that the best way of training people in tackling wicked problems “is to expose them to the principles and methods of both sciences and arts” (Jones 1970a, pp. 355f). Scientific and artistic research is combined in these “studio-laboratories” by “heterogeneous engineering” (Law 1987, p. 113) or “hybrid manoeuvres” (Nickelsen & Binder 2009, p. 174 f. 13). Designers can be described as “system builders” (Law 1987, p. 112) who manage several design constraints and relate different processes with each other to establish an integral entity. They mix principles, contributions, people and things together (Nickelsen & Binder 2009, p. 168). Objects and issues are produced and exchanged by a large amount of participants (Hirsch & Müller 2005, p. 536). Real world conditions also mean mobilising and developing social instruments (Yaneva 2009, p. 276). The borders and barriers between designers and non-designers, i.e. between experts and laypersons, gradually disappear. If the world itself is transformed into a laboratory by prosuming and co-designing, the paradigm of the design laboratory needs to be put in perspective.

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Olivetti's New Canaan Electronic Laboratory: when design meets computing

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The development of computer technology and its application by architectural research centres is a recent area of study. Initial research focused on the early work in design and computation that took place in university centres, their key figures and the theoretical and practical advances. Within this context, this paper aims to unveil the historical role played by the Olivetti Company and its Electronics Research Laboratory in New Canaan, US in shaping the first fully transistorized computer in the world and also in inaugurating multidisciplinary design research within the field. Founded in 1952, the laboratory worked closely with its main headquarters in Italy, introducing many technological innovations into the design process for new Olivetti electronic products. The paper draws on research conducted at the Olivetti archive, presenting a broader view of Olivetti's contribution to the field of computing and its innovative aesthetics. The work of Dino Olivetti, Ettore Sottsass and Mario Tchou was fundamental to this endeavour, anticipating what would become the concept of personal computing.

olivetti, computing, design, architecture

1 Introduction

The history of computing and its impact on architectural thinking and production is a developing area of study. Research on these themes has grown in recent years, focusing on particular aspects of the intellectual history of architectural computing.

Studies exploring the relevance of the Second World War within this emerging field and the inception of architectural research centres are beginning to be published[1]. These works place particular emphasis on the development of computing in the US and in the UK, but there is still a lack of any broader historical account that includes similar developments in Italy.

[1] See: Author PhD Thesis, Rocha, João, Architectural Theory 1960-1980: Emergence of a Computational Perspective. MIT (2004); Alise Upitis, Nature Normative: The Design Methods Movement, 1944-1967. MIT, PhD Dissertation, (2008); Daniel Cardoso Llach, Builders of the Vision. Software and the imagination of design. Routledge, (2005); Vardouli, Theodora (2012)."Design-for-Empowerment-for-Design: Computational Structures for Design Democratization. M.Sc, MIT.

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This paper attempts to bridge this gap by presenting an interpretation of Adriano Olivetti's decision in the early 1950s to develop a pioneering research agenda for the design, construction and commercialization of the personal computer. This vision also included a unique investment in architecture, product design, advertising and media for an industry which combined extraordinarily high standards of visual communication with a remarkable culture for disseminating developments in computing.

The company *Ing. Camillo Olivetti & C*. was best known for its early success in manufacturing typewriters and was founded in October 1908 in Ivrea, a small city 50 miles north of Turin at the foot of the Valle d´Aosta mountains in Italy, by Camillo Olivetti (1868-1943), an industrial engineer who had studied at the Politecnico di Torino. His son, Adriano Olivetti (1901-1960), was a chemical engineer and industrialist with drive and ambition that would later make him a leading entrepreneur and patron of the arts. When he took over from his father, all Olivetti products were based on mechanical technologies and it was Adriano who gradually started to transform the company into a modern factory. Looking ahead, he predicted that sooner or later mechanical devices would reach their limits and that the future of the company lay in moving into electronics. In order to achieve this goal, by the early 1950s Adriano Olivetti planned to found a small electronics laboratory in New Canaan, Connecticut, in collaboration with another Olivetti research lab located in Pisa. At the end of World War II, Italy was a devastated country with a legacy of twenty years of fascist dictatorship, defeat by the allies and the turmoil of an internal political crisis. Alcide de Gasperi (1881-1954), the first prime minister of the Italian Republic, led the reconstruction of the country using funds from the "Marshall Plan", drawing on the unconditional political and financial support of the United States. The post-war period thus became a fertile time for the reindustrialization of the country and Olivetti soon started to take advantage of this opportunity.

2 Dino Olivetti and New Canaan

Andrea Mantegna (1431-1506), the great Venetian master, painted the *San Bernardino da Siena tra due angeli* around 1460, a portrait of the figure of Saint Bernardino, who is said to have visited Ivrea in 1418 and invited the religious authorities to build a convent there for the Franciscan order. The convent, which was built, became known as the *Convento di San Bernardino* and included a main church, and was decorated with magnificent frescos depicting the life and passion of Christ[2] . It was here that the Olivetti family lived and where the six children of Camillo Olivetti and Luisa Revel were born. Dino Olivetti (1912-1976) (the last of their sons) received a degree in engineering from Milan Polytechnic and spent many years outside Italy, particularly in the US where his work contributed greatly to the success of the Olivetti Company, although even today his efforts are still underestimated.

By the mid-1930s Benito Mussolini was forging his new empire inspired by Hitler's ambitions, but Camillo Olivetti did not share the same ideological convictions. To gain some political distance, Camillo sought to educate his sons abroad where the spirit of modernity could offer them different ideas from those that were threatening the country's freedom. Dino went to Cambridge, US, in the late 30s, after serving in the Italian fascist military campaign in Ethiopia that culminated in the conquest of the city of Addis Ababa in May 1937. From January 1939 to May 1940 he enjoyed the thrilling atmosphere of the Massachusetts Institute of Technology, albeit in a difficult political context due to the onset of WWII. He registered as a student in the Mechanical Engineering

Department and took several courses on diesel engine design given by Prof. J.F. Riley before submitting a dissertation entitled "Performance test on a Sterling Diesel Engine" as a requirement to obtain his Bachelor of Science Degree in General Engineering (1940).[3] During this stay he was involved in several experiments at the Aero Engine Laboratory where he also worked for a brief period of time, focusing on the optimization of diesel engines. Dino´s brother Roberto Olivetti (1928-

[2] Life of Christ, 15th century, cycle of frescoes by Giovanni Martino Spanzotti.

[3] Dissertation co-authored with John Vanderpoel under the supervision of Prof. C. Fayette Taylor.

1985) strongly supported the idea of developing Olivetti's electronics department (Divisione Elettronica Olivetti) and, having completed a degree in economics from the Bocconi University in Milan, went on to do a Business Administration course at Harvard University in 1954. Was this affinity with US academia and mainstream industry merely fortuitous or was it the result of a family empathy with the US scientific milieu? The Olivetti family had certainly had previous contact with the US university and its entrepreneurial and research environment. Camillo Olivetti had visited the US in the fall of 1894 and had worked for a semester as an assistant professor of electrical engineering at Stanford University in California, which was a remarkable venture at that time. Moreover, Adriano made his first trip to the US in August 1925 at the age of twenty-five. This was a six-month journey involving visits to several industries including the Remington, Lincoln and Ford factories, which left profound memories and influences. In one of several letters from the period Adriano said: "I believe we are at a stage in civilization in which progress is developing in a positive, even if asymmetrical, geometric line."[4]

After a period in Brasil coinciding with the eve of World War II, Dino Olivetti divided his time between Massachusetts and Ivrea and in 1950 was appointed President of the Olivetti Corporation of America (OCA), a position that he would hold till the end of 1960. During this period Dino made business trips to survey new market opportunities and was actively involved in recruiting young scientists at MIT, and also in New York and at Columbia University, for Olivetti´s forthcoming New Canaan Electronics Research Laboratory. These activities were realized as a scientific offshoot of Olivetti's headquarters in Ivrea, with the company having established an electronics research laboratory in Pisa in association with the University of Pisa to design and build the *Calcolatrice Elettronica Pisana* (CEP).

Located 25 miles west of Manhattan and southeast of Boston, the city of New Canaan was considered part of Connecticut's Gold Coast and was the place where many of New York's wealthy citizens had decided to settle beginning in the mid-1800s. During the post-war period, the US was fuelled by a new sense of optimism and potential for reawakening. Nowhere was this more in evidence than in New Canaan, with its white picket fences, colonial wooden farmhouses, 19th century churches, conservative politics and Cold War children playing in the gardens. After the war this quiet and beautiful area became a hub for contemporary architecture and prosperous businesses. Probably attracted by the city's new charm, Dino and his wife Posy decided to live there. It was close to New York City, not too distant from Cambridge, where Dino had several acquaintances, and the ideal place to raise a family and establish a truly innovative Electronics Research Laboratory. Moreover, reinterpreting design based on the changing post-war US way of life represented a new attitude and an innovative collective design philosophy. The appointment of Walter Gropius as professor at the Harvard University Graduate School of Design, and the work of modernist architects such as Marcel Breuer, Philip Johnson, Eliot Noyes and John Johansen (known as the Harvard Five) contributed significantly to this, as they began to design houses for their clients and themselves in New Canaan, transforming it into a glamorous and prestigious residential area. In 1950 the Olivetti Corporation of America was founded in New York City, with its headquarters in the heart of the great metropolis, just a few blocks away from Rockefeller Center, and with Dino Olivetti as its president.

The US market was a challenge for Olivetti and now, with the establishment of a branch in New York, it became possible for the company to expand its commercial horizons and invest in new and better production facilities, setting itself apart from its competitors through its commitment to design excellence. Under Dino Olivetti's leadership a major exhibition on the work of the Olivetti Company was organized at the Museum of Modern Art (MOMA) in 1952. *Olivetti: Design in Industry* (Fig.1) was on display from October 22 to November 30, showcasing Olivetti architecture and industrial

[4] "Io credo che siamo a un punto della civiltà in cui il progresso cresce in linea geometrica positive anziché aritmetica" In, Ochetto, Valerio (2013), pp.15.

design products by architects Luigi Figini and Gino Pollini, Ugo Sissa, and Marcello Nizzoli. It was a major success with the American public, proving that an industrial company could also be a market leader in design innovation. Olivetti demonstrated that it was a model of intelligent and imaginative management and a cornerstone of Italy's post-war economic revival. Dino Olivetti was also responsible for opening a showroom in New York´s Fifth Avenue, entrusting the design of the store to the Milanese architectural firm of Banfi, Belgioioso, Peressutti and Rogers (BBPR). Central to its success was its enlightened patronage of contemporary design and art, and the elegance with which this was integrated into its commercial interests. By the mid-1950s Olivetti was a leading brand in the US and their Manhattan office was now located in the recently opened Seagram Building designed by Mies van der Rohe.

It is known that when Thomas J. Watson Jr. was preparing to succeed his father as chief executive of IBM he visited the Fifth Avenue Olivetti showroom and was so impressed that he travelled to Italy to meet Adriano Olivetti to discuss design matters for IBM. The Olivetti machines were sleekly designed in a variety of colours and the architectural space in its showrooms was modern and full of light, almost resembling a stage in a theatre. In contrast, the IBM commercial areas were still very conventional and not as glamorous and the brand communication rivalry between IBM and Olivetti thus had its roots in the New York Olivetti showroom. In order to change IBM's position on design policy, Watson hired Eliot Noyes as the company design consultant, commissioning him to draw up a new corporate design programme for all IBM products. Noyes brought in a wide range of artists, designers and architects, including Charles and Ray Eames, Eero Saarinen, Marcel Breuer and Paul Rand, all working towards a new underlying design philosophy responsible for the design turnover that IBM would soon achieve.

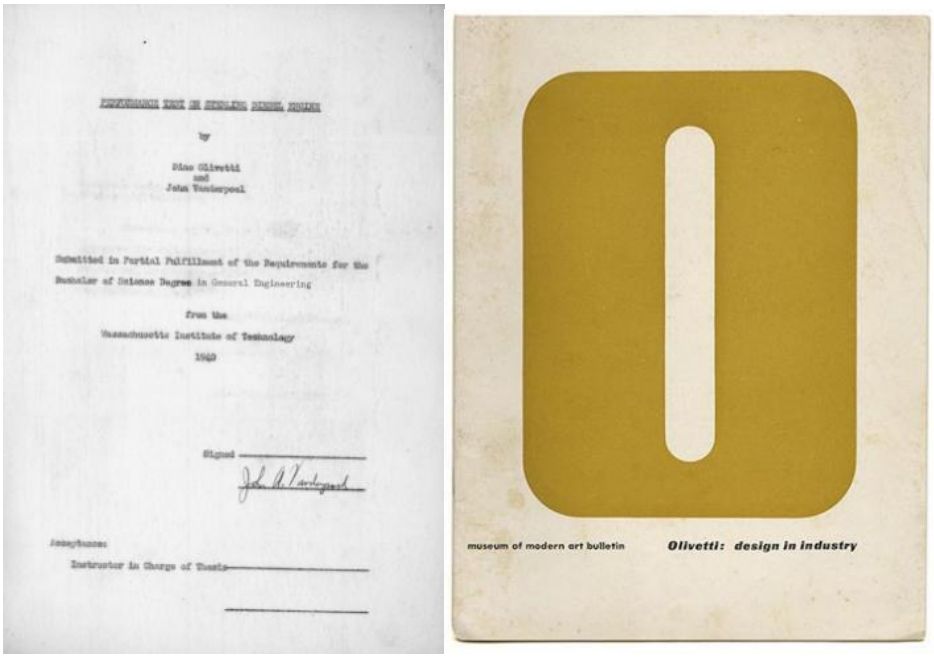


Figure 1. Dino Olivetti's Bachelor's dissertation at MIT, 1940, and front cover of MOMA Catalogue exhibition, Olivetti: Design in Industry, 1952. (Associazioni Archivio Storico Olivetti).

3 Olivetti Mathematics and Computing

In the early 1950s, a group of distinguished Italian mathematicians went on a study trip to the US to visit the main laboratories where computers were being designed and tested. The idea came from Mauro Picone (1885-1977), a notable Italian mathematician who had founded the *Istituto Nazionale per le Applicazioni del Calcolo* (INAC), one of the first institutes dedicated to developing applied research in mathematics, in 1927. The need for sophisticated computing machines for practical applications involving advanced mathematics was initially cited by Picone, inspired by the first reports of the appearance of automatic computers in the US. He subsequently began to envisage the possibility of raising funds and establishing partnerships to design and build an Italian computer, which would require first-hand insights into the emerging field of computing and electronics. Therefore, at the request of Mauro Picone, Gaetano Fichera, (Picone´s student), the mathematicians Bruno de Finetti (a consultant at the INAC), Angelo Guerraggio, Giulio Rodinó and Michele Canepa, an engineer already working for Olivetti, visited some of the most advanced research centres in the field in the US. Throughout the spring of 1950, they also participated in important scientific conferences and seminars that coincided with the International Congress of Mathematics, held at Harvard University and the Massachusetts Institute of Technology[5], where mathematicians from all over the world gathered for their first post-war assembly. The result of this enthusiastic visit was an early contribution to Adriano Olivetti's decision to expand his business into electronics.

Picone, together with Fichera and Guerraggio, left the city of Naples for New York in August 1950, on a ten-day voyage on the *Conte Bicamano* cruise ship.[6] The group visited several institutions on the west and east coasts of the US, but the best contacts were established at the Harvard Computer Lab where Howard Aiken (1900-1973) was involved in building the Navy's Mark I, the first IBM automatic computer —having succeeded in convincing IBM to fund his project. Aiken became responsible for the construction of subsequent automatic and electronic computers that could perform mathematical operations quickly and efficiently. The group spent the summer in the US and attended the Harvard Congress of Mathematics, chaired by John von Neumann. The meeting, which ran for a week, included several thematic sessions, many given by leading scientists whose work became relevant to the field of computing. Claude Shannon and Stanislav Ulam gave a paper entitled "Random processes in physics and communications", John von Neumann and Sydney Goldstein presented "Partial differential equations" and Norbert Wiener discussed aspects of "Statistical Mechanics."[7] Bruno de Finetti and Gaetano Fichera spoke at the congress, an indication of their familiarity with the topics that were addressed.[8] Although advances in large-scale digital calculating machinery were running in parallel in the US and in the UK, an important systematization of technological knowledge had emerged from the first course on the construction of electronic digital computers held at the University of Pennsylvania Moore School of Electrical Engineering, known as the "Moore School Lectures" (July 8 - August 30, 1946) and the joint symposium at the Harvard Computation Laboratory in January 1948, which provided another important forum for discussing problems and approaches to the design, operation, and application of computers (Fig.3). Mario

[5] August 30-September 6, 1950. The American Academy of Arts and Sciences, Boston College, Boston University, The Massachusetts Institute of Technology and Tufts College.

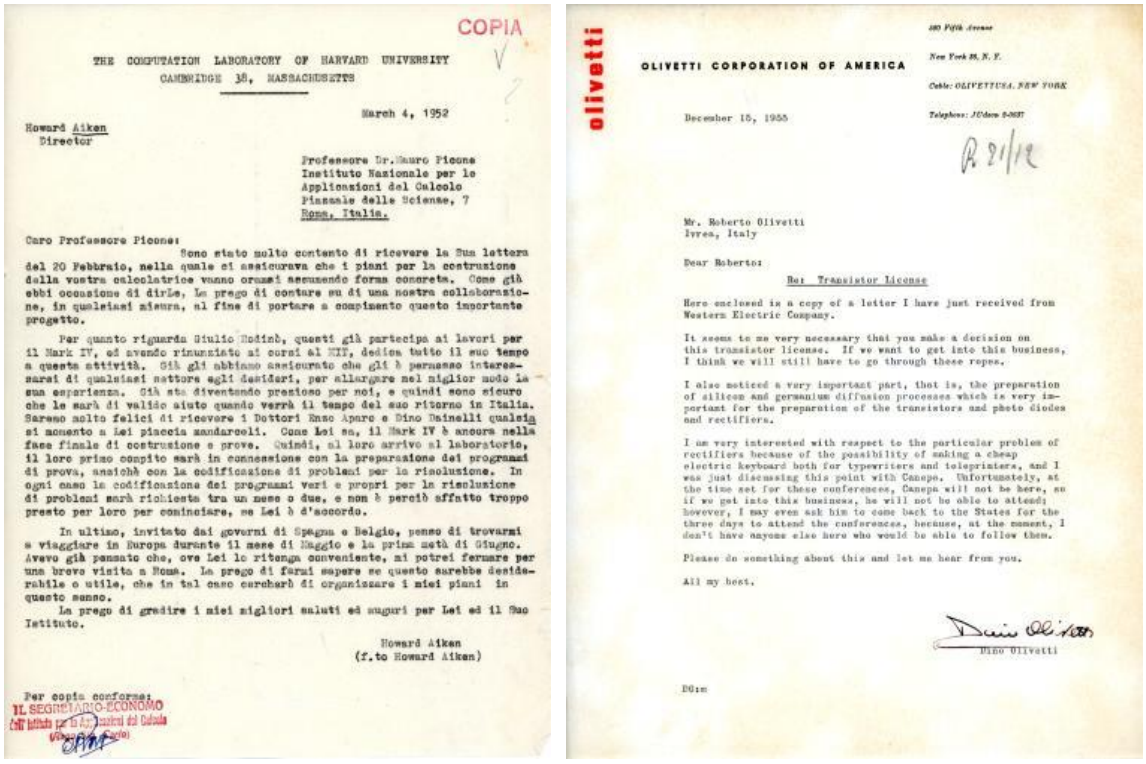
[6] On this subject, see Guerraggio, A.,Mattaliano, M and Nastasi, P.: Alla fine fu FINAC. In, SAPERE, 42-55, Aprile (2005).

[7] The programme also included: Szolem Mandelbrojt, the Rice Institute and College de France, "Théorems d unicite de la théorie des fonctions", Saturday, September 2. Section II Analysis; Norbert Wiener, MIT, "The statistical mechanics in communication", conference in applied Mathematics Statistical Mechanics", Wednesday, September 6; Howard Aiken, Harvard University, "Computing Machines", August 31 evening lecture; Claude Shannon, Bell Telephone Laboratories, "Some topics in information theory", Saturday September 2.

[8] Finetti presented the paper "Lanozioni di beni independenti in basi ai nuovi concetti per la misura della utilità", in Proceedings of the International Congress of Mathematicians, Cambridge MA. published by the American Mathematical Society, 1952.pp: 588-589. Fichera presented a paper entitled "Methods for solving linear functional equations, developed by the Italian Institute for the applications of calculus". The success of this meeting followed the Symposium on Large Scale Digital Calculating Machinery, which took place precisely one year earlier, also at Harvard University, sponsored by the Navy Department Bureau of Ordnance and the Computation Laboratory.

Picone felt that he was in the right place: there was an exciting scientific atmosphere and he was committed to establishing lasting connections that would favour his electronic project with Olivetti in Italy. In fact, the contacts made with Howard Aiken´s Laboratory led to a research visit of eighteen months for Michele Canepa, who received training in circuit and component design for electronic digital computers. In addition, Giulio Rodinò started to collaborate at the Lab. In a letter addressed to Picone dated March 4, 1952, Aiken mentioned the work of the Italian mathematicians in his Lab, stating (Fig.2):

> *as mentioned before, you can count on our full collaboration as a means of advancing your important project (...) Regarding Giulio Rodinò, he is already collaborating on Mark IV and, having given up the MIT courses, is dedicating all his time to this research (...) He has been doing excellent work and I am sure he will be extremely helpful to you when the time comes for him to return to Italy. We will be pleased to receive Enzo Aparo and Dino Dainelli whenever you think it would be convenient* [9]
>
> *(letter from Howard Aiken to Mauro Picone, March 1952. Associazioni Archiviio Storico Olivetti, Torino)*



COPIA

THE COMPUTATION LABORATORY OF HARVARD UNIVERSITY
CAMBRIDGE 38, MASSACHUSETTS

March 4, 1952

Howard Aiken
Director

Professore Dr. Mauro Picone
Instituto Nazionale per le
Applicazioni del Calcolo
Piazzale delle Scienze, 7
Roma, Italia.

Caro Professore Picone:

Sono stato molto contento di ricevere la Sua lettera del 20 Febbraio, nella quale ci assicurava che i piani per la costruzione della vostra calcolatrice vanno ormai assumendo forma concreta. Come già ebbi occasione di dirLe, La prego di contare su di una nostra collaborazione, in qualsiasi misura, al fine di portare a compimento questo importante progetto.

Per quanto riguarda Giulio Rodinò, questi già partecipa ai lavori per il Mark IV, ed avendo rinunziato ai corsi al MIT, dedica tutto il suo tempo a questa attività. Gli abbiamo assicurato che gli è permesso interessarsi di qualsiasi settore egli desideri, per allargare nel miglior modo la sua esperienza. Gli sta diventando prezioso per noi, e quindi sono sicuro che le sarà di valido aiuto quando verrà il tempo del suo ritorno in Italia. Saremo molto felici di ricevere i Dottori Enzo Aparo e Dino Dainelli qualsia si momento a lei piaccia mandarceli. Come Lei sa, il Mark IV è ancora nella fase finale di costruzione e prova. Quindi, al loro arrivo al laboratorio, il loro primo compito sarà in connessione con la preparazione dei programmi di prova, anzichè con la codificazione di problemi per la risoluzione. In ogni caso la codificazione dei programmi veri e propri per la risoluzione di problemi sarà richiesta tra un mese o due, e non è perciò affatto troppo presto per loro per cominciare, se Lei è d'accordo.

In ultimo, invitato dai governi di Spagna e Belgio, penso di trovarmi a viaggiare in Europa durante il mese di Maggio e la prima metà di Giugno. Avevo già pensato che, ove Lei lo ritenga conveniente, mi potrei fermare per una breve visita a Roma. La prego di farmi sapere se questo sarebbe desiderabile o utile, che in tal caso cercherò di organizzare i miei piani in questo senso.

La prego di gradire i miei migliori saluti ed auguri per Lei ed il Suo Istituto.

Howard Aiken
(f.to Howard Aiken)

Per copia conforme:
IL SEGRETARIO-ECONOMO
dell'Istituto per le Applicazioni del Calcolo

olivetti

OLIVETTI CORPORATION OF AMERICA

580 Fifth Avenue
New York 36, N. Y.
Cable: OLIVETTIUSA, NEW YORK
Telephone: JUdson 6-5037

December 15, 1955

R. 21/12

Mr. Roberto Olivetti
Ivrea, Italy

Dear Roberto:

Re: Transistor License

Here enclosed is a copy of a letter I have just received from Western Electric Company.

It seems to me very necessary that you make a decision on this transistor license. If we want to get into this business, I think we will still have to go through these repes.

I also noticed a very important part, that is, the preparation of silicon and germanium diffusion processes which is very important for the preparation of the transistors and photo diodes and rectifiers.

I am very interested with respect to the particular problem of rectifiers because of the possibility of making a cheap electric keyboard both for typewriters and teleprinters, and I was just discussing this point with Canepa. Unfortunately, at the time set for these conferences, Canepa will not be here, so if we get into this business, he will not be able to attend; however, I may even ask him to come back to the States for the three days to attend the conferences, because, at the moment, I don't have anyone else here who would be able to follow them.

Please do something about this and let me hear from you.

All my best.

Dino Olivetti

DO:m

Figure 2. Letter from Howard Aiken to Mario Picone, March 1952 and letter from Dino Olivetti to Roberto Olivetti, regarding the need to acquire a transistor licence. New York, December 15, 1955. (Associazioni Archivio Storico Olivetti).

[9] Translation by the author. Finetti and Rodinò also attend the International Symposium on Automatic Digital Computing in Teddington, London, March 1953. See: Symposium on automatic digital computation (in collaboration with N. Kitz, and G. Rodinò). In: La Ricerca Scientifica, n.7 (1953), 1248-1259.

Figure 3. Cover of the Proceedings of the Harvard Computation Laboratory Symposium, January 1948; letter from Howard Aiken to Mauro Picone, March 1952; front page of the Bruno di Finetti article, "Macchine che pensano". (Harvard Archive and Bruno di Finetti Archive).

In 1949 Finetti travelled to the US to attend the Symposium on Probability at the University of California at Berkeley[10] and the Industrial Computation Seminar, which took place in New York and was sponsored by IBM. The ninety participants discussed fundamental computational methods applicable to a variety of research problems, drawing on the success of the IBM Selective Sequence Electronic Calculator (SSEC), built under the direction of Wallace Eckert, the astronomer and founder of the Thomas J. Watson Astronomical Computing Bureau at Columbia University. The paper presented by Eckert at the seminar, "The Role of the Punched Card in Scientific Computation", caught Finetti´s attention, since he had been working in this field with leading insurance companies. When Finetti's trip was over, he wrote a major review of the state of the art in computing "machines that think and that make you think" [11] (Fig.3) which was the earliest key source of reliable and detailed material ever made available to the Italian scientific community. Initially published by the University of Trieste, Finetti´s article was full of first-hand analysis gathered during his journey, with technical descriptions of the computing machines he had observed and studied and an appendix containing detailed illustrations and photos of the "machine calcolatrici", including SIMON, conceived by Edmund Berkeley (1950), the SSEC (Selective Sequence Electronic Calculator) designed and built by IBM (1947), the UNIVAC, (Universal Automatic Computer) designed by the Eckert-Mauchly Computer Corporation (1951), and the SEAC (Standards Eastern Automatic Computer) built at the National Bureau of Standards, Washington, D.C, (1950). All this insightful information, together with the research internship completed at the Harvard Computation Lab by Picone and Olivetti's mathematicians, strengthened Picone´s faith in founding an electronics venture in Italy.

[10] Finetti presented a paper entitled Recent Suggestions for the Reconciliation of Theories of Probability. Proceedings of the Second Berkeley Symposium on Mathematical Statistics and Probability, 217-225, University of California Press, Berkeley,1951.

[11] "Macchine «che pensano» (e che fanno pensare)", in, Pubblicazioni delle Facoltà di Scienze e di Ingegneria della Università di Trieste. Serie A. Trieste,1952, 40pp.

4 The Electronic Research Laboratory

Despite the success of the Olivetti brand in America, the partnership with Pisa University and with Mauro Picone began to wind down. The lack of financial support from the Italian government meant that the project could not be implemented as initially planned and Olivetti then decided to pursue alone the challenge to construct its first computer machine. In a letter dating from December 1951, Michele Canepa, who was working with Howard Aiken's team, told Picone that he was willing to cooperate, regardless of the decision taken, stating: "i 18 mesi trascorsi negli Stati Uniti d´America con i solo scopo di studiare il problema mi permettono ora di vedere in modo chiaro quale la strada deve essere seguita verso la realizzazione della ricordata Macchina (...) nel frattempo avrò pure interpellato la Direzione di Ivrea circa il detto progetto e potrò quindi riferire sulla possibilità della mia collaborazione".[12] At this point Dino convinced Adriano to open an Electronics Research Laboratory (ERL) in the US so that the expertise gained would not be wasted, but would be an asset if Olivetti moved into the electronics field. The research and decisions taken at the ERL did not always concur with the main assessments made by the company in Ivrea, which sometimes led to difficult relations between the two and is probably the reason why Dino´s leadership is still not fully recognized today.

The primary goal of the Laboratory was to develop R&D and to keep in close contact with the technological advances in electronics and information technology that were being developed in the US. The correspondence exchanged between the Olivetti Corporation of America and the Ivrea headquarters, mainly involving Dino and Adriano, shows the company's lasting interest in participating in the latest developments in the field and also in the viability of incorporating these new technologies into their new electronic products. Their communication focused on issues such as the technology that *Philco* used for its electronic brain machine and matters concerning its design. In one letter Dino writes: "the machine is very neatly designed, very advanced in design especially for production" and in another missive he talks about the importance of using and producing electronic transistors, stating: "I enclose a copy of a letter I have just received from the Western Electric Company. It seems to me very necessary that you make a decision on this transistor licence. If we want to get into this business, I think we will still have to go through these steps."[13] (Fig.2) This is an example of the company´s audacity in developing a small-scale electronic devices industry as quickly as possible so that when Olivetti started to produce its own digital machines it would be able to manufacture the key components itself. Thus it would constitute a true industry, rather than an assembly process, as the vast correspondence from these early days demonstrates. In discussing the various options for the production of transistors, Roberto states:

> *I apologize for a late reply to your letter regarding the transistors but we had the occasion to sign some contacts with the Battelle Institute and, according to Tchou, wondered whether, before acquiring a license, it might be better to carry out a preliminary inquiry and eventually ask at the Battelle if we can do so. This would help with the problem of producing these components.* [14]
>
> *(17th October 1955. Associazioni Archivio Storico Olivetti, Torino)*

Moreover, the OCA also sponsored Italian graduate students at US universities with the subsequent possibility of being hired by the New Canaan Laboratory where, at its peak, almost seventy

[12] Translation by the author: the 18 months spent in the United States of America for the sole purpose of studying the problem now allow me to see clearly where the road must be followed towards the realization of the mentioned machine (...) in the meantime I have also asked the Department of Ivrea about the project and I will report on the possibility of my collaboration. Olivetti Archive.

[13] Letters from Dino Olivetti to Roberto Olivetti, December 1955 and December 1956. Associazione Archivio Storico Olivetti.

[14] Translation by the author.

researchers and staff worked. In another letter dating from this period Dino Olivetti, writing in English to his brother Adriano, says:

> *For the past three or four months, we have sponsored Mr. Gian Carlo Cillario and Mr. Valentino Gradis who originally came here with a F.O.A scholarship, one at Harvard and the other at M.I.T. In these months, they surveyed, some-what, for us the electronics field, especially in banking, and they also slightly surveyed the department store field. The work they have done has been very useful as it gave us a clearer idea of some of the needs and problems existing in the field of electronics.*
>
> *(16th December 1955. Associazioni Archivio Storico Olivetti, Torino)*

The development of electronics at the Olivetti Company emerged within this context and may be divided into four phases covering sixteen years of pure and applied research. The first phase is firmly associated with the foundation of Olivetti Bull Spa under a commercial agreement signed in 1949 with the French company Machines Bull, the main rival of IBM in Europe, for the distribution of mechanographic punchcard equipment in Italy. Olivetti Bull made a fundamental contribution to the understanding of market requirements in terms of information processing, paving the way towards the successful adoption of electronic data processing systems consistent with the Olivetti vision. The second phase encompasses the early years of the 1950s when Dino Olivetti became President of the OCA in New York and was responsible for founding the Olivetti Electronics Research Laboratory[15] in New Canaan, with technical supervision provided by Michele Canepa. The third phase may be defined by the agreement between the University of Pisa and Olivetti for an initial partnership to design and build the "Calcolatore Elettronico Pisano" (CEP). At this stage, Olivetti established the Electronics Laboratory in a nineteenth-century villa in Barbaricina, near Pisa. Mario Tchou, the son of a Chinese diplomat in the Vatican and a professor of Electrical Engineering at Columbia University, was invited to lead Olivetti's scientific participation in in the development of the CEP. Olivetti was introduced to Tchou in New York in the spring of 1954 through Dino Olivetti and, at the age of 31, Mario Tchou became the head of the Olivetti Electronics Division, responsible for planning, designing and constructing the first electronic products for the Ivrea company. In a letter from Roberto Olivetti to his brother Dino in New York, the early launch of the laboratory is described:

> *we have rented a villa in Pisa and we are in the process of refurbishing it and converting it into a new research laboratory. We have contacted a group of young, talented Italian engineers who seemed extremely skilled and intelligent. This group will also be joined by a scientist from Ferranti (a British engineer who designed the speed memory with magnetic nucleus for the last Ferranti computer). The Bull Company has sent us the engineer Sarti, who will collaborate with Tchou and with another group in Pisa on the specifications and machine implementations.* [16]
>
> *(17th October 1955. Associazioni Archivio Storico Olivetti, Torino)*

These endeavours led to the fourth phase, with the birth of the "Elaboratore Elettronico Automatico" (ELEA) project in 1959. The acronym referred to the ancient city of Elea, famous as the home of the philosophers Parmenides and Zeno, who were considered the founders of rationalism in philosophy. The ELEA computer series constituted a major technological and commercial breakthrough. It was the first fully transistorized computer, whose mainframe and console design was entrusted to the architect Ettore Sottsass (1917-2007), hired by Adriano Olivetti in 1957 as a design consultant for electronic devices.

[15] Centro di Ricerche Elettroniche.
[16] Translation by the author.

5 When Design Meets Computing

Designing all the electronic apparatuses and mechanical connections for a new calculating machine represented one of the most challenging and unusual areas for the designer. It was not a matter of giving form and meaning to an external corpus of a machine but, more importantly, of organizing several isolated building blocks that had to communicate in a number of ways. The full development of the computer series ELEA 9003 (and P101) and the relocation of the Electronics Division to Borgolombardo on the outskirts of Milan was an extremely exciting period for the Olivetti Company. The participation of the architects Mario Bellini, Ettore Sottsass and Tomas Maldonado and their involvement in the full design process was fundamental to the innovative design praxis. Sottsass, aware of the anxiety-inducing image of a new computing era, gave the apparatus a colourful visual interface. How would one design and give visible form to objects and buildings in a fully industrialized world dominated by the new media? The influence of the Ulm Hochschule für Gestaltung, HfG, had an enormous impact on design thinking in the late 50s, when the role of the designer emerged as a coordinator of various disciplines. Not surprisingly, the work that Tomas Maldonado developed at the HfG was crucial and very attractive for the new electronic project at Olivetti where, together with Sottsass, Maldonado created a new sign system for the computer console interface.

Concerning the pioneering design concept for the ELEA 9003, Sottsass mentions:

> *regarding the formal solutions for the Olivetti electronic computers, the accepted principle was that from now on computers, as machines, are becoming closer every day to the public. Not only are they exposed to an audience of technicians but also to a heterogeneous public where the computer will become increasingly familiar to all citizens*
>
> *(Sottsass, E. (1960). Forme nuove per i calcolatori elettronici. Notizie Olivetti, 68, 27-29)*

For Olivetti, the computer should not remain an anonymous, expressionless object, but should display individual characteristics and relate to the needs of contemporary society. Mario Tchou, embracing this spirit, assigned different tasks to every member of the team. The first ELEA prototype initially ran with vacuum tubes, but this was soon replaced by a fully transistorized architecture, an absolutely necessary and quite demanding requirement, which the Electronics division quickly provided. This new technology had been in vogue since William Schockley (a former PhD student from MIT), John Bardeen and Walter Brattain, were awarded the Nobel Prize in Physics for their research on semiconductors and their discovery of the transistor effect. In the autumn of 1959 the Olivetti production line at Borgolombardo was able to deliver the ELEA 9002 and 9003 series, one of the earliest – possibly the first – solid-state commercially available computers in the world.

The ELEA 9003 (Fig.4, 5), was a magnificent machine featuring a different concept: it was constructed on a human scale, with cables running above, not under, the ground, and as a modular system with a console keyboard designed according to the latest semiotic theories, for which Ettore Sottsass was awarded the Compasso D'Oro (Fig.5). Olivetti promoted the new products' well-crafted design, with each model specifically created for an individual customer, as the brochure for one of its first buyers, the Monte dei Paschi bank in Siena, clearly illustrates (Fig.5). Excellence in graphic design, advertising in the press and a documentary film with original music by Luciano Berio, constituted the marketing strategy for how design and technology should represent Olivetti's new philosophy of electronics.

A few days before the official presentation of the ELEA 9003 to the President of the Italian Republic, Giovanni Gronchi, at the Olivetti headquarters in Milan, Adriano Olivetti delivered a very relevant and visionary speech at the public exhibition at the Fiera Campionara di Milan in November 1959, in whch he stated:[17]

[17] Translation by the author.

Electronics not only permitted the scientific use of atomic energy and the beginning of the space age but also, with the conception and construction of new complexes and precise automated machines, is leading man towards a new freedom and unseen explorations (Il mondo che nasce, Edizioni di Comunità, Roma-Ivrea 2013. pp.122-123)

During the early sixties, the Olivetti ELEA series represented almost thirty percent of the Italian share market, a result that may have been satisfying, given the lack of financial support from the Italian government for such a robust, pioneering project. The ongoing need for solid-state components gave Olivetti the opportunity to set up autonomous production in Italy, a venture that had been envisaged since the early days of the New Canaan Laboratory. Mario Tchou and Roberto Olivetti convinced Olivetti to grasp the opportunity and the Societa Generale Semiconduttori was then established in association with Telettra. One of the assistant engineers involved in this ambitious project was the young Federico Faggin,[18] who had taken a job there to learn about transistors and logic circuits and was working with Tchou on germanium transistors, which served as a model for what would eventually become the Olivetti Programma 101. However, Olivetti was not able to build on the success of these extraordinary technological endeavours and vision, because his audacious plan for the company to buy the American Underwood factory did not bring immediate profits as expected. The Olivetti Corporation of America soon changed the brand name to Olivetti Underwood, the new administrative boards dismissed the electronics division and Olivetti was acquired by General Electric (OGE), which held 75% of the company´s capital.

Figure 4. Interior view of ELEA 9003 modular computer system at Borgolombardo, Milan and ELEA 9003 advertising brochure for the Monte dei Paschi Bank. (Associazioni Archivio Storico Olivetti).

[18] Faggin worked with the Fairchild Company in partnership with Olivetti, moving later to Intel where he worked in the design team for the Intel 4004 microprocessor, the first commercially available microprocessor.

Figure 5. Cover of the 1959 Compasso D´Oro brochure; ELEA 9002 and 9003 at Borgolombardo, Milan. (Época 25 Ottobre 1959. Foto Federico Patellani - Associazioni Archivio Storico Olivetti).

Nevertheless, in the midst of this political turmoil Olivetti would soon release a far more accessible machine, thanks to research carried out in the meantime by a few members of the Olivetti Electronics Division. Pier Giorgio Perotto, an engineer who had been in Mario Tchou´s team since 1957, Giovanni de Sandre and Gastone Garziera, together with Roberto Olivetti, worked on developing a small, programmable "desktop computer." Designed long before the spread of the integrated circuit, the Programma 101, as it was called, was built entirely from discrete components such as transistors, diodes, resistors and capacitors and an innovative memory drum. The designer was Mario Bellini, a young architect from the Sottsass team, who soon became a leading industrial designer in the years which followed. A prototype of the Olivetti P101 was presented at the New York World Fair in October 1965 (Fig.6) and proved astonishingly successful, rivalling the IBM electronic products on display in the ovoid company pavilion designed by Eero Saarinen, and Charles

and Ray Eames. It was the first time it was unveiled to the general public and soon several research projects worldwide requested the P101 computer, including NASA, which acquired sixty machines for the calculations for the 1969 Apollo 11 moon landing, and Jacques Cousteau's Oceanographic Institute at Marseille, which used the P101 for its ocean research programme (Fig.6). In an era when people largely regarded computers with suspicion, the P101 had an impact few could have anticipated.

Considered the first "personal computer", the P101 became a major commercial success, with sales over the years totalling 44,000 units shipped worldwide under the name of the Olivetti-Underwood brand (Fig.7). Early on, Olivetti had foreseen the difference, in terms of design and function, between a scientific machine and an industrial one. The main innovative concept was to envisage this electronic instrument as an industrial possibility: it had to meet specific needs for mass production as well as offer easy maintenance, ergonomics and excellence in design and aesthetics. The New Canaan Laboratory was, from the outset, a research facility whose main goal was to survey developments in the field of electronics in the US and engage in technology transfer with the Olivetti Company in Italy. The financial turnover from this activity began to emerge with the sales of the P101 computer but the new administration did not want to continue with the laboratory. The New Canaan Lab only appeared to be a source of expenditure and it was closed in 1961. However, even in the last months of 1959 the will to continue with the Lab was uncertain, as can be seen in the correspondence between Adriano Olivetti and Michele Canepa (Fig. 7). Adriano wrote:

> *The uncertainties that have arisen regarding the New Canaan laboratory in the last few months and that still prevail after the initial agreement with Underwood, even if in other terms, force me in writing to you to deliver my opinion on the lab operations that I can observe and acknowledge. (17th October 1955. Associazioni Archivio Storico Olivetti, Torino)*

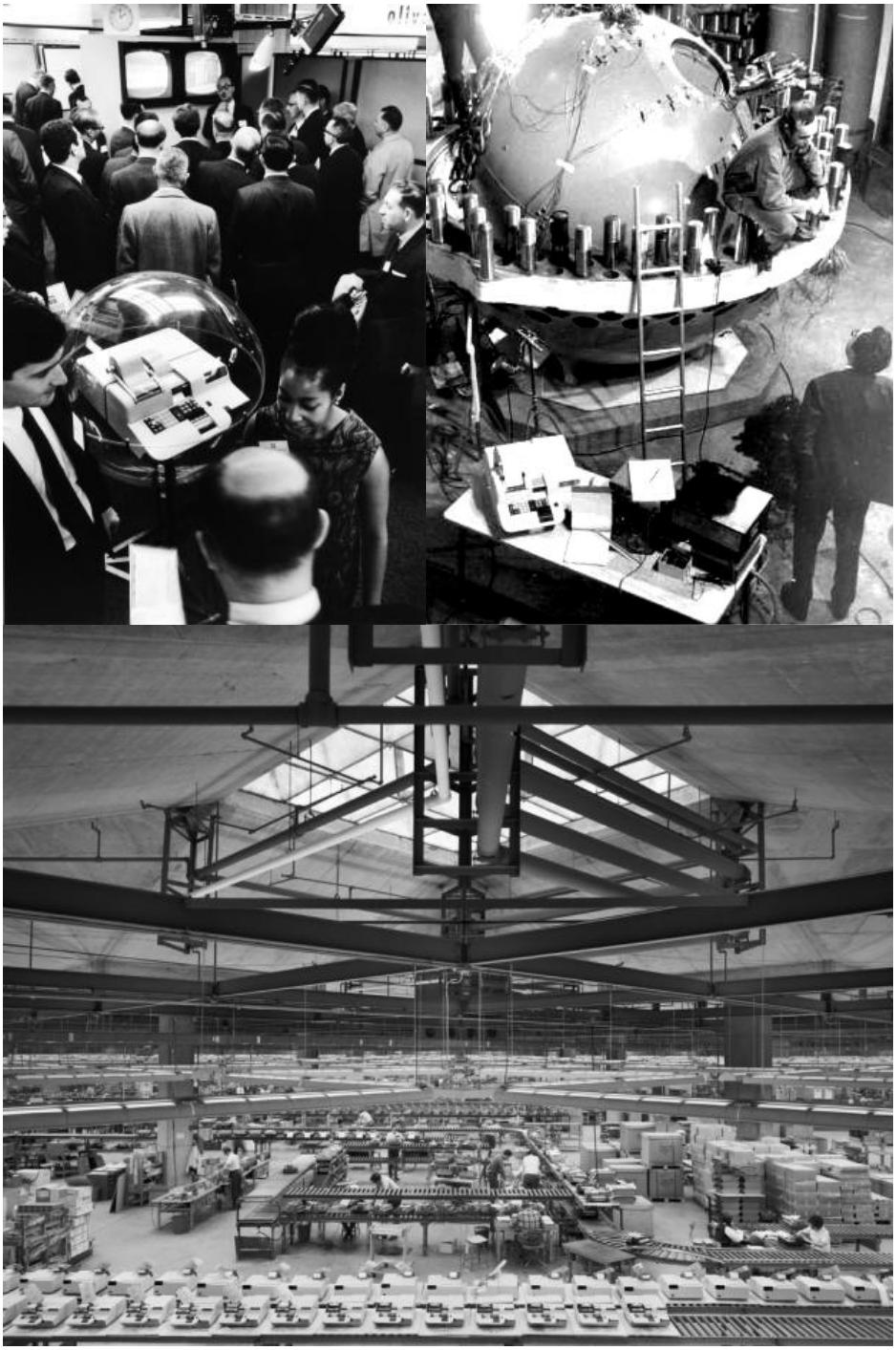
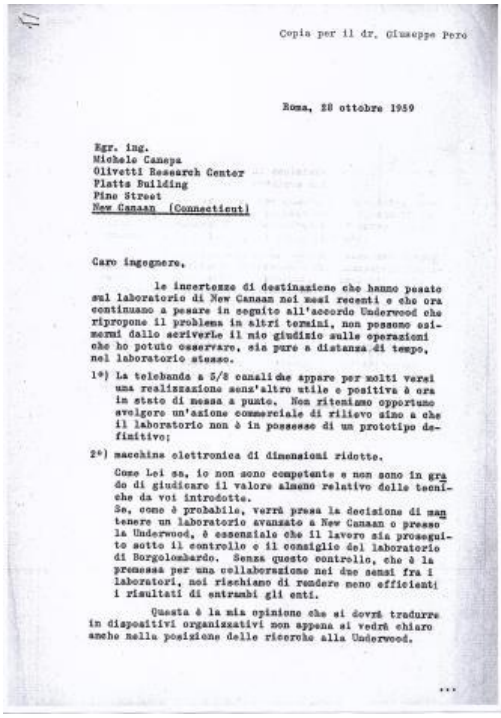


Figure 6. The P101 Computer being presented at the New York Fair in 1965 and in use at Jacques Cousteau's Marseille Oceanic Research Center. P101 in production at the Olivetti-Underwood factory in the US, designed by Louis Khan. (Associazioni Archivio Storico Olivetti).

It appears that Adriano's wish was overruled by the Olivetti administration, where his influence was beginning to decline. The decision to close the lab prevailed and Dino returned to Italy in 1961. An Initial Report on the laboratory facilities and completed projects was started in November 1959, listing 49 effective staff members at the time, and the laboratory was finally sold in during the first months of 1960 (Fig. 8). This unforeseen path became apparent after the tragic loss of Adriano in February 1960 and, just nine months later, of Mario Tchou, who died at the age of thirty-seven in a strange car accident on the road from Ivrea to Milan.



Copia per il dr. Giuseppe Pero

Roma, 28 ottobre 1959

Egr. ing.
Michele Canepa
Olivetti Research Center
Platts Building
Pine Street
New Canaan (Connecticut)

Caro ingegnere,

le incertezze di destinazione che hanno pesato sul laboratorio di New Canaan nei mesi recenti e che ora continuano a pesare in seguito all'accordo Underwood che ripropone il problema in altri termini, non possono esimermi dallo scriverle il mio giudizio sulle operazioni che ho potuto osservare, sia pure a distanza di tempo, nel laboratorio stesso.

1°) La telebanda a 5/8 canali che appare per molti versi una realizzazione senz'altro utile e positiva è ora in stato di messa a punto. Non riteniamo opportuno svolgere un'azione commerciale di rilievo sino a che il laboratorio non è in possesso di un prototipo definitivo;

2°) macchina elettronica di dimensioni ridotte.

Come Lei sa, io non sono competente e non sono in grado di giudicare il valore almeno relativo delle tecniche da voi introdotte.
Se, come è probabile, verrà presa la decisione di mantenere un laboratorio avanzato a New Canaan o presso la Underwood, è essenziale che il lavoro sia proseguito sotto il controllo e il consiglio del laboratorio di Borgolombardo. Senza questo controllo, che è la premessa per una collaborazione nei due sensi fra i laboratori, noi rischiamo di rendere meno efficienti i risultati di entrambi gli enti.

Questa è la mia opinione che si dovrà tradurre in dispositivi organizzativi non appena si vedrà chiaro anche nella posizione delle ricerche alla Underwood.

...

Figure 7. Letter from Adriano Olivetti to Michele Canepa, October 1959 and brief report on the Laboratorio di New Canaan, November 1959. (Associazioni Archivio Storico Olivetti).

Computerization, as a process that increasingly characterizes societies, is also a benchmark of technological supremacy. Olivetti's countless technological achievements in the field of computing were conducted with a fierce passion and firm belief that electronics would be the leading industry of the future and that high standards of design were essential to success at all levels of the production chain. Between 1959 and 1966 Olivetti developed a different range of products and projects, working with architects such as Marcello Nizzoli, Ettore Sottsass, Mario Belinni, Giovanni Pitori, Le Corbusier, Louis Khan and, earlier, with the Ernesto Rogers firm, creating an exciting new culture of design excellence and significantly influencing design in the computing field. Moreover, the P101 computer remained in production at the Olivetti-Underwood factory in Pennsylvania until late 1971, just five years before the appearance of Apple I. The design and technology idea associated with the concept of the "personal computer" benefited greatly from the various patents and design thinking that Olivetti, Mario Tchou and their Electronics Division pursued so persistently during their lifetime. No other corporation acted so early or from such an integrated perspective, and its products established an inspirational and technological form that would last for years to come.

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Data Streams, Data Seams: Toward a seamful representation of data interoperability

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Data archive and database design have typically fallen under the purview of data workers who seek to create a seamless vision of data integration. Following the technical practices of data work, this research seeks to provide theoretical scaffolding to inform the design of data archives and interfaces that treat the history of datasets as seamful, that is, as selectively revealing the heterogeneous transformations that data undergo from their generation to the present. Drawing on ethnographic and historical investigations of data interoperation efforts in the State of Alaska's Salmon and People (SASAP) project, we retell a series of debated and negotiated alterations of datasets. From these vignettes, we extract a common set of transformations that data undergo, which we call data genealogies. Usually, following closure of negotiations, datasets reveal little to nothing of the debates that went into them; however, our approach will seek to keep present these narratives of data transformation.

data; seamful design; ethnography; salmon

1 Introduction

Our research team joins a group of scientists discussing measurements of the length of salmon in the Goodnews River of Alaska. They are assessing why their dataset seems to suggest that a handful of salmon were unusually smaller in 1994 than all other years. Through a process of data discovery – i.e., visualizing the data in Shiny Apps, a tool used to visualize data in R – a data science postdoc is able to identify the anomaly, and through consultation with a salmon biologist conclude that it is due to a measurement error: for a short window of time, the length of fish was recorded in centimetres rather than millimetres or included measurements of juvenile salmon rather than adult salmon. In this instance, the team decided to flag those data, marking them as unreliable or potentially erroneous. Through flagging, no data are removed from the file, rather they are marked with this form of cautionary metadata.

Mundane stories of this kind are ever present in the histories of virtually all data. Datasets accrue many such transformations over time. As David Ribes writes "data are always already interoperated"

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(Ribes, 2017): the activities of data production are attuned to generating comparable, reliable data in many ways, i.e., instruments that lead to data are calibrated and recalibrated, data are carefully cleaned, outliers are thrown out, schemas are restructured. This is later followed by further transformations, such as data modeling, changing formats or media across years, and integration with newer and older datasets. In short, as Lisa Gitelman put it, "raw data is an oxymoron" (2013): the little entities we call data are always the product of heterogeneous transformations, from their generation and thereafter throughout their complex genealogies. Subsequently, these transformations are rendered relatively opaque leaving only seamless datasets, occasionally captured in esoteric metadata (Ribes, 2017).

This paper presents the initial work to develop a *seamful* approach to data archiving, that is, we seek to explore inventive ways of exposing the deliberations and decision-making around data by sustaining their historicity and illuminating the challenges of stitching together once incompatible datasets. To do so, we draw inspiration from discussions about the concept of seamfulness (Chalmers et al., 2003) and connect this to the literature on infrastructural studies of knowledge production (Edwards et al., 2013).

Seamfulness is a nascent design tradition in Ubiquitous Computing offering an approach that does not design technological artifacts to "fade into a neutral background, but to engage us in an exuberant foreground" (Kuniavsky, 2010). Foregrounding the interests of the user, seamful design values the agency of users to own part of the process by being presented with opportunities to see and engage deep functionalities or provide behind the scenes look at the system. To inform the creation of a seamful data representation, we illustrate data transformations via three cases of alterations to a single Alaskan Salmon data repository, and we use these cases to explore seamful designs of data archives. Our research addresses the challenges of transforming knowledge about data practices into design activities as we seek to scaffold a framework for engaging salmon scientists, data scientists, and data producers.

Ultimately, this research seeks to inform the design of a data archive or data portal that will support temporal and historical perspectives, taking the integration of data as its point of departure. Rather than presenting the appearance of seamlessness, i.e., concealing the negotiations and historical obstacles that went into producing an interoperated dataset, this paper seeks to document those negotiations to give more context to data as well as the work implicit in data interoperation.

1.1 Seamfulness, Data, Infrastructure and Design

Seamfulness is a conceptual response to the lionized virtue of seamlessness in the design of computational artifacts. Seamlessness, broadly, refers to the design of clean interfaces that make a user's work faster or easier, hiding complexity and rendering invisible the detailed technical workings of system, software, or interoperability. Long a computational design virtue, seamlessness was particularly emphasized in early studies of Ubiquitous Computing, or as Mark Weiser (1994b) characterized seamlessness, nonintrusive and largely invisible to the user. Weiser himself prefigured the critique of seamlessness, suggesting that an approach toward seamful systems might shift away from making things the same, seamless product, and instead, focusing on systems with "beautiful seams". Taking up Weiser's call for seamful design, Chalmers and MacColl (2003) note that "making everything the same is easy; letting everything be itself, with other things, is hard" (p. 2).

As a designerly response to the overreach of seamlessness, seamfulness calls for strategically providing more handholds, selectively revealing complexities, and creating opportunities for downstream choices, configurations, and representational styles (Weiser 1994a; Chalmers et al. 2003). In short, seamfulness seeks to foster additional agencies and competencies in the user by generating openings to engage with technical complexities rather than delegating (and thereafter concealing) choices to the initial designer and consequent computational artifact. Sengers and Gaver (2006) characterize seamfulness as a design strategy for representing the "limitations and uncertainties in data, allowing users to make up their own minds about to how interpret it" (p.104).

In our view, however, seamlessness and seamfulness are not opposites, rather they are useful complements. Drawing from studies of information infrastructure (Bowker and Star, 1999; Edwards, 2010; Ribes and Lee, 2010; Millerand et al., 2012; Vertesi, 2014), we note infrastructure does not reveal all its internal operations, nor does it grant its users full agency. As Star and Ruhleder (1996) have asserted, well-functioning infrastructure tends to fade into a background, embedded in routines and everyday practices. But in moments of breakdown, debate, deliberations, or evaluations such operations may be resurfaced in what Geoffrey Bowker (1994) has called infrastructural inversion.

Data and its attendant systematic structures are infrastructural to a wide array of activities. Data are a resource that may be reused or repurposed outside of the context of their original collection. Similarly, infrastructures can be repurposed by different communities or individuals and at different moments in time. But such data repurposing presents many challenges: how can data collected by someone else, at some other time, be trusted? How can the technical limitations of data be communicated to others downstream? And how can the downstream effects of these errors or limitations be accounted for in practice?

Such questions are examples of precisely the efforts concerned with metadata. Metadata is a requirement in a litany of work done to data to ensure it is reproducible, interoperable, and commensurable. Research on why data is likely to be reused (Faniel & Jacobsen, 2010; Karasti & Baker, 2008) or shared (Borgman, 2012; Wallis et al., 2013) illustrates the complex technical and political arrangements that lead to data reuse (Edwards et al. 2011). Moreover, there is a temporal aspect to data: to the sustaining, transforming, and fitting data to current uses. While data are clearly situated in time, they are also situated in place (Loukissas, 2016). Data artifacts (Loukissas, 2016) register "not only local changes in technology, personnel, and organization but also broader cultural rhythms and events" (p. 18). As such, data do not stitch together seamlessly on their own, but are made amenable to stitching by human and technological actors working together. Depending on the regimes of maintenance and care (Jackson & Kang, 2014; Jackson, 2014), some of these transformations are well documented (i.e., as metadata), while others disappear from the record altogether.

However, metadata annotation offers no panacea to understanding data. Even data transformations annotated with metadata present a challenge for downstream users: they can be technical, esoteric, or captured in vastly specialized fields that require prior knowledge of the data before implementing it (Millerand & Bowker, 2009; Mayernik et al., 2011). Furthermore, often metadata is not provided with the data requests or it has been added post-hoc to data collection. Here is where we see the role for a seamful representation of data transformations, one that offers handholds for users to dig into the, often vast, morass of histories and technical documentation and metadata. Our investigations below, then, seek to inform a seamful response to the complexities of data and metadata.

2 Methods and Case

Our broader research focuses on the State of Alaska's Salmon and People (SASAP) project, which aims to generate new knowledge necessary for improving management practices. To understand Alaskan salmon and people, SASAP has targeted the acquisition, annotation, and interoperation of datasets currently held by multiple state and national agencies, companies, and scientific organizations. These data were created in the past across shifting measurement requirements, technological eras, and political regimes. For SASAP members, the heterogeneity of these data contributes to potential for limitations in temporal and spatial coverage of data, and by observing their work we have sought to characterize the challenges of working with such data, and to develop approaches to seamfully representing these.

Drawing from primary archival sources and ethnographic fieldwork, our work identifies the ways that salmon have been instrumented and how sociotechnical eras of inquiry have shaped the design

of such instrumentation. The study of scientific data work entails a great deal of complexity given the varied technological eras in which data are created, the infrastructural aspects that support or constrain data collection, archiving, and sharing, and the practical dynamics of working with data. As such, this work employs a grounded theory approach (Charmaz 2014; Glaser and Straus 1967), which formulates themes inductively based on the empirical findings. This method allows the researcher to engage in simultaneous collection and analyses of data, constantly refining and building upon the findings. Kathy Charmaz's (2014) explains that any study is an interpretive portrayal rather than a direct explication of the studied world.

The first author engaged in fieldwork between August 2016 and 2018 that resulted in over 100 hours of observations. She attended working group meetings at the synthesis center in Santa Barbara, California, and observed conference rooms in Anchorage, Alaska. Respondents allowed her to follow their activities through many email listservs, shared cloud-based docs, and GitHub, a software versioning platform. The primary data source we analysed was the commit, issue, and comment logs from the GitHub repository. To acquire this data, we used the GitHub API along with a Python script to pull and analyse 691 comments, 1004 commits, and 185 issues. Through exploratory analyses, we were able to identify the areas that drew the most attention from the data scientists. Through in vivo coding and memo-writing, we distilled high level categories of data transformation over time.

Fieldwork also included participatory ethnographic research, working as a field technician with the University of Washington's Alaskan Salmon Program, which houses and curates one of the largest collections of historical data about Alaskan salmon dating back to 1946. By "following" (Latour 1987) scientists in their everyday work of collecting data about the salmon, we traced the practices of how salmon are translated into a number and entered into a spreadsheet for downstream analysis and management. Eventually, we hope to study the downstream uses of this data synthesis effort and look into how historical data translations and preservation are integrated into forecasts for the future. However, the vignettes we will present in this paper is a small portion of this study, taken primarily from communication over email, Google Docs, and GitHub around late 2016 through 2018.

Ultimately, this ethnographic work was conducted to scaffold designs for crafting seamful data representations. Drawing from Ehn and Kyng (1991), we take the use of mockups as tools for engaging with stakeholders rather than final prototypes. By starting with the anomalies in the data, this work provides a representation of the data work and should provide insight into how to move forward with data collection standards. As such, our analysis is centered around the technical practices of data scientists. Our investigation is inspired by what Daniela Rosner has called "design as inquiry" (Rosner, 2015): the researcher can "use novel constraints and possibilities as interjections in the current lived experience" of the research subjects. By acknowledging the many ways that knowledge is produced and the ways that different actors shape data, this work documents those novel constraints. As such, this work should be read as the preliminary research in conducting design workshops, providing theoretical scaffolding for thinking through data integration projects. In particular, we develop taxonomies of designing data interfaces, leaving the discussion of visualization tools to future research.

3 Three Vignettes of Data Interoperation

Below we highlight three examples of data disruptions when synthesizing long-term, disparate data. As Ribes and Jackson (2013) argue, "long-term, comparable, and interoperable become a sort of actor, shaping and reshaping the social words around them" (148). To illustrate the ways that these terms act upon archival practices, we will account for three cases in which disruption at the seams (of interoperation, commensuration, and integration) caused further exploration and data cleaning.

All three vignettes focus on scientists' activities with salmon "age, sex, length" data (ASL). We selected these vignettes because they were well documented, and thus highly traceable, i.e, out of the 185 issues created on GitHub about the salmon data integration, the "ASL Data" topic was among the top 6 issues discussed. Furthermore, these vignettes illustrate the varied configurations

of achieving data synthesis within a single dataset, and the ways in which this work creates new avenues for exploration. By highlighting the myriad ways that errors and data gaps are reconciled, this research illuminates several examples of 'small' data transformations, which lead to what we describe as *data genealogies* in the next section.

3.1 Measurement Errors, or when fish anomalies become data anomalies

For our first case, we return to the event introduced above, a moment in which breakdown of data integration leads to further exploration of data provenance. In this case, a data scientist discovers some data anomalies about the size of salmon in the Goodnews River in 1994. Data cleaning is often the precursor to interoperation, and in this instance, presented an opportunity for scientists to further negotiate about how to cleanly use this data. In consultation with a fisheries biologist, the data scientist comes to the conclusion that the error is due to a documentation or sampling error, thereafter flagging those data as potentially erroneous to downstream users.

Temporal uncertainty is one of their primary concerns in this case, that is, both the uncertainty of representation of data from the past and the uncertainty of data that will become useful to future users. In other words, these scientists display a sensitivity to the many ways data have been misunderstood in the past and could be misunderstood in its further uses. Or, in what Ribes and Finholt (2009) have called the 'long now', concerns for potential futures are often considered in daily work.

When the data scientist discovers what seems to be some extraordinarily small fish in the data, they open up a discussion with the biologists in the group. It is clear that when data do not cleanly interoperate, an opportunity for negotiation follows and often new seams are added to stitch together once incompatible datasets. In the future, when someone wants to use the data, they would enter code in R that says [a$Flag <- NA] to denote that the flag column should be empty—or rather, that there is nothing erroneous to flag. According to the data team, these data sets are still preserved in their original form; however, columns for flagging or transforming data have been added. This takes data cleaning downstream to the original data collection and documentation phase, which tend to simply remove data at the site of collection, to provisioning some agency to the user in allowing for decision-making with respect to how to manage and use these erroneous or unreliable data. As the data scientists remarked, our current knowledge may tell us a large or small fish is absurd, but more information in the future could prove us wrong. These sensitivities to future usage of data and potential misunderstandings currently are integrated into their treatment of the data.

As with the cases that follow, moments of breakdown become a central feature. At each juncture in the data journey, an error, or moment of technical breakdown (Star 1999), signifies a break in content, form, and social-organizational structures, leading to further exploration and documentation of these data genealogies. While the primary focus on the data moves back in time to document the histories that produced such data, the uncertainties about what the future holds leads much of the actions taken on data.

3.2 Data Translation/Commensuration Errors, or when standards change

All data interoperation offers a benefit and exacts a cost. A benefit may be working with more, now integrated, data. A cost may be some compromise in accuracy or granularity in how data are brought together. In the case below, the actors weighed the options and decided against data commensuration because the loss in accuracy was considered too great a cost to merit wholly integrating the data. While the issue may be caused by a change in data collection standards or inconsistent usage of standards, the primary data integration concern is whether or not to apply conversion algorithms.

To account for and reconstruct the "Salmon run"—which is the number of fish that return from the ocean to their spawning grounds every year—the Alaska Department of Fish and Game (ADF&G) monitors the number, size, and ages of returning fish, collecting ASL data by brood year. There are,

however, eight competing standards available for determining fish length. The most common standard is the mid-eye-to-fork (MEF) measurement. The routine MEF measurement goes to the nearest millimeter with a measuring tape, or with a manual, or electronic measuring board (Lewis et al. 2015). However, the National Oceanic and Atmospheric Administration (NOAA) tends to use snout to fork measurements, primarily because they often deal with fish in the marine environment, as opposed to freshwater where kypes (jaws) of salmon have yet to develop. However, once salmon have spawned, their tails are too frayed to measure MEF (because they flick their tails back and forth when spawning). As such, in many carcass surveys, the mid-eye to hypural plate (MEHP) is preferable.

Table 1 shows the variety of measurement standards that can be used, and the number of actual cases, from the data collected by NCEAS, that used that standard.

Table 1 Length Measurement Types (LMTs) and number of measurements from the NCEAS GitHub comments

Length Measurement Type	n
Mid-eye to fork of tail	9858923
NA	2243795
Tip of snout to fork of tail	225505
Post orbit to hypural plate	43154
mid-eye to hypural plate	32330
Cleithral arch to fork	16532
Post orbit to fork of tail	4953
Tip of snout to tip of tail	1568

While the data team developed algorithms for transforming all measurements to the MEF standard, that algorithm carries the risk of creating more error in its transformation. The problem with the conversion is the use of a linear model. The model has a confidence interval to determine confidence in the estimation; however, every time that a transformation occurs, the confidence interval increases. This is in part due to the error implicit in observation data that is being transformed; however, there is also error in the data used for the transformation as well as in the model itself. The subsequent increase in confidence interval muddles confidence in the estimation it produces. In short, while integrating salmon length across these standards enables working with more data, it comes at the cost of multiplying the unreliability of those data.

As table 1 shows, the vast majority of measurements are taken mid-eye-to-fork (MEF). More precisely, of the 9 million rows of data, only 20-30 thousand rows are taken using other measurements, a tiny percentage of the entire dataset. And so, the team ultimately decided that transforming the data would create more uncertainty in the data than was worth the benefit of having a marginally larger number of data points. Given these concerns, the group concludes that having standards the same across sites is not as important as having consistency within a site through time. Due to the uncertainty implicit in both the data collection as well as algorithms for data transformation, the data are *flagged* as problematic.

As with the previous case, this vignette illustrates erasures and additions in that data that was once collected is no longer useful given the small percentage of the whole dataset it represents. This case also touches on classification processes and standards as well as equivalencies and translations exploring when and how data have been combined with other datasets or when data has been converted from one measure to another. Before a standard is set in place, there are many negotiations that take place in the classification process. As Star and Bowker (1999) have shown, each category “valorizes some point of view and silences another.” This case illustrates not only the downstream impact of changes in standards through time, but also, the hesitation by data workers to transform or remove data in their ultimate decision to flag data as unreliable. Partly what is then archived is the concern with temporal certainty rather than standardization across spatial variation.

3.3 Representation errors, or when fish are too young or too old

Through data discovery, identification of erroneous data, flagging in R, and adding metadata to explain the flags, a similar story around age data occurred. At each instance of breakdown in the data, an error leads to a deeper story about how the data was acquired, shaped, and integrated with other data. This case illustrates the way that representation or media storage changes particularly when working with atypical data (e.g., scales or otoliths) and how historical practices shape present-day data

When integrating the ASL data from the Prince William Sound and Copper River areas, the files are structured the same way that the data were collected. In NCEAS' R Markdown[1] document—the preprocessor for tagged metadata, or a formatting syntax for authoring HTML, PDF, and Word documents—the data coordinator passes along information from one of the fisheries biologists: The ASL samples were gathered by taking scales[2] from fish out of a representative sample during an ASL sampling project (e.g., escapement enumeration projects, commercial fishing operations, or hatchery operations). For these Prince William Sound/Copper River salmon, the Chinook and Coho have a maximum of 10 fish sampled per scale card; whereas, Sockeye and Chum have a maximum of 40 fish sampled. This is due to tendency for Chinook and Coho to lose their scales. As such, a larger number of the sampled scales are regenerated. In describing this process, the information highlights the actual shape of the dataset: The scale cards have 4 rows and 10 columns. For the Sockeye and Chum, each of the 40 positions get a scale from an individual fish. While the Chinook and Coho each get a column that gets 3-4 scales from an individual fish.

Returning to the spreadsheet on the computer and away from the physical scale card, the data task force team discusses a few anomalies in the age data ultimately seeking advice from domain experts. The request is for clarification on what is likely to be a reasonable cut off age for different species, in a similar way that they determined cut-offs for size. After agreeing on some reasonable cut offs with regard to age, they find that less than 1000 fish are flagged as outliers. That number is quite low, but the numbers seem to be aggregated in specific areas. It is asked if anyone wants to follow up with those populations. One of the domain experts notes that while it seems unlikely that a Sockeye would have a higher than salt water age 4, it is perplexing to know if those populations with a high number of flagged individuals is due to an aging error or if it an actual phenomenon.

The case is marked primarily by a moment of breakdown in the data, which led to uncertainty in the data integrity. By consulting experts on the reasonable bounds of data, a partial consensus is reached. However, this concern with a long-term perspective and the way that "processes acting over decades are hidden and reside in the invisible present" (Magnuson 1990) comes to light. The other major aspect of this case is the use of scales for data. Given the particularities of the scales on the fish as well as reading the scales, the data files are shaped by these particularities (e.g., because Chinook and Coho require 4 scales vs. 1, there are 4 rows and 10 columns). With newer research that stands to replace the reading of scales, will these data shapes remain?

These cases illustrate just a few ways that data follow different pathways than are imagined. The data scientists often follow dead ends or have to dig deeply into archives; they are often met with their own lack of expertise with respect to the domain; they typically express uncertainty about the future usage of data and are reluctant to remove or commensurate data, which leads to the use of the standard "flag" action.

[1] In Markdown, there is a knit function, which is used to generate a document that includes the content as well as the output of the R code. For example, there are comments in the data about Sex to combine unknown entities with "examined, but…" to add more specificity to the data collection processes.

[2] Scales can be read like rings of a tree to age the fish. The growth on the scale starts in the center for the scale; as the scale grows, additional plates are added. When scales are taken from fish, the data is entered into "scale cards" along with other information about the sampling event (e.g., data and location) as well as the fish length and sex measurements.

4 Discussion: Towards seamful data genealogies

These three vignettes illustrate the work of achieving data interoperation, commensurability, and integration within a single dataset. In this section, we combine insights from these vignettes with findings from the broader social-historical literature on data transformations, curation, reuse, and interoperability to conceive a mock-up representation of seamful data genealogies.

We use the term *genealogies* both in its vernacular sense – a line of descent traced continuously from an ancestor, in our case, how data are combined and recombined—as well as the nuanced historiographical sense that Michel Foucault imparted to that term. In our study of data synthesis, we found data rarely progressed in a linear trajectory from collection to present condition, but rather meandered through a journey that demonstrated many branches and breakages. Foucault's genealogical method takes such dead ends as consequential and holds that each branch signifies social-organizational actors at play. Put very briefly, Foucault's genealogical method approaches the historical constitution of an object—in this case data—as shaped by its various moments of deliberations. Debates, controversies, and negotiations do not simply fall away with no further effect once seemingly resolved but have constitutive consequences that carry forward. For instance, that homosexuality has been institutionally depathologized by the American Psychological Association does not simply revert homosexuality to some neutral position; rather, that medicalized history continues to have on going consequences. More proximate to the topic at hand, we approach data as having been constituted not only by the direct accounts of ongoing changes in ownership and structure often encompassed by the concept of provenance, but also by the "paths not taken": those deliberations that shaped how data may have been otherwise in form or content. Our ongoing work is to represent such genealogies in a seamful way.

Table 2. presents 9 sensitizing categories (Glaser, 1978) for the inspection and representation of data genealogies. These categories have been developed from both our primary research and secondary reviews of the technical and social-historical literatures on data.

Table 2 Data Genealogies

Content	Ontology	Changes in what is being captured and represented as data across time (Ribes & Polk, 2012).
	Epistemology & instrumentation	What assemblage of technology and technique has generated these data? What instruments, forms of calibration, and practices of collection have led to particular datapoints? What changes have occurred over time?
Form	Categories, Standards, & residual states	The parsing of data into concrete bins (i.e., the columns and rows of data), and changes in those categories over time; the instantiation of standards and what happens to the things that don't classify: "residual encompasses everything that doesn't quite fit into a category system" (Star and Bowker, 2007; Feinberg et al., 2014)
	Representation & Media	What are the transformations in the structure (or "schema") of the data? What is the material medium of the data (i.e.., paper/disks/drives) (Dourish, 2012)? Where is it stored (i.e., locally, in a central repository) (Borgman et al., 2007)?
	Equivalencies & Translations	When and how have data been combined with other datasets (i.e., interoperated) (Ribes)? When and how have data been converted from one measure to another (i.e., from Fahrenheit to Celsius)? What, if any, record is available of these translations?
	Erasures & Additions	Data once collected may no longer be useful ("shedding" Ribes) or data once seen as not useful may be valued (Slota & Bowker, 2015), and there may be additions. Occasionally, that which was "shed" may be later be collected again.
Social-Organizational	Regulatory	Changes in requirements, officially, such as privacy regulations; or, unofficially, such as organizational norms for sharing.
	Institutional	Who or what is producing, archiving, sharing over time? Who has or is responsible for data holdings (ie., an individual, a lab, an institution)? What are the regimes of maintenance, repair, and upgrade for data, their preservation and access? And how do the values of those institutions shape data production and data sharing (Vertesi & Dourish, 2011)?
	Accessibility	Who has access to these data? How are data made available? Who is responsible for the work of accessibility? How does accessibility change those data?

Not all datasets demonstrate features associated with these categories; they are "sensitizing" in that they can help the analyst uncover these features as they inquire on and represent data genealogies. The categories are not mutually exclusive: quite often a change in one is coupled with changes in others e.g., as data holdings shift from one institution to another, they will be maintained in different ways, or, ontological changes (what is being transformed into data) are often coupled with categorical shifts (how data are parsed).

The social-organizational genealogies are pervasive in all three cases as they inevitably concern regulatory, institutional, and accessibility attributes. Accessibility is the major concern for the institution in charge of funding and storing the data (e.g., while much of the state department data is available online, it is not considered raw data because it has been made accessible to the public). However, the data is also historically positioned; various institutional or regulatory regimes have shaped the data in specific ways. To gather the data necessary for this project, the data team established a Memorandum of Understanding with the state department to request, clean, and archive their data. This largely involves getting data from a variety of sources often stored locally.

As always with data, sharing is a matter of substantive concern (Borgman, 2012). Hours of work and resources were poured into the production of these data, and thus, they do not extricate easily. As such, regulatory and institutional arrangements are set up to make data requests less painful for data providers. While this regulatory and institutional facet is evident in the negotiations that take place at NCEAS, it is rarely documented for downstream users. By adding a flag column to the dataset, all three cases illustrate erasures and additions. Erasures and additions invoke notions of removing a *bad* piece of data or adding new piece of data; however, in this instance, no data are actually removed. On the contrary, an additional seam is added to this dataset to call attention to potentially erroneous data. As the framework is part of preliminary research, the categories illustrated are provisional. We intend to iterate through research, feedback, and conceptual development[3].

5 Future Work: Low Fidelity Mockups

Low-fidelity design concepts are useful for representing and iterating on findings. Low-fidelity mockups tend to be in the form of paper sketches while high-fidelity are more fully functioning. Our mockups are low-to mid-fidelity as we move from paper sketches to digital visual representations; the future steps in creating these mockups will include adding interactivity and testing with users. Kukla et al. (1992) writes that "mockups must be flexible, inexpensive, easy for users to interact with, and designed to enhance their imagination" (p.48-9). While the purpose of this research is not to parse the nuance between mockups and prototypes, we do see our future interaction with users through these mockups as performative in the sense that Suchman et al. (2002) argued that "prototyping represents a strategy for 'uncovering' user needs, taken as already existent but somehow latent, unarticulated or even unrecognized by practitioners themselves" (p. 166).

In our future work, we are exploring two kinds of data representation to test with potential users: the first representation offers a timeline view of data work to provide data scientists/scientific programmers a way to document their work; the second representation maps the workflow of data production to engage upstream data collectors and data holders.

In both concept designs features of the interface are each a seam, offering a user the option to explore a deeper historical dive or to understand common errors or uncertainties when dealing with data – features of data often unavailable at hand. In the first concept for future engagement, the seams are representative of a way to add more information. In the second, the seams are interspersed throughout the workflow section and highlight actions that are typically invisible in final research or data products. Ultimately, these prototypes will be tested with the users in the study with the goal of iterating on each design.

[3] We chose to exclude metadata as a genealogy as it tends to encompass both macro and micro level activities in that it both shapes the activities that data organizations take and is also shaped by historical metadata documentation. It is, however, critical to understanding the data work as it relates to seamful design. As Edwards et al. (2013) note: "preserving the meaning of data is a human affair, requiring continuous curation. For these reasons, managing and preserving ecological data for the long term ultimately required new organizational forms." Future ethnographic work will document the role of metadata and how it can be leveraged in design spaces.

In the first mock-up, the intended user is a data scientist/scientific programmer who is trying to piece together and fill in errors and data gaps. The seams are representative of a way to add more information, similar to the flagging that is added to archived data sets. However, these additions are more informal and would allow for a richer telling of the stories that are implicit in historical datasets.

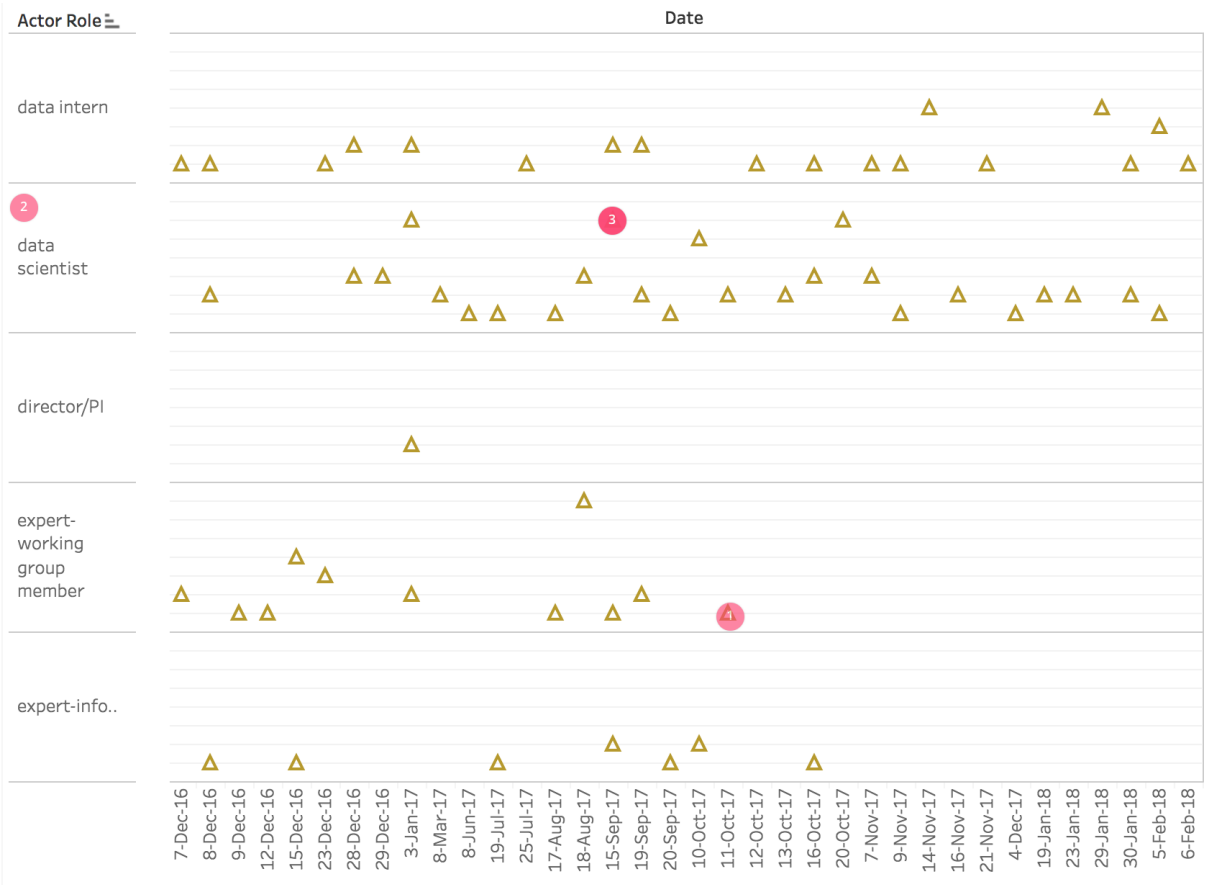

Figure 1: Seamful representations of data genealogies in Age, Sex, Length (ASL) data

Figure 1 highlights the interaction throughout the project timeline. The data from the ASL issues were coded for various actors' roles as well as their interaction with one another. The representation highlights that the data scientist has the most interaction throughout the project, consulting with experts early on in the project.

Not all "raw" data comes with good metadata documentation. By providing the user with a timeline marked with historical signposts, the user might be able to more accurately add breadcrumbs for locating experts or finding reports that contain the requisite data. We envision a "drill down" functionality in which a user can explore the details of a particular change. The delta symbols indicate a moment in which an actor in the project made a change whether it be added information to the project, flagged a data point, removed erroneous errors, or called attention to a potential error. on the top allows the user to explore the possible reasons for these uncertainties or errors as well as chart their own findings as to what is flagged. These areas present opportunities to tell myriad perspectives of data and would be used in design workshops to elicit the knowledge of participants further explicating the intellectual work of data teams. Ultimately, there would be multiple frames for different data types, which should provide an easy way to compare across various sites and types of data collection.

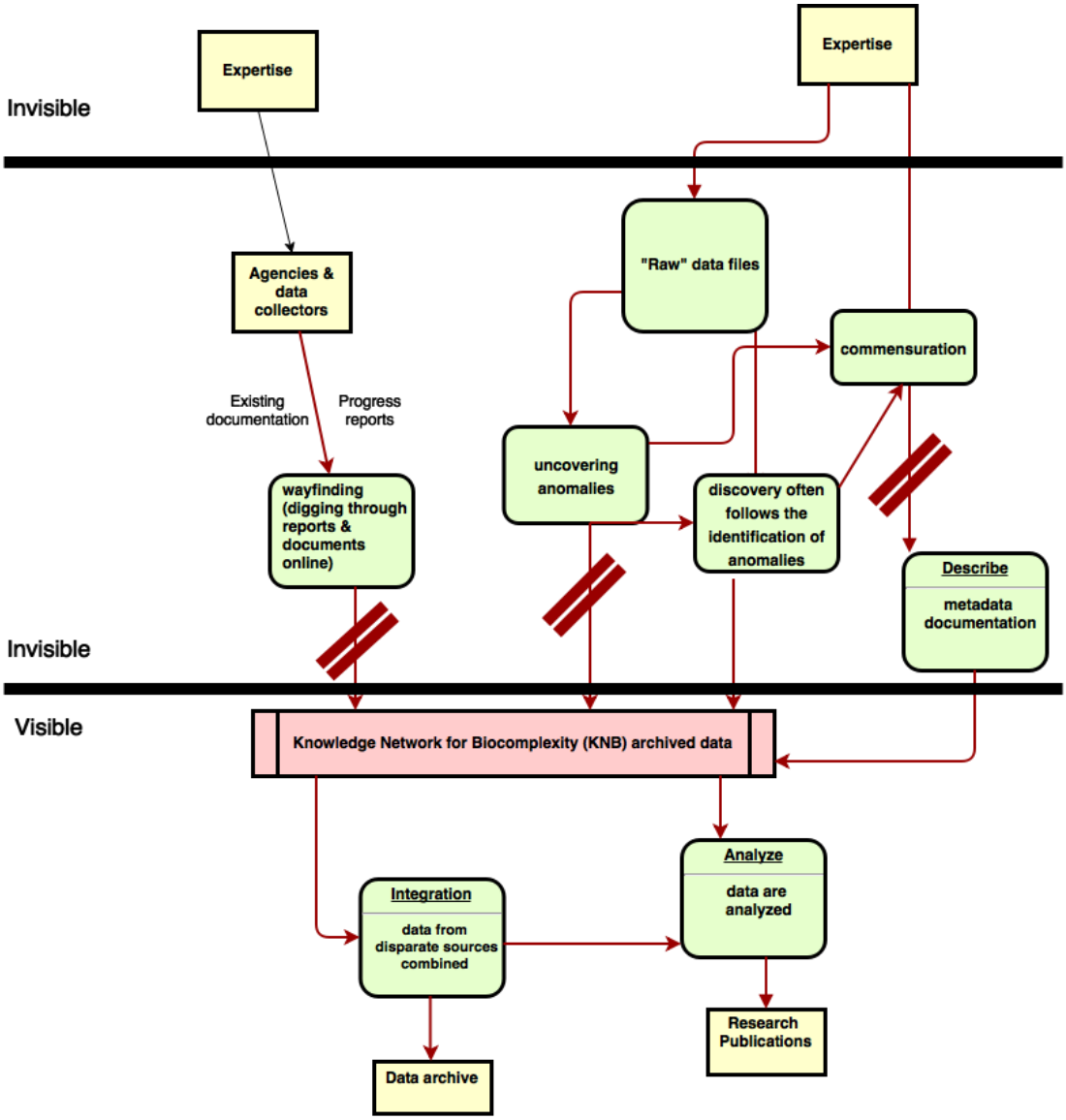

Figure 2: Seamful representation of workflow for cleaning and integration ASL data

The intended user for the second mock-up is the data collector or data producer. This example workflow is meant to provide data collectors with a map of current data archival practices to potentially inform how to scaffold their own data collection practices. It provides a representation of what work is visible and what is invisible to typical end users of data; this workflow reveals two layers of invisibility as there is expertise knowledge even access to the field site does not reveal. Two of the common actions we have observed is data workers digging into reports and consulting experts to assess the cause of errors. The double red lines indicate a moment in which the data do not cleanly integrate and a flag is added by the data scientist. Having a clearer idea of problems downstream could encourage future policies around better data collection standards or plans for building tools that are more adaptive to heterogeneous data.

This preliminary future work is grounded by the ethnographic research we presented in this paper. The theoretical underpinnings of infrastructure studies and seamful design exposits the framework of data genealogies present in data scientific work. By applying this to our initial design mock-ups, we are better positioned to engage with our field site in a more meaningful way around data practices.

6 Conclusion

Through ethnographic and historical investigations of real world data work we have sought to develop the categories for a seamful representation of data genealogies. This ethnographic approach provides a more in-depth understanding of design practices with respect to data archives and provides scaffolding for thinking through ways that breakdowns in data interoperation might be a catalyst for change in design. Furthermore, our work opens up opportunities to broaden participation for wider users of data downstream. Thus, our ethnographic studies of scientific practices lay the groundwork for exploring participatory design interventions. Our results lead to better understanding for designing and developing a data tools and techniques for exploring the role of data in participation in scientific deliberations, and ultimately public life and the local knowledge that fishers and processers have regarding current data.

Seamfulness is a promising countervailing strategy for managing the black boxing in infrastructure, interfaces, and data, even as we acknowledge that some level of blackboxing, or seamlessness, is necessary in the operations of complex sociotechnical systems. Seamfulness cannot serve to reveal all complexities, delegated technical decisions, or debated deliberations. Instead, we approach seamfulness as a strategic design choice, and so too is seamlessness. The creation of seams should serve to support the occasioned need to dive deeper, to configure more carefully, to examine more thoroughly, or engage in unanticipated ways.

We take seamfulness and seamlessness to be complements rather than opposites. Our future research will seek to iterate on these initial designs concepts by returning to the ethnographic field of inquiry and presenting our approach back to our respondents. We hope that such participatory and "talk back" design approaches will help inform what, out of the vast mass of data transformations, to show and not show in our final seamful data representation. Our approach to design will not seek to represent all transformations (an exclusively seamful representation); but to offer relevant handholds for data users. Discovering and articulating such relevance will require further iterative and participatory research with the intended and imagined users of this tool e.g., what forms of inquiry may best serve future data inquiry users? Such future uses are necessarily imaginary; they can only partially account for the future needs and inventiveness that may actually be required for inventive re-uses of data. But the design of a particular tool, representation, or interface must ultimately make decisions that create, in some form, a parsimonious rather than cacophonous set of seams, that is, seamfulness still requires a measure of synthesis, clean data, and seamlessness.

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Regimes of Digital Quantification: making data-driven decisions?

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In light of the proliferation of sensors, data and analytics, multiple digital quantification regimes are emerging under promises of a revolutionary change in the way in which decisions are made in areas such as urban planning and government. These regimes present a growing need to differentiate themselves in order to capitalize their data, deploying particular technologies that go beyond the digital. In this paper, we review two digital quantification regimes of urban cycling in Santiago, Chile: the RUBI device and KAPPO smartphone application. Through the study of the design of material and narrative technologies of these regimes, we will show how they try to distinguish their modes of quantifying the cyclists' mobility, configuring particular versions of target users, the city and its forms of government, in order to promote an urban planning driven by data.

digital quantification regimes, data-driven decisions, self-tracking, smart urbanism

1 Introduction: A world made of data?

The digital has invaded the city, and with it, the logics of planning and governing urban spaces. Sensors, networks and microprocessors of all kinds have become part of the urban landscape in increasingly ubiquitous and invisible ways, populating domestic and public spaces, companies and governments. Vast quantities of natively digital data are generated each minute on urban dynamics, and they are beginning to be reoriented for various purposes and decisions. The "datafication" or growing translation of multiple phenomena in the format of computable data has become an exponential process which various authors see as forming a true "revolution" or large-scale "epochal change" for contemporary life (Mayer-Schönberger & Cukier, 2013; Kitchin, 2014b). It is believed that digital devices, data, algorithms and analytics will allow for traceability of the social as never before (Venturini & Latour, 2010) providing what enthusiasts like computer scientist Alex Pentland (2012: 45) describe as a "god's-eye view of ourselves" that would increase the efficiency and responsiveness of a series of processes ranging from the use of public transport to medical exams to bureaucratic processes. In this scenario, data have become highly valued as a new economic asset,

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being described as a new “gold mine” or the new “oil” of the 21st century (Schwab, Marcus, Oyola, Hoffman & Luzi, 2011). From this optimistic perspective, the processing (distillation, refining, etc.) of data would provide beneficial and valuable insights to inform or even automate the decision-making of individuals, companies, citizen organizations and governments. In all these areas, one finds the naive belief that more and better data is required to be able to solve and act in a "smart" way, appearing the digital technologies as ideal tools to quantify everyday life and obtain the necessary data for it. As Edd Dumbill (2013, p. 1), the editor of Big Data journal, resume it, “we might compute our way to better decisions.” In this paper, we want to problematise this belief by exploring the diverse modes of quantifying urban mobility and the efforts to justify and capitalize the value of particular devices, data and analytics.

2 The promises and perils of smart urbanism

The idea of making data-driven decisions has permeated local governments through the proliferation of many Smart Cities initiatives around the world. The so-called “smart urbanism” (Kitchin, 2014a, 2014b; 2015; Marvin, Luque-Ayala and McFarlane, 2016) promises that public planners and officials will be able to make better decisions if they quantify and instrumentalize urban space using sensors and smart devices. This would achieve a more holistic vision of the city and more coordinated and efficient management of government resources in order to improve people’s quality of life (Flowers, 2013; Goldsmith and Crawford, 2014).

Three main promises are made to promote data-driven decisions in urban planning from smart urbanism. First, thanks to the algorithmic gathering and processing of digital data, decision-making would be informed and even automatically driven by “objective evidence” or “facts” rather than prejudices, emotions, ideologies or even expert opinions (Esty, 2004, Esty & Rushing, 2007; Kitchin, 2014a, 2014b, 2015). It would be possible to overcome declarative answers and reflect on actual behaviors in a more direct manner (Kitchin, 2015), uncovering “hidden” patterns that cannot be anticipated using traditional methods. In this “dataism” (van Dijck, 2014), it is believed that the data would speak for themselves (Mayer-Schönberger & Cukier, 2013), promoting ideas of empiricist rigor, neutrality or a distancing from the subject of study under an “aura” of objectiveness and certainty (Boyd and Crawford, 2012; Gillespie, 2014). Secondly, it is argued that the gathering and analyzing of digital information would change the time that passes between the measurements and decision-making processes, generating a fantasy of acting in real-time or immediacy (Andrejevic, 2013; Beer, 2016). If before urban planning and government focused on the long-term, the proliferation of sensors, data and analytics in smart cities would turn this into an increasingly ongoing and “immediate” process in regard to the changes experienced (Batty, 2013; Batty et al. 2012). Thirdly, it is promised a new era of citizen participation by experimenting with digital technologies that will bring us closer to a more participatory and open digital democracy (Le Dantec, Asad, Misra & Watkins, 2015) along with greater symmetry or “horizontalization between governors and the governed” (Crawford & Goldsmith, 2014) or a true “democratization of policymaking” that would reduce the government monopoly on decision-making (Esty, 2004; Esty & Rushing, 2007). There is the belief that citizens could turn into sensors of their cities, for example, producing relevant volunteered geographic information about their needs and demands for urban planners and public officials (Burke et al., 2006; Evans-Cowley, 2010; Goldsmith & Crawford, 2014; Goodchild, 2007).

Despite the promises of smart or data-driven urbanism, it is necessary to be cautious and problematise the suppositions, limits and prejudices involved in the introduction of sensors, data, algorithms and analytics into the urban ecology. For example, it has been said that this process could promote forms of surveillance or “dataveillance” that are more invasive, ubiquitous and impossible to anticipate, operating even without a specific target in opportunistic or unsystematic ways (Andrejevic & Burdon, 2015; Bauman & Lyon, 2013; van Dijk, 2014). Instead of empowering the people through data production, government agencies and companies now can exercise power over

people through processes of regulating urban environments with sensors and algorithms (Gabrys, 2014; 2016). Instead of horizontalization, new digital divides and structural asymmetries are increasing between a majority that generates data (voluntarily and involuntarily) on a daily basis and a minority that concentrates the ownership and the necessarily skills and infrastructures to process the data, exploiting and subjecting the data producers to new economies of data (Andrejevic, 2014; Andrejevic & Burdon, 2015, Boyd and Crawford, 2012; Tenney & Sieber, 2016).

Along with methodological questions about the quality, replicability or representativity of the data, the performative and political nature of digital quantification has been called into question too, specifically in regard to the "dataist" belief in digital data as factual, neutral or objective evidence and excessive trust in the independence and integrity of the agents that accumulate and trade data (Boyd and Crawford, 2012; van Dijck, 2014). The data will never merely be a "reflection," "mirror" or immediate "doubles" of exterior physical counterparts. They are always produced by and embedded within a combination of diverse forces, logics and interrelated social entities –companies, academics, government agencies- that mold what they seek to measure through specific designs, interests and ideological agendas (Kitchin, 2014b; 2015; Lupton, 2016). There wouldn't be "raw data," but rather data that are always already cooked to provide the basis for a rhetoric or action determined in a interested manner, which means that they are always inscribed with a series of expectations and purposes, interpretative frameworks and normativities, privileging and marginalizing certain ontologies over others in the process (Boyd and Crawford, 2012; Gitelman, 2013; van Dijck, 2014). In this way, quantification involves an operation that politically and ethically impacts on the ways of knowing, governing and practice power in urban space.

3 The info-glut and the struggle between digital quantification regimes

Beyond these problematizations, it is necessary to consider that the extraordinary production of data also has made evident an excess of information that is increasingly difficult to process and manage, which Andrejevic (2013) has called the infoglut. The digital has increasingly made us aware of this excess and the impossibility of fully absorbing the vast amount of information that is available in our time. In this regard, given the multiple recording and measurement systems that function in parallel to one another in the city, it is increasingly important to manage techniques, algorithms and analytics that allow us to identify the most "representative," "valid" or "valuable" records for decision-making. The multiplicity of data collection technologies in the city thus do not necessarily lead to smarter and more precise decisions, but could also increase the sources of uncertainty and difficulty, forcing us to choose among many "data doubles" of the cities. As a result, the various sensors, databases and analytics available to quantify similar phenomena increasingly enter into competition with one another. It becomes more and more difficult to convince key stakeholders (companies, public institutions, etc.) that data are "important", "valuable" or "true" and how to process them and visualize them in order to obtain their promised "hidden value." This is why data-brokers seek out different channels for positioning themselves and gaining legitimacy within this smart or data-driven urbanism.

In this paper, we argue that the proliferation of modes of digitally recording and tracing the life of individuals, spaces and organizations has led to the simultaneous emergence of various records of similar social dynamics, increasing the plurality of existing quantification regimes. As Deborah Lupton (2016) has said, when developing a sociology of self-tracking, there are diverse ways of quantifying daily activities that would range from commercial exploitation to individual self-knowledge. This suggests that we cannot take as a given a sort of singular and homogeneous "datafication" process. Instead we must start to consider the idea that quantification processes can present multiple purposes and meanings which can only be addressed on the basis of their particular contexts of realization (Espeland and Stevens, 2008). To that end, we propose to start exploring in the multiple digital quantification regimes that run parallel to one another in contemporary societies, presenting varied directions and modes of quantifying social life. We must begin to study

the various assumptions, rationalities and scripts that these regimes establish in their diverse spheres of action and designs (Akrich, 1992). Each digital quantification regime is pushed to differentiate itself and present a special configuration, valorisation and justification for the data that they gather, which makes it important to explore how the spokespeople for these regimes (data brokers, designers, engineers and others) perform their sensors, analytics, algorithms and data under specific goals and driving principles, define special types of "users" or "clients" and promote particular visions of the city and its government. Establishing public-private agreements with municipalities or ministries, selling data to third parties and/or promoting the use of data for social changes are arduous achievements that involve a material and discursive effort to persuade relevant actors so that certain digital quantification regimes gain value and can position themselves over other pre-existing sources of quantification. This work of justification has not been examined in the literature and may be more difficult and complex than the data production process itself.

4 Digital quantification regimes of cycling mobility

In order to explore this phenomenon, over the past few years we have been studying cases on digital quantification of urban cycling. Thanks to the benefits for health and the environment and the reduction of urban congestion, bicycle use has been characterized as a "green" and "sustainable" form of mobility over the past few decades that is highly valued by cities around the world. Under this trend, urban cycling has been increasingly quantified, monitored and augmented by various sensors and self-tracking apps included in smart cities projects (see Fundación Telefónica, 2011; Viechnicki et al. 2015). However, in spite of the growing digital device and analytics industry for urban cycling, there are few studies that explore the implications of the intersection of smart devices, cyclists, data and cycling practices (Tironi and Valderrama, 2017; Barratt, 2016; Sumartojo et al. 2016; Taylor, 2016). Moreover, there is hardly any literature that explores how these new cycling tracking technologies are designed and programmed to guide decision-making processes for topics related to urban planning and government (Le Dantec et al., 2015; Powell, 2014).

In this paper, we analyse and compare the development of two digital quantification regimes of urban cycling in the city of Santiago, Chile: the RUBI device and the KAPPO smartphone app. These cases will reveal how modes of quantifying and knowing the urban through the digital are being promoted by experiments, bottom-up initiatives and start-ups based on the imaginary of smart urbanism. As we will see, both regimes openly seek to allow public officials to make better and data-driven decisions about infrastructure planning and construction for cyclists. However, they present different stories and specificities that go beyond the chosen digital technology. They establish different ways of justifying their use, positioning themselves above the other quantification regimes in the market and legitimating their data as the best for urban planning decision-making.

We conducted semi-structured in-depth interviews with the spokespeople and creators of these tracking devices, ethnographic visits to the places in which the sensor and app were designed and produced and events linked to the initiatives, and a secondary source review that included videos, news coverage, websites and official documents of the two technologies. In this paper, we will focus on the material technologies (inputs, interfaces, designs, development processes, operation and maintenance of these regimes) and narrative technologies (discourses, presentations, rhetoric and pitches to make themselves known and convince specific stakeholders) that these digital quantification regimes deploy to achieve a valorization and capitalization of their data and promote a "data-driven change" in urban planning and government.

4.1 RUBI: "Let the bikes speak"

The first case analyzed is RUBI, which emerged in 2013 as part of the bottom-up project Stgo2020. Inspired by the idea of smart cities, this project promoted that urban cyclists' knowledge and practices must be incorporated into urban planning of Santiago because they are most familiar with the problems and needs of cycling infrastructure. With this goal in mind, Sebastián, a young engineering student, developed a small prototype for self-tracking called Rubi, the Urban Bike

Tracker, as his undergraduate thesis. This allowed him to record the routes taken by each cyclist in a georeferenced database that was later processed on a web platform (RubiApp) to obtain metrics and visualizations of the user's activity.

RUBI gathered data from over 100 volunteer cyclists, and the information was aggregated to generate graphs, tables and heat maps on their routes. This information was shared with the Transportation Office, hoping that public officials could make smarter decisions about future cycling lanes using more data. But the RUBI device went beyond the thesis project focused on the city of Santiago. During 2016, it lost its bottom-up nature and was scaled up to other cities using new business formats. Sebastián founded the company RubiCo and reached agreements with local governments and international consulting agencies like the Inter-American Development Bank in the area of urban mobility. In the process, RUBI was offered as "a powerful and innovative way to analyze urban cycling" (https://rubico.org/) that challenges the status quo and allows cyclists to act as "co-designers" of their own city.

RUBI's entire development was based on a strongly scientific narrative due to its academic origin. The Stgo2020 project was born out of the assessment that there was a "lack of data" on the routes taken by cyclists in major cities. According to Sebastián, local governments have focused exclusively on gathering data through cyclists' origin-destination surveys. It was still unclear what happened in between those two points, which routes cyclists chose and how fast they traveled and there was no data on other variables that would be key for analyzing the demands and infrastructure needs of cyclists. Given that need, Sebastián decided to design a hardware that could quantify, capture and gather "precise", "objective" or "accurate" data on bicycle use that then could be used by public planners and officials to make decisions.

> *More and more people are cycling and are more interested in it. Like every new thing in this digital age, we need data to make decisions…. in order to be able to say that you made informed decisions, in order to have a justification in case you make a mistake, and that is very scientific, very healthy (Sebastián, interviewed on January 13, 2016).*

In this sense, the decision to design hardware was not random. For Sebastián the major problem of other available technologies on the cyclist tracking market like wearables or apps is that they require a human user with enough economic resources to have a smartphone or the appropriate data plan. The user also must be attentive enough to turn the self-tracking system on and off when necessary. Mistakes would muddy the sample and it would not be a "faithful reflection" of cyclists' mobility. The RUBI device would thus be differentiated from the apps and gain value by generating "a sample that is clean, pure and scientifically correct" (Sebastián, interviewed on January 13, 2016).

This scientific narrative marked the design and materiality of the RUBI. The first prototypes, which were made using candy boxes, were large, fragile and very much dependent on the human user in several respects. In fact, Sebastián playfully drew a human face on the first prototype. Several problems emerged with these first versions. The initial prototypes had an on/off switch, and users continually forgot to turn it on or off when necessary, reducing battery life and capturing erroneous data. In response, the engineer added a three-axis sensor to the device to measure acceleration so it could automatically turn on and off when the bike started to move and when the bike stopped for more than 35 seconds. This change completely marked the orientation of the device towards a design focused on the characteristics of the bike: "It is really oriented towards the bike. It doesn't have buttons because bikes don't have hands." (Sebastián, interviewed on January 13, 2016). In Sebastian's view, this change gave the device greater autonomy and intelligence. Second, the first versions of RUBI required the volunteer cyclists to upload the routes stored in the device's memory to the project platform. This was particularly problematic because some users did not know how to upload the information or lacked the adaptors or cables necessary to complete this step. The device was thus again redesigned so that the data would automatically be uploaded through a connection of an open Wi-Fi signal and then through the Bluetooth connection to the cell phone. Third, the

device underwent a literal “blackboxization.” Given that the first prototypes boasted visible LED circuits and lights, the likelihood that they might be stolen or get wet or suffer a bump were high. The size was thus reduced and the device was wrapped in an opaque, resistant box, ensuring as little interaction with the cyclist and their environment as possible. Making it smaller and more difficult to see made it even more important to make it more automated or “smarter” and increase its connection to the bike.

But it was not only the device design that underwent changes. The processing of the data also became more sophisticated. Cyclists’ routes were initially reviewed manually to identify any anomaly in the measurement, imagining mundane stories to make sense of errors. However, RubiCo subsequently developed an algorithm that weighs the properties of each route (such as speed, variability or distance) and automatically determines whether it is a bike trip, an “uncertain” trip or a trip completed using a different mode of transportation (for example, in a car), including only the first ones in the final sample. This algorithm also made it possible to identify poorly measured routes due to GPS problems or poor satellite calibration, increasing the “smartness” of the digital quantification regime in regard to justifying its sample as one that is as bias-free as possible.

In short, the development of RUBI clearly shows how the efforts in implementing a scientific narrative completely impacted the material design of the device used to quantify. RUBI went from being eye-catching, friendly and even “humanized” to opaque, automated and oriented towards the actions of the bike. For Sebastián, the human user is viewed as an agent that is prone to errors, forgetting and multiple contingencies that could contaminate the data so it became necessary to make the device could work autonomously. As such, giving the device “true intelligence” was a “solution” to these possible errors, and also added value and solidity to the regime compared to the competition. In contrast to other self-tracking technologies (apps, wearables, etc.), RUBI controlled the biases and noise of the sample on cyclists’ mobility, constituting RUBI interaction with the bike as an authentic “moving laboratory” -in Sebastian’s words- that would capture georeferenced data precisely and objectively. As a news piece about Stgo2020 exaggeratedly said, the RUBI device would allow bikes to speak for themselves (Araus, 2015), reducing cyclists’ interference in the measurement.

4.2 KAPPO: More than a game

The second case starts from a similar spirit of making Santiago more bicycle friendly, but uses different materialities and narratives. In early 2014, four Chilean entrepreneurs spent around three months developing a social game for smartphones called KAPPO that sought to have success similar to games like Candy Crush Saga or Angry Birds while increasing bike use in Chile. The app currently has over 50,000 active users in over 200 cities around the world, and Chile is home to the largest number of users.

Since its inception, KAPPO was structured around levels in which each trip on the bike wins the user rewards, virtual coins and experience points (XP). The highest level of the game is “Capo.” The app measures the routes using variables such as time, speed, weather and jumps during the trip, offering special bonuses if certain thresholds are crossed. It also offers a series of challenges and rankings for competing with friends or other KAPPO players. The developers had to read and learn about “gamification,” analyze the rules of competition and design a bonus structure that would be attractive enough to hook the user so that he or she would continue to play the game until the end.

Though this materiality of gamified design, KAPPO puts together a narrative focused on its ability to “provoke,” “motivate” or “create the habit” of regularly using a bicycle and improving the user’s health. KAPPO claims to help build a virtuous circle that will increase the number of cyclists in the streets of a certain city –for example, promising that if KAPPO is disseminated in Santiago de Chile, the city will have the same level of bike traffic as Holland or Denmark within five years. This narrative also identifies a specific target user. According to the spokesperson, Iván, the company was not looking to reach high performance cyclists who want to improve their times and be faster for

competitions. They would have created another type of app or a self-tracking wearable for the market, which would be quite costly and "not very accessible" in his opinion. KAPPO focused instead on "casual urban cyclists," people who were starting to try out the bike as a mode of transportation and who could encourage others to get on a bike. In order to reach this audience, the algorithms, reward structures and rankings in the app would be design to motivate them. For example, the rankings were configured so that all users reach the top spots, restarting the rankings each week and including parameters other than high speed or distance traveled. The company also sought to create a "non-competitive atmosphere" among users, but one that would motivate them enough so that the indecisive cyclist would begin to cycle regularly. "They will be motivated because it is designed for that" (Iván, interviewed on January 10, 2017).

But KAPPO has sought to position itself as "more than a game" for smartphones, seeking out different ways of capitalizing the app and the data generated through its use. For example, KAPPO developed "Health and Wellbeing Programs" for companies that promise to improve productivity and workers' mood and health by increasing bike use through the app. They also organize a competition held twice each year called "Cool Places to Bike" that involves varied organizations (universities, state entities, companies) that pay a subscription to KAPPO to see which organizations are most encouraging bike use among their members, using the app for the measurements. KAPPO have sought clients in local governments too, by the development of KAPPO Insights, a web platform which allows users to process and visualize anonymized routes tracked by the app to help public planners and officials to make decisions.

> *With this analytic platform, we provide more than hard data, right? We also process that information and give it to them in a fairly attractive visual format so that anyone, expert or not, can reach some conclusions based on the data they are looking at (Iván, interviewed on January 10, 2017).*

This narrative for capitalizing the analytics and databases is particularly relevant because it creates a contrast between traditional ways of conceiving of and planning the city and the "new" opportunities provided by KAPPO. For Iván, governments invest large sums of money in infrastructure for cyclists, but "the problem is that they do it thinking the way that they did 20 years ago" using fairly limited, expensive and involved traditional methods to gather data such as traffic studies or origin-destination surveys. Like Sebastián of RubiCo, for Ivan those methods could not quickly and cheaply capture the "real demand" for cycling infrastructure. In spite of this, they continue to be preferred to following a status quo in city planning, over valuing certain standards and requirements such as the procurement of representative samples for urban planning even though that implies an excessive disbursement of resources and can take a long time. For Iván, the city would be an entity that is constantly changing, which means that smart government should intervene and improve the urban space in micro way, in the short term and experimentally. The sample obtained by KAPPO presents important biases and lacks representativity, so instead of emphasizing the scientificist goals of the RUBI case, an important part of the narrative technology deployed by KAPPO is convincing the public officials on three aspects: an inexpensive method that captures data in real time and allows for participatory citizen involvement that encourages bicycle use. Citizens are again invoked as protagonists of the changes in the city:

> *If today you tell your community, 'Look, we are going to test new ways of building new things in which I will really know what you want using this application or whatever, so that it isn't difficult for you, I will start to obtain information and will improve my way of building things,' the citizen will say, 'They finally listened to me! I am finally part of the city planning process!' (Iván, interviewed on January 10, 2017).*

In sum, the KAPPO analytics and flow maps acquire value, accordingly to its spokesperson, because they would help make smarter decisions and modify the city in a more experimental, fast-paced manner guided by the "real" movements of cyclists gathered in a non-declarative way. KAPPO thus

does not seek to measure and quantify cyclists' mobility representatively like RUBI, but seeks to intervene directly by encouraging and causing greater bike use, presenting bicycle use increase statistics biannually in order to legitimate this digital quantification regime.

5 Conclusion

In the context of multiple regimes and modes of quantifying contemporary social life, it becomes important to note how new agents have entered the design of cities, agents that did not exist prior to the invasion of the urban space by digital technologies and that are capitalizing on the smart cities imaginary in particular ways. Here we focus on two regimes of digital quantification that are framed by the smart urbanism discourses and the promises to change how urban planning decisions are made.

Comparing these two regimes, it is possible to see that they are not simply different because of their interfaces (app and device), they design and develop particular material and narrative technologies (summarized in Table 1) in order to set themselves apart and defend their devices, databases and analytics as the most convenient, objective or adequate for knowing, planning and governing the city in a data-driven or smart way. These technologies become important because they justify the design of their inputs, target users, versions of the cities and the modes of quantifying it, and at the same time they allow the persuasion of important audiences and clients. We did not only find differences between the two regimes, but also the spokespeople for those regimes insisted that they are different also from other methods and quantification devices of the competition, both digital and analogue, invoking limitations and biases of them. In a word, capitalizing digital devices, analytics, algorithms and data requires a complex effort to justify and communicate them that should not be taken for granted and that goes beyond the production of data.

Table 1. Summary Table

	RUBI	KAPPO
Narrative technology	Achieve an objective representative sample	Encourage bike use and citizen involvement
Material technology	Automated device oriented towards bikes	Gamified app oriented towards casual urban users

The differences show that the promises of smart urbanism reviewed above do not necessarily follow a homogeneous and stable development over time. As we have seen, the KAPPO regime exacerbated areas such as the participatory or citizen nature under commercial logics from its inception. By contrast, the regime of RUBI started out emphasizing participatory and bottom-up elements but was decanted by more automated designs in which the agency of cyclists for obtaining objective and representative data was displaced (for a more in detail examination of the displacements occurred in the development of RUBI, see Tironi and Valderrama, 2017). As such, in both cases design plays a key role in how the cyclists are called on to participate in these initiatives but from different programs, either seeking to capture "pure" data or looking to "provoke" changes in user's habits. These discrepancies between the cases reveal the complexities of the collection, justification and capitalization of data in front of other competing quantification regimes. It becomes evident that the exaggerated promises of some authors about the "new" possibilities of gathering more objective, real-time and participatory data thanks to new digital technologies, tend to underestimate the practices, trajectories, economic interests and the multiple specificities of each digital quantification regime. This suggests the relevance of how the materialities and narratives of these kind of regimes are tested and adjusted to promote certain promises -instead of others- for data-driven decision-making.

But despite the discrepancies between the cases analysed, we note that both cases start from a relatively common socio-technical imaginary of data-driven city governance. From this imaginary, opening and sharing data on the mundane practice of riding a bicycle is invoked as a means of citizen involvement with the capacity to make the city smarter and more bike-friendly. However, this imaginary lead, first, to a reconfiguration of citizen participation towards more passive, invisible an unnoticed versions of participation that are free of true effort, in which this is seen as an exchange of data and is capitalized for the benefit of certain stakeholders with interests that go beyond democratic ends (Gabrys, 2014; 2016; Powell, 2014; Tenney and Sieber, 2016). Rather than turning cyclists into "co-designers" or "participants" in city planning, they act only as data producers without ever being informed of the real use of the data generated in a government decision or other use by third parties.

Second, urban planning using digital data also opens up the discussion of how notions of "expertise" and the "political" are developed. The digital quantification regimes analysed here do not seek to gain authority based on exclusive technical knowledge, as in other previous regimes. In fact, both spokespeople identified themselves as non-experts on urban transportation and planning. As we saw, through the development of the narrative and material technologies, these quantification regimes are seeking to overcome a distance between the "real" and "immediate" behaviour of cyclists and decision-makers. They believe and promote that "anyone", without necessarily being an expert on the topic, could make a "smart" decision in a technical manner or could be driven by the numbers of "real" citizens' behaviour and not by "hunches," ideological differences or party pressures. The political is enacted by these regimes as an obstacle, something that must be eradicated through the gathering and processing of data on people's behaviour. This politics of technifying decision-making is nothing new. As Morozov (2014) has written, the idea of an algorithmic regulation evokes the old technocratic utopia of politics without politics: "Disagreement and conflict, under this model, are seen as unfortunate byproducts of the analog era – to be solved through data collection – and not as inevitable results of economic or ideological conflicts." In this sense, smart urbanism would not only carry old and naive belief in an objectivity or immediacy of data, but also would create new distances (Porter, 1995) by promoting a depoliticization of urban planning and government in favour of more technocratic and automated decision-making systems (Vanolo, 2014). It becomes necessary to analyze in future studies how decision-makers are interpreting these digital quantification regimes and the actual role of "the political" in decision-making that these regimes seek to eradicate by promoting urban governance increasingly driven by automatisms and behavioural data.

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Digital, Analog, Discursive: knowledge practices and sense-making in design-build architecture

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Through referencing ethnographic research among university architecture students, this paper reflects on practices of sense-making that bridge digital and material media (including bodies). Our discussion follows students and instructors as they develop designs that are analytically feasible or "true" in digital environments (i.e. in various rendering and modeling software such as AutoCAD and Rhino), only to be confronted with incongruities of material resistance and problems of embodied skill (or lack thereof) when the design enters the "real" world. The paper explores the sense-making, socio-material aspects of design-based activity, considering how the digital and the analog may be puzzled over before being more or less reconciled in final material objects (physical prototypes and models, drawings, a structure). As various moments of design happen, we note how actors (instructors, students, shop technicians, and building and model-making materials) punctuate and discursively shape the trajectory of sense-making, highlighting the extent to which translation from one form of design media to another (and back again) is much more than a question of technical competency.

architecture education; digital to analog; ethnography of design; multimodality

1 Introduction: Innovation and collaboration

This paper draws on ethnographic research among university architecture and design students to reflect on practices of sense-making which bridge digital and material media (including bodies) and which point to some of the ethical challenges and potentially-progressive qualities of socio-material engagement in architecture education. This work is part of a collaborative project undertaken by Nicholas (University of Nebraska-Lincoln) and Oak (University of Alberta, Edmonton), with our discussion here following students as they design and problem-solve within digital environments, only to be confronted with incongruities of material resistance and the difficulties of embodied skill (or lack thereof) when the design enters the "real world." Those kinds of frictions in the design

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process are considered in this paper as issues of translation or "transmodality" (Murphy 2012) – which is related to the specificity of different semiotic media. As has been widely discussed, design is iterative – with each stage of sketching, modelling, and refining a product or building emerging from the results of the prior stage (Baxter & Berente 2010; Henriksen, Richardson & Mehta 2017; Jonassen 2008). Within this broad context of iteration, during each phase of activity, the direction of sense-making tacks back and forth between the digital and the analog until these are more or less reconciled in a final material object. Along the way, human actors engage with each other, as well as with various tools, technologies, building and model-making materials, as they punctuate, shape, and discursively negotiate the trajectory of sense-making (Murphy 2005, 2012; Nicholas & Oak forthcoming; Oak 2011, 2013; Yaneva 2009, 2012). With regard to this process, we highlight the extent to which translation from one form of design media to another (and back again) is more than a question of technical competency. In our view, disjunctures or problems arise from the way different semiotic media telescope habits of sense-making, the way these unfold in time, how they are arranged and ordered, and the social relations involved in their production. This mode of analysis is critical to the understanding of design and architecture practice more generally, though to date it remains a relatively neglected approach. The insights from this research also offer an important contribution to the study of design and architecture education, where the disjunctures or problems we describe are in fact productive: built into the structures of education and professionalization, driving the learning process itself. Our discussion of these issues here is loosely structured by three illustrative episodes.

This paper has emerged from the "Thinking While Doing" research/creation project (funded through the Social Sciences and Humanities Research Council) that brings together four North American architecture education programs that feature courses in "design-build" architecture. Design-build courses are increasingly popular with students. These classes involve students in fully realizing structures that, while usually relatively modest in size and in terms of their infrastructural requirements (e.g. plumbing, electricity, HVAC), nevertheless require that students engage with "real" clients, real engineers, real subcontractors, and real budgets. The drawings and models that design-build students make will contribute to the creation of a full-scale structure, which itself is built by the students who work together on "real" construction sites. The design-build experience is substantially different from much architecture education wherein most projects are, inevitably, hypothetical. That is, studio-based students draw and make models of structures that will never be built, due to the complexity, expense, or time involved. Traditional architecture education is also hypothetical because a considerable portion of architecture education is oriented towards imaginative experimentation, where the student's challenge is to invent what *might* be possible, rather than to actually realize it. Design-build projects thus straddle the design studio, physically sited in the specialized setting of an educational institution (Farias and Wilkie 2016), and the more accessible locations of the public domain, since most design-build projects are constructed with the intention that they be used by members of the general public (Hardin, Eribes & Poster 2005; Harris and Widder 2014; Kraus 2017).

The Thinking While Doing (TWD) project is striking because students are working with their professors (and other participants, such as engineers, local clients, materials suppliers, etc.) to design and build structures that are both realizable and also "structurally innovative" (their definition). Each of the TWD buildings is a gridshell – a curved shelter made of either a timber or metal lattice that forms the roof or the roof and a substantial portion of the walls. As Chilton and Tang point out in their recent book *Timber gridshells: Architecture, structure and craft*, the gridshell poses interesting problems for architects, engineers, and the craftspeople who build them, with "recent developments in digital design, 3-D modeling software and timber fabrication technologies reinforcing architects' interest" in these structures (2016; frontispiece). The innovative nature of the TWD gridshells is a significant issue with regard to our discussion, since there is no straightforward template or precedent that the participants can follow in either designing or building these structures. Moreover, while the professor who is leading the overall project has considerable

expertise with the specificities of gridshell construction, not all of the other professors do (though they do have a high level of knowledge concerning structures in general). Likewise, the engineers, who are working closely (if at a considerable physical distance) with the professors and students, have varying levels of acquaintance with calculating how the gridshell materials can be expected to react to the conditions of form and site. In consequence, the engineers are actively negotiating with the experience and knowledge evidenced by the professors and students, as well as with the analytical and sense-making capabilities of their computer programs, as they model and produce technical drawings that assist those on site with the gridshell creation. All collaborators - the engineers, professors, and students - are engaged in ongoing problem solving with the knowledge acquired through the series of small gridshell projects, subsequently brought to bear on the largest gridshell (a timber structure that is currently being built in a National Park in Canada, and which features in the latter part of this paper).

The TWD project is also striking because, along with the architecture professors, students, and engineers who are designing and building the structures, the project includes a group of social science and humanities scholars who are following aspects of the builds, and reflecting upon them through the lenses of philosophy and history, as well as sociology and anthropology/ethnography. It is to this group that we belong, as we (Nicholas and Oak) study the various aspects of designing and building through an ethnomethodologically-influenced ethnography (Suchman 2006). By audio and video-taping the everyday occurrences of designing and building that would have happened whether or not we were present, we collect data that, upon reflective analysis, enables us to explore how the students, instructors, and others work intersubjectively to construct meaningful, common-sense views of what is going on in specific contexts of action. We are concerned to outline how participants collaboratively build meaning with each other and also with tools, materials, and modes of representation and simulation. Through this ethnomethodologically-inflected approach, we seek to understand how participants display in and through their multimodal interaction the understandings, misunderstandings, and resolutions that enable the gridshell structures to move towards completion.

As already noted, in this paper, we consider three vignettes that index and illustrate moments of translation or “transmodality” (Murphy 2012) wherein the specificity of different semiotic media – ranging from the printouts generated by a CAD program to “real” PVC or metal pipe – are sufficiently incommensurate to cause confusion, on-the-spot problem-solving, and discursive engagement amongst the participants. The first episode is not from one of the TWD projects, but from a conference featuring architecture professors, many of whom were discussing their design-build projects. The second is from one of the TWD project sites, “Southeast University” (in this paper all institutions, people and locations are given pseudonyms, with the exception of the professor whose published work and conference presentation are discussed in episode one). In this second episode, as discussed below, two students are grappling with the difficulties of translating a computer drawing into the materials and processes that will realize a bench – part of the seating that is planned for the gabion walls of the larger gridshell site design. The final episode follows a professor and several students as they seek to reconcile an engineer’s computer-generated technical drawing and the actual materials and structure that are in the process of being constructed. In this episode we particularly consider how an instructor and his students move from considerable confusion to partial resolution through employing a stance of humility and focused attention towards the items they are addressing: a computer drawing, hand sketches, various materials, a laptop screen, and the “real” structure of the gridshell’s steel-truss edge beam.

2 Episode 1: Making sense of ruled and unruly materials

At a recent conference on design-build architecture education sponsored by the American Collegiate Schools of Architecture (ACSA), Tiffany Lin, a faculty member from Tulane University, related a series of case studies meant to convey problems of sensing and sense-making across different design

modalities. Though she didn't frame it this way, her presentation was concerned with the issue of what Keith Murphy (2012) has called "transmodality" – the production of sequential, linked semiotic chains over long periods of time and across multiple semiotic modes (p. 1966). In these cases, Lin was pointing to disjunctures or dissonance between the modes of the digital and the analog – here, the 3-dimensional and gravity-governed materiality of paper, earth, tools, and PVC pipes. For Lin, these disjunctures related to both a pedagogical problem and one of professional ethics, concerns that design-build education explicitly seeks to address.

We begin with a re-telling of aspects of her presentation, which she titled, "Level and Plumb Without Rhino." For those unfamiliar with Rhino, it is a 3-D modeling software used by architects, designers, engineers, and others. Lin began by showing her winning design for innovative disaster relief housing, composed entirely of SIP panels (Structural Insulated Panels), one of which featured multiple oval-shaped cutouts or apertures. She showed the audience the computer-rendered line drawing of the apertures, marked up with detailed measurements, and then described how her students initially approached the problem of fabricating these apertures. In accordance with their training, they began to make sense of the problem in Rhino (see Fig. 1). Lin re-traced the students' proposed modeling sequence: First, you would 3-D model the pipe in Rhino and intersect it with planes; Second, you would run the "Boolean Split" command, which produces the cut oval surface; Third, because the Rhino model surface is a "ruled surface," you can then "Unroll surface," making it into a template on a flat plane, which can then be plotted, printed at full scale on paper, and wrapped around the actual PVC pipe to mark where the cut should be made. However, Lin dismissed the students' approach as wasteful, in terms of time, plotter paper, and ink. Then she introduced the advice and expertise of a local craftsman involved in the project.

> *Then this wonderful craftsman, [who had] this intrinsic understanding of water and earth and gravity that comes with the working of materials - so that's the difference between the craftsman and the designer, they first explore the material, and then they learn. So, he looked at it and said, well, stick it in the tub - and that was like an ah-ha moment for everybody working on it - stick it in the tub, because ultimately that water line of wherever you intersect is going to be level - water will find its own level. (Lin, 2014, oral presentation)*

Though in the end the architecture students modified the craftsman's suggested method to produce a kind of jig to mark the pipes, the principle they used was the same.

As Lin pointed out, the craftsman and the architecture student are coming at the problem from different starting points – both of which are ingrained from practical experiences – for the students, the habituated practice of using Rhino to design, and for the craftsman, the experience of putting together various construction materials to make an object or structure, for which the act of testing the level (horizontal) and the plumb (vertical) (using gravity and a spirit level), is a regular occurrence. Part of the intention of design-build education is to challenge the students to consider and deal with these problems of transmodality – between a Rhino model, and the particular conventions and logic which govern the software's version of space, and a full scale PVC pipe, with weight, thickness, and other specific material qualities, as these relate to tools and instruments like a jigsaw, straight edge, and SIP panel. As Lin's case study suggests, the problem is not simply one of moving between or across different semiotic "modes," what Gunther Kress and Theo Van Leeuwen (2001) describe as the affordances and resources brought to bear in making meaning material. There is a disjuncture here between the different "worlds" conjured up in the digital space of Rhino, versus the 3-D space governed by the laws of physics here on Earth, and the differing logics and sequences of proper or efficient action to be taken in these worlds.

Moreover, the sense-making habits learned as appropriate to each of these "worlds" emerge from different contexts of social and labor relations – for example, the relations and roles specific to architecture education and ultimately professional practice, versus the relations and roles specific to

the construction site or workshop. A significant premise of design-build education is that you're a better architect if you have at least an inkling of how a maker or craftsperson makes sense of the world of building and materiality (Boling 2017). Through insisting that students actively participate in the mundane activities of encountering materials, calculating budgets, and undertaking construction, the students' bodies, as well as their modes of cognition, together demonstrate an ethical commitment to realizing the everyday practices through which the built environment is created (Rockhill & Kraus 2017). In the illustration discussed above, Tiffany presents both the recognition of this commitment, and the students' desire to realize it, while also acknowledging their lack of understanding when compared to the knowledge and skill of a seasoned craftsperson.

Further, however, her comments suggest a conundrum that often plays out in the setting of design-build courses: students seek out and desire the "hands on" experience of making "real" structures at the same time as much of their studio-based education (and their extra-curricular engagement with the digital world) is increasingly screen-based, and underpinned by the structured simulations and algorithms of computational drawing and modeling software (Loukissas 2012; Turkle 2009). This again relates to design-build's professional-ethical commitments, namely an insistence on the value of handcraft, making and construction experience *alongside* the digital and computational skills which have transformed both architecture education and practice (Bruegmann 1989; Llach 2015). Lin's comments, her consternation at the students' reliance on "thinking with Rhino," echo those of the engineers Loukissas (2012) spoke with at Ove Arup: in short, a concern for a kind of de-skilling, which is in part a generational issue where younger designers, "ignore what's behind the software, the building physics" (p. 32).

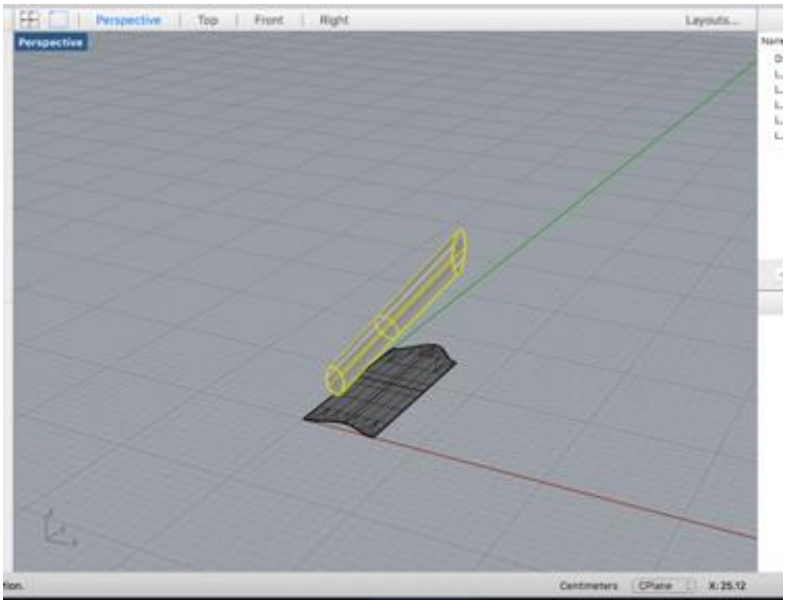

Figure 1. Re-tracing students' Rhino logic, step 3. Source: Authors' image, modeled after Lin, 2014, slide presentation.

3 Episode 2: Reconciling Paper, Wood, and Power Tools

The second episode is drawn from the TWD project's ethnographic fieldwork conducted within Southeast University, an American university school of architecture, in the context of a design-build studio course in which instructors and students are working to create one of the gridshell pavilions. Towards the end of the semester, the students were working feverishly to complete the mock-up of a series of full-scale prototypes of various project details in time for the final design review. These prototypes included the gabion landscape walls and bench seating. In the days leading up to the review, we followed the trials and tribulations of a group of students working to mock-up the bench seating (see Fig. 2). In what follows, we'll highlight several problems the students encountered along the way, problems of material resistance, bodies that falter, and sequence.

Two students, who we'll call Jesse and Sarah, began to develop the prototype with a discussion of a paper printout of a CAD drawing created by Jesse. The bench was designed as a 4-foot long, curved, slatted bench whose width was composed of 18 wooden lathes separated by spacers. The students' initial conversation referenced Jesse's drawing, in order to imagine the materials, operations, and temporality involved in making it in "reality" and at full scale. However, they were quickly confronted with the inherent vagueness of the drawing – it captured elements of the "what" of the bench (its basic dimensions and shape), but not the "how" of bringing it into being. In particular, it did not sketch how the jig – the device to shape and hold the bench slats in the curve as it was being fabricated – should itself be made. Thus, when it came time for the students to make the jig, and determine how to bend the wooden slats into the appropriate shape, they had to improvise: the drawing was of little assistance. This improvisation included experiments with clamping techniques, which themselves produced secondary material and force effects which then had to be accounted for. For example, the wooden lathes on the outside of the bench curve started to rise up slightly off the surface of the jig in response to the pressure of the clamping. This was ultimately managed by literally screwing the lathes down to the wooden jig. But the solution itself brought about a problem, and later Jesse had to use an angle grinder and pliers to remove one of these screws in order to lift the bench off the jig.

As noted in our introduction, the problems Jesse and Sarah encountered here cannot simply be attributed to the fact that a line drawing and an assemblage of building materials communicate different "content" or in a different mode. We return to the claim that different media telescope different habits of sense-making and their temporalities, as well as the social relations which structure these habits. Here, one of the main issues the students discovered was the issue of sequencing – the proper ordering of actions in time. The CAD drawing is a finished object (though not sufficiently developed for a smooth translation into 3D full-scale wood); it stands at the end of the process of sense-making performed by Jesse on the computer. That "ending" prompted a new sequence of sense-making and problem solving: the making of the jig and bench. This emergent and iterative quality of designing and making is of course one of the central qualities of skilled practice, as discussed by prominent anthropologists and theorists of craft (Ingold 2000; Scott 1998; Sennett 2008). But here the endpoint of one iteration did not provide much in the way of assistance in guiding the next. Anyone who has taken technical spec sheets and tried to fabricate an object understands the value of sequentially segmented diagrams (i.e. IKEA drawings), but Jesse and Sarah learned that lesson over the course of hours during which the solution to one momentary problem created the next problem to be solved (and so on). At the outset, they had assumed the line drawing – the result of a relatively friction-less process of playing with "shape grammars" in CAD (Knight 1999; Stiny 2006) – would more or less correspond to the process of arranging eighteen wooden lathes in a curved bench shape. Or at least, they had not bargained for the magnitude of the difference in practice.

Jesse and Sarah's challenges were compounded by the issue of precision and their mastery, or lack thereof, of power tools. Though the students carefully marked and drilled through each of the eighteen layers of the bench slats as they went along, at the end of the process some of the holes were misaligned. Jesse needed to re-drill through all eighteen bench slats and the spacers, in order to insert a threaded rod to hold everything in alignment. This is at least partly attributable to the fact that materials push back, and it takes a fair bit of experience – embodied knowledge – to be able to use a power drill as though it is an extension or prosthesis of the hand and arm, to develop a sense for how hard to push, how to position the body and the hands for maximum stability, how to keep the drill level, etc. In this particular instance, we have the opportunity to observe the formation of what Sennett (2008) calls the craftsman's "material consciousness" – essentially a felt or embodied sense of the materials at hand, their possibilities, limits, and "behaviors." Notably, this is simultaneously a feel for the possibilities and limitations of one's own body. Ideally, this results in a kind of seamless embodied intersubjectivity (person plus tool plus materials), what Ihde (1990) has referred to as an "embodiment relation" between human and technology. But as novices, Jesse and

his fellow students often initially encounter both tools and materials as antagonistic “Others”, an extreme form of Ihde’s (1990) characterization of the “alterity relation.” While the ultimate goal of design-build education is not to make every student a master craftsman, the pedagogical ethics espoused by many professors privilege giving students at least a taste of what those who build might experience in the execution of the architect’s vision.

Figure 2. (Top) Finished prototype, gabion bench. (Bottom) Students crafting bench prototype. Source: Authors’ images.

4 Episode 3: Transmodality and Collaboration

The third, and concluding example is drawn from fieldwork among architecture students and faculty involved in the largest of the TWD project's design-build gridshell pavilions, in this case the final gridshell which is constructed in a Canadian National Park, and which involves participants from each of the architecture programs who earlier created smaller gridshells. This episode also involves the challenges of transmodality. Here, however, we're concerned with both what's "lost in translation" *and* the excesses or "what's gained" in working transmodally and collaboratively. To outline the context, at this point in the project, the concrete foundation and walls of the large gridshell structure have been poured, according to the specs of engineering-approved construction drawings, generated in part from a 3-D Rhino model. The situation that follows is centered around the design and fabrication of a triangular steel truss which was in the process of being mounted on the walls, and which will ultimately support and "finish" the lattice-gridshell roofing system.

At the beginning of one day on the site, the instructor gathered with a team of students around a computer-generated, printed construction drawing of the truss-webbing pattern. The discussion began with the professor and project manager (a Master's student) identifying which section of the truss the drawing represented. Students and the professor first pointed at various places on the drawing, then through speech that connected finger and gesture with the drawing, they sought to relate the drawing to the "real" built structure, which they occasionally looked towards for reference (it was around 50-60 meters from where they were meeting). Given the group's difficulties in understanding the relationship between the two-dimensional computer drawing and the actual truss-webbing, the instructor pulled out a pencil and started to sketch a more realistic, perspective rendering of the engineer's more basic rendering. As he sketched, he labeled parts of his drawing in correspondence with parts on the computer drawing. The discussion then became intently focused on how the two drawings corresponded, with considerable confusion ensuing concerning the relationship between the computer-generated construction drawing, the pencil-drawn sketch, and the "real" partially-built metal truss (see Fig. 3, top).

Eventually the group re-located to a spot directly next to the truss to more closely consider the relationship between the drawings and the metal structure. The printed drawing was placed on the wall and the project manager brought over her laptop, which contained an image of the Rhino model (the model had been created collaboratively by the students, the engineer, and an architectural consultant with experience in gridshells) (see Fig. 3, bottom). Various students intently engaged with the problem – attending to and thoughtfully expressing their ideas concerning the principles of triangular truss webbing systems. Their perceptions, largely drawn from memories of coursework, mostly concluded that the engineer's drawing couldn't possibly be right. The instructor, still seeking to understand the incongruities between the modes of representation, pulled out a length of orange string and tied it around the metal frame, interweaving it in the truss configuration he believed to be correct (noting as he wrapped "nothing like, you know, visualizing"). The instructor also engaged in a highly-focused discussion with a student who, through gripping the metal frame and gesturing with reference to how he believed the engineer's system worked, explained what he thought was going on: that the engineering drawing did not take account of a change to the structure (to add a steel plate in place of one side of the triangular truss).

At one point in their exchange the student advances the notion that part of the truss diagram has been replaced by the "real" steel plate, and the professor considers this opinion carefully by checking the student's words: "alright, so you're saying it's plausible *if* you didn't have the plate and *since* you have the plate it's okay?" to which the student replies "right, the plate resolves". While considering this proposal, the professor climbed on the structure, took a series of iPhone photos of the string (as a possible truss pattern) and then, emailed these to the engineer. A few hours later the engineer responded, with the information that the webbing pattern the engineer had modeled (and that was on the original drawing) was derived from the standard design of a triangular truss and dated from a time when the gridshell's proposed truss respected that standard. However, in

subsequent design phases, the professor and students had decided to substitute a metal plate for one side of the truss. But the engineer's model hadn't been updated to reflect this - in effect confirming the suspicions that the group arrived at when deliberating on site. In the end, to further change the webbing pattern for what the architects thought would be a more satisfying "aesthetic" reason would require another week or more to re-model and re-test the structure, so the group ultimately decided to follow the original webbing design, which they would use alongside the metal plate.

The total time of this sense-making episode, in which the students and professor puzzle over the lack of correspondence between the computer-generated drawing and the "real" structure, is over half an hour. The time until the engineer cleared up the confusion was several more hours. In this example, the interaction and engagement with the materials and forms of representational media follows a somewhat circuitous path, but it illustrates the myriad ways and modes by which the architects attempt to reason and make sense of the best way forward, given the "plans" charted in the past by others (i.e. the engineers, or even previous versions of themselves). In particular, this episode demonstrates the nature of collaborative sense-making when a structure is particularly innovative. That is, this gridshell is not of a standardized type that participants are familiar with from previous experience, or that can be readily extrapolated from existing precedents, therefore making sense of it requires particular actions of "puzzling through."

What occurs here reveals the imperfect seaming of one semiotic medium to another – from the CAD-rendered plan elevation to a hand-drawn perspective, to many conflicting verbal descriptions and to a full-scale physical structure. But also, and no less critical, we see evidence of the swirling quality of collaborative sense-making in these circumstances of uncertainty and disjuncture – the processual reconciling of multiple opinions (all of which are informed by varying levels of engagement and history with this particular project, and skill levels) – in conjunction with bringing all available tools to bear on the problem. No matter that in the end they could have just proceeded with the engineer's webbing design and saved considerable time. Part of what was pieced together in the process recounted here was a more comprehensive understanding of how and why decisions were taken in the first place, and a consensus about how to move forward as a group – further cementing (forgive the pun) the cohesion and social relations within the group itself – not an inconsequential thing for a project of this nature.

Indeed, we would argue that it is partly through the manner in which a tenured professor (and expert on structural forms), talks with a Master's student (the current project manager of the gridshell), and several undergraduate students, in ways that overtly display his misunderstanding and incomprehension that inter-group cohesion and social relations are fostered. That is, because it is clear that the professor genuinely does not understand how to make sense of the drawing in relation to the structure, all the students become actively focused on solving the problem alongside him. All participants grapple with the matters at hand, and remain fully engaged, despite only coming to a partial understanding of what is likely going on (an understanding that is eventually confirmed later by the engineers: i.e. that the drawing they had been referencing had not taken account of a panel that replaced a series of trusses). However, it is in working through the confusion together that the students and professor parse aspects of the relationship that exists between a distant engineer's calculations and the materiality of welded steel. Students also witness the relationship that exists between the professor's confusion and his persistence in bringing all faculties to bear upon his goal to understand – whether that be hand drawing, gesturing, engaging with the "real" structure, measuring, wrapping string, and listening intently to others. While the professor does seek final confirmation from the engineer, who he clearly trusts (at one point as he is talking to the students he describes the engineer as "totally solid"), the professor does not do so until fully working through, with and alongside the students, what might be going on with the drawings, trusses, and steel frame. By fully engaging with what is simultaneously the social and the practical

aspects of design we can see how a kind of humility of discovery exists between human participants, hand and computer-generated drawings, and the relative immutability of the welded-steel truss.

Figure 3. (Top) Professor and Project Manager (MA student) parse the engineer's drawing. (Bottom) The group engage in sense-making on/near the gridshell. Source: Authors' images.

5 Concluding comments: Architecture as socio-material practice

Throughout the paper, we have addressed three facets of the socio-material nature of design, making, and technological mediation (Ihde 1990, Latour 1994). First, in episode one, we considered the ethical positioning of design-build vis-à-vis professionalization and hand / digital craft, as well as

the larger social and professional context of the construction of the built environment. Second, in episode two, we examined the socio-material and embodied dimension of working across and with various design media and materials, and insisted that an ethnographically-informed study of architecture practice sheds light on the various relationships novice (and expert) architects must develop with tools, materials, representations, and their own bodies. Third, in episode three, we emphasized the intersubjective and communicative aspects of designing and building with others and explored how the disjunctures between design media, and the misunderstandings and uncertainty which followed, in effect facilitated both student engagement and learning. The "not knowing" that underpins the designing and building of innovative or unusual structures means that participants – including senior professors - may open themselves up to a level of discomfort wherein the "live performances" of doubt and bewilderment may necessarily occur as often as the more reassuring presentation of resolution and understanding. We argued that in fact these secondary effects of working transmodally are central to the pedagogical model of design-build education. Indeed, given the nature of design-build education, where students and instructors collaborate at all levels of a project, it is through seeing how a professor manages doubt and confusion that some of the most profound lessons of architecture may be learned. Together, these vignettes affirm the productive nature of disjunctures and working transmodally (and collaboratively). In other words, we propose that disjunctures, uncertainty, and confusion should not be treated as problems with the pedagogy (and therefore to be eliminated), but rather as built into the mode of teaching and learning itself. They are thus central to guiding and pushing forward inquiry and learning for design and architecture novices.

Taken as a whole, these vignettes point to the ethics of particular design-build projects as educational opportunities wherein hand skills and digital skills are valued, and where the experimentation and interiorization of the studio space is directly connected to the outside world of construction site and community. Of course, encompassing such diversity involves messiness and risk, that, as we have indicated here, occurs both at the level of confusion concerning materials, tools, calculations, and representations, but also at the level of social interaction and role performance. In these contexts, understanding is created over time, alongside and through materials (PVC or metal pipe, wooden slats, truss rods), tools (jigs, clamps, drills, string, smart phones), representations (drawings on paper and on a laptop screen), embodied gestures (pointing, grasping, measuring, reading), and discursive action (conversation), and as such points to the profoundly social dimensions of designing and building with multiple others.

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Scenes of Writing

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This paper looks at how speculative fiction can provide a design space to explore the effects of technologies for critical interpretation. Using *Trina: A Design Fiction* as a case study, the paper builds upon Lucy Suchman's study into how technology teams design "the human" in tandem with the computer, asking can there be a model of "the human" suited to technologies for subjective judgment? Looking closely at the characters in *Trina*, we see individuals whose capacities, specificities, social histories, and individual biographies inform the degree of agency that each has with the writing technologies that define their work and worth. Accounts of writers and their inscription technologies found in recent literature from media and literary studies further demonstrate the contingent nature of textual composition. Rather than look for a generalized human-computer fit, the paper argues for the design of story-worlds in which specific humans, non-humans, and networks are designed in one and the same gesture, revealing the productive misalignments and contested boundaries that define their interactions.

design fiction; human-computer interaction; writing technologies; digital humanities

1 Introduction

When I set out to create a design fiction in order to imagine future technologies for critical interpretation, my choice of genre was driven by the need to design things that don't yet exist and the activities and worlds these new things might make possible. In particular, I was interested in what happens when digital tools for reading and writing are conceived to support literary interpretation informed by critical theory. I had already been working on that question for years in collaboration with literary critics and linguists through applied projects such as the electronicbookreview.com and the Austrian Academy Corpus. But I wanted to be more ambitious than current budgets and technologies would allow. I was interested in the n-dimensionality of interpretation (McGann, 2001), the design of visual epistemologies (Drucker, 2014), and the subjectivities and ambiguities central to feminist and literary theories. I wanted to provoke new thinking and questions about what might be if these theories were the starting point for the design of interpretative tools for the Digital Humanities. I wanted to see if one could design software for reading and writing that embodied and enabled critical thinking.

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Thus, I created *Trina, A Design Fiction*, a story told through sixty images plus narration that could be realized as a graphic novel or performed as a 3-part *PechaKucha* (1 part = 20 slides, 20 seconds each), co-written with author Janet Sarbanes. The design work went beyond building a new digital tool; I had to develop an entire story world, the scenes of reading and writing referred to in this paper's title. Creating a narrative-based design fiction — an actual story with words and pictures as opposed to the objects or installations — necessitated that I design situated actions *in toto*: in a specific place and time with specific humans and specific things along with a network of specific forces, all of which pushed and pulled on the action as it unfolded throughout the story. This required creating an assemblage of humans and nonhumans in an iterative, mutually-defining cycle. From a speculative design perspective, it turned out to be the borderlands — the interactions and intra-actions amongst this assemblage — that gave the story its shape.

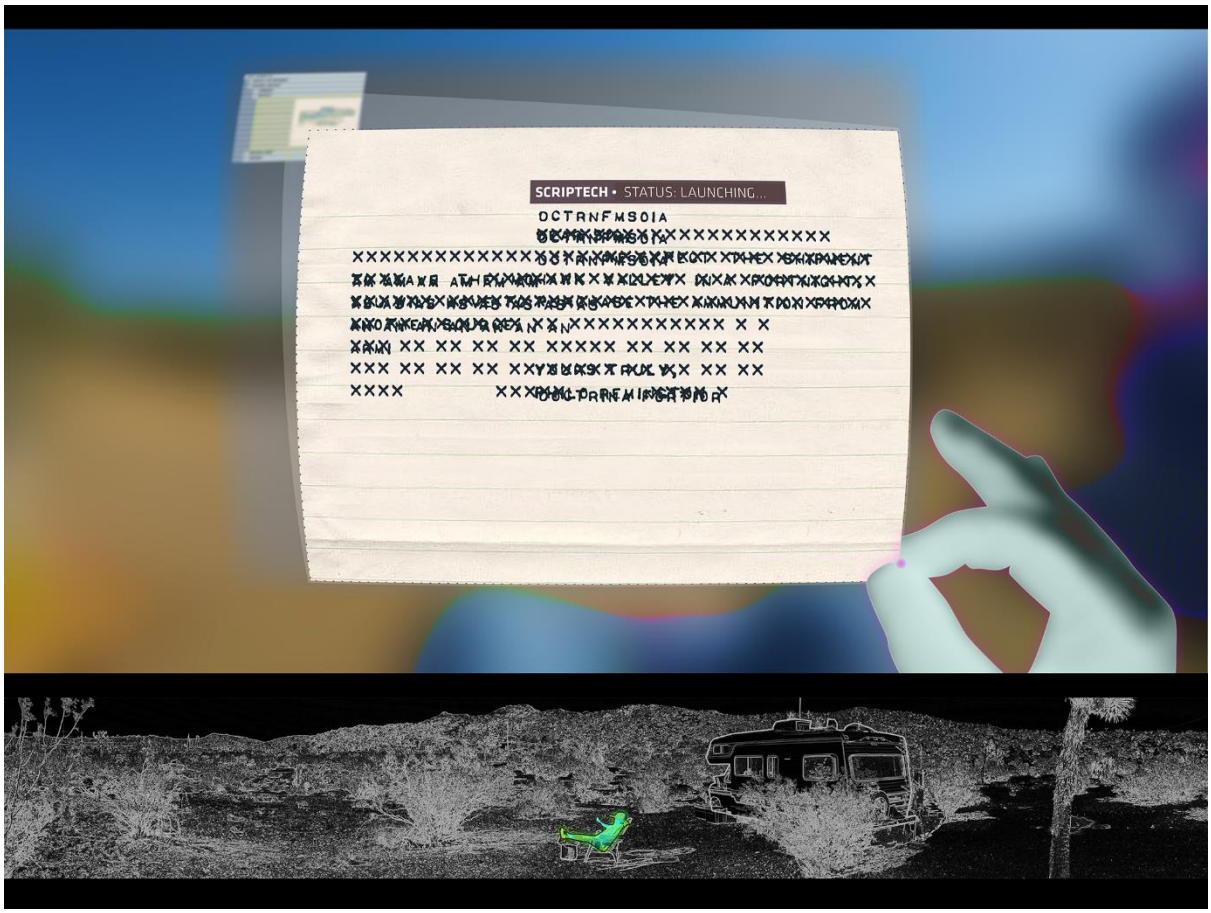

Figure 1. A screen/panel from Trina: A Design Fiction. *Each screen/panel captures a single moment from two perspectives: Trina's first-person view on top and a third-person panorama on the bottom with Trina at the center. Shown here: Trina selecting the text of the "Doctrina Letter" whose elusive meaning and provenance drive the story.*

The *Trina* project — particularly the research that informed my design decisions — also allowed me to investigate the fit of technology development best practices, such as user-centered design, for the creation of software for critical interpretation. It forced the question: can the act of writing be framed as a kind of use? Informed by Lucy Suchman's research into how designing human-computer interactions involves configuring the "human" in tandem with the "computer," the project investigates what model of "the human" is best suited to the design of technologies for subjective judgment. (Suchman, 2006) Thus the *Trina* project became an experiment in prototyping a complicated, messy, and situated subject in tandem with her digital counterpart. Informed by theories of distributed agency, the story demonstrates how software design can only account for so much. As we shall see, textual composition is contingent upon complex interactions amongst writing technologies, language, the body, and social and political forces.

2 Messy subjects: Trina, Ida, and Doctrina

Trina envisions the mixed reality world of a literary scholar who works alone in an RV in the desert, sometime in the future. Through Trina's eyes we see the software-mediated daily reality within which she must interpret a cryptic, typewritten document (the Doctrina Letter) as part of a text analysis H.I.T. (human intelligence task) she takes on to make ends meet. But it isn't until she gets into the gendered history of the typewriter and assumes the hands of the typist that she is able to decipher the document's hidden meaning. And although Trina herself works with devices implanted in her eyes and her hands, it is her embodied relationship with writing that renders her a cyborg.

Trina's implants allow her to interact with a virtual environment. Her digital eyes and fingers are committed to her employer, Humanitas Inc., a service in which analysts decipher documents mainly for military and government intelligence in the War on Terror. In the backstory for *Trina,* Humanitas Inc. is conceived as an employment agency for freelance digital humanities scholars who are recruited for their skills in computational text analysis. As a labor pool, they are cheap and abundant, due to the demise of Humanities departments in universities across the western world. One of the benefits of working for Humanitas Inc. is that Trina gets access to many other areas of the information network, access she used to get through her University.

Trina works with a few different kinds of "speculative software"—what Matthew Fuller calls "software whose work is partly to reflexively investigate itself as software. Software as science fiction, as mutant epistemology." (Fuller, 2006, p.30) For example, Trina does her work for Humanitas Inc. within Analyssist, an enterprise software platform. Analyssist has a variety of plug-ins, tools with which to perform various computational textual forensics to determine the provenance of digital documents. Analyssist is a proprietary, utilitarian environment of categories, forms, and fields that is hostile to ambiguity. As Trina says in the story: with Analyssist, "empty boxes are better than educated guesses." (Figure 2.)

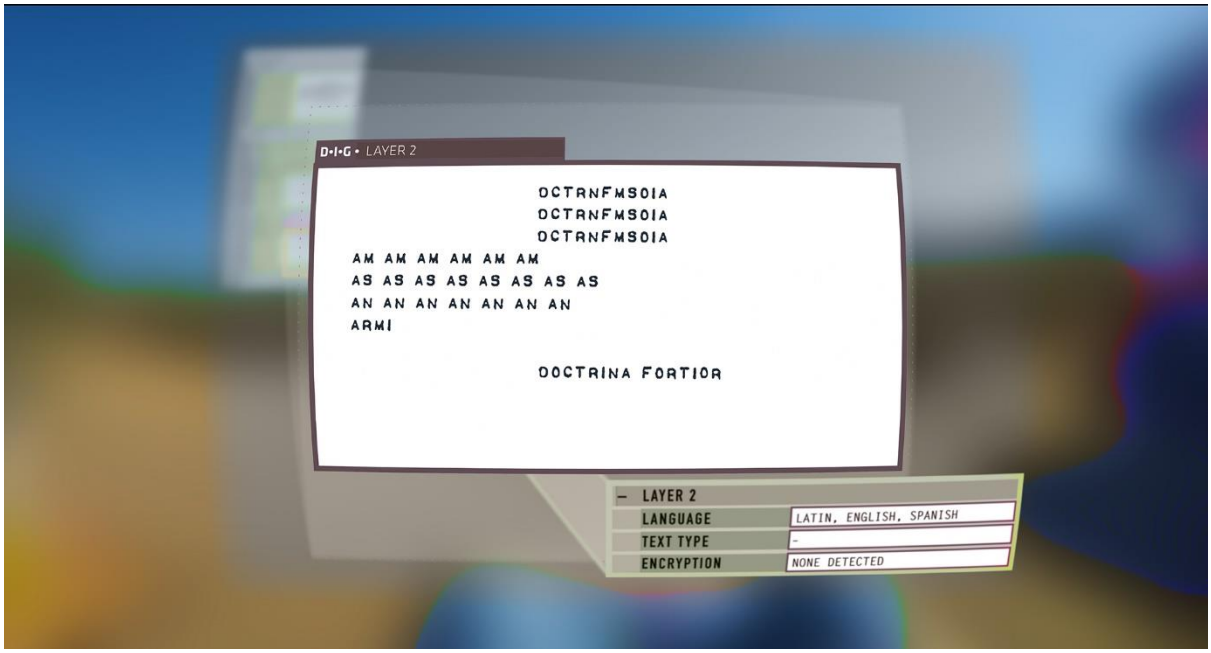

Figure 2. Detail from Trina: A Design Fiction *showing the telescoping form fields of Analyssist as seen through Trina's eyes.*

During her free time, Trina wanders The Commons, an open access 3-dimensional landscape of documents distributed across a horizontal plane — like the library, it is a scholar's playground. The spatial distribution of the documents is based upon a mapping of meaningful relationships between the visible texts and the reading subject. Multiple interpretations co-exist simultaneously; a reader can follow an unending path of associations. (Figure 3.) It is in The Commons that Trina works with a network of hobbyists and scholars to generate potential readings of the Doctrina Letter.

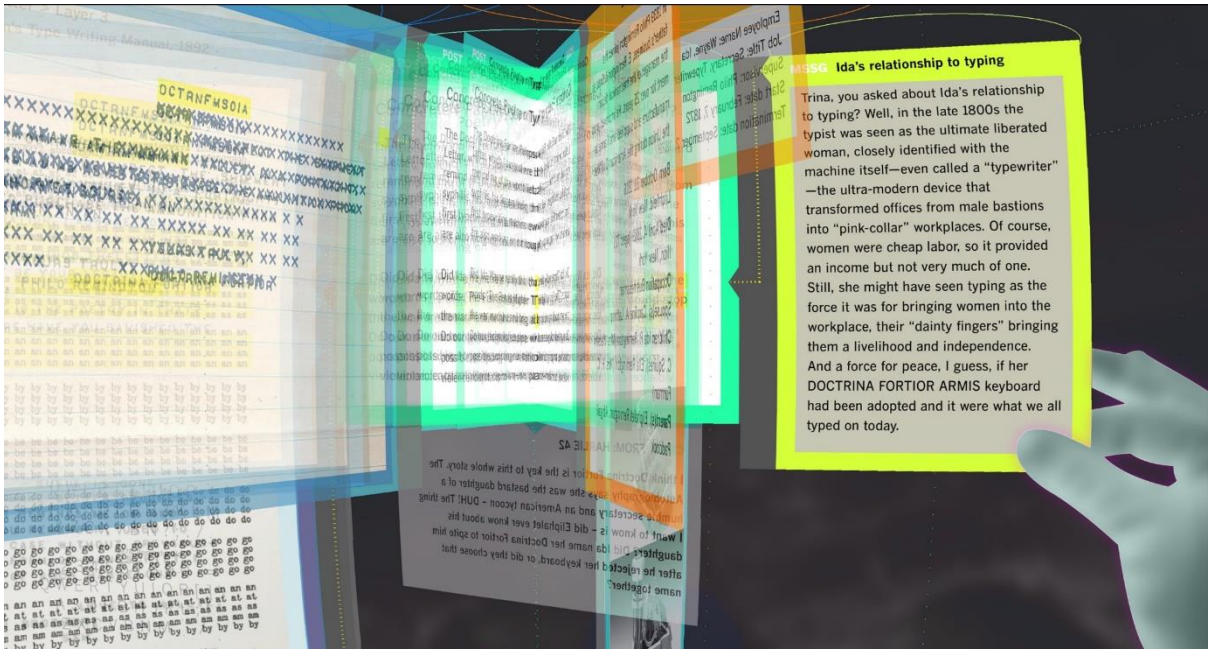

Figure 3. Detail from Trina: A Design Fiction. *Annotations, responses, and interpretations of a document in The Commons as seen through Trina's eyes.*

The assignment at the heart of the story is different from those that Trina usually gets: the Doctrina Letter is a historical print artifact, rather than a contemporary digital communication. It is a collector's item thought to be written on an early code-generating typewriter. (Figure 1.) Using her digital tools, Trina separates out the document's three layers and through some detective work determines that the page was composed in one of two places and times. It may have been created in 1874 by a secretary named Ida Wayne who worked for the rifle and typewriter manufacturer, E. Remington & Sons. Or it may have been typed in the 1920s by a concrete poet named Doctrina Fortior who may be Ida Wayne's bastard child. The provenance is unclear and the meaning of the document is open to numerous, conflicting, interpretations. Trina follows Ida and Doctrina's story within a story. The fictional characters are interwoven into the real history of the typewriter.

In the story, Ida Wayne is a single woman who in the late 1800s was the secretary of Philo Remington, then in charge of the firearms division of E. Remington & Sons, in upstate New York. Ida may be pregnant with the child of Eliphalet, Philo's bookish younger brother who is in charge of the mechanical type writing machine, which is in the early prototyping phase and will go on to become the Remington Standard Type Writer. Christopher Sholes has just introduced what would become the QWERTY keyboard to the machinists at Remington & Sons.

Like Sholes's real life daughter, and later Mark Twain's, Ida is the young woman who works the typewriting machine for the men. She is one of the first Type Writers as such women were called. But Ida has ideas of her own and sees in the typewriter a chance to inscribe thoughts into people's minds as they press the keys. Ida believes in the aphorism "The Pen is Mightier than the Sword," and sees the keyboard as a chance to spread her pacifist ideals. Trina speculates that Ida convinced Eliphalet to create a prototype typewriter with the letters from the Latin version of this aphorism as the top row of keys (DOCTRINA FORTIOR ARMIS = DCTRNFMSOIA). If so, and if Ida used the prototype to type the artifact, the question for Trina is: what do the layered texts mean? Was Ida simply practicing with the keys? Or was she composing some kind of poetry or secret message? And why does what appears to be gibberish so closely resemble typing exercises that were published later in the *Type Writing Manual* of the Christian Women's School, where Ida was next employed? Ida's class and gender gave her a limited ability to influence the design of a new writing technology. Trina ponders: since Ida's attempt to alter the machine itself failed, did she instead try to alter its

use? Did she compose typing manuals to affect the minds of the working class women whom she taught for the remainder of her life?

We know less about Doctrina Fortior, who may also be the author of the document, some thirty years later. In the story, the only thing we know about Doctrina is that she was a concrete poet who lived on the Left Bank and her poetry disappeared long ago. In *The Autobiography of Alice B. Toklas*, Gertrude Stein (in the *Trina* story) refers to her as having done "funny things with type. Everyone thought this is what writing should look like in the machine age." If Doctrina is the author of the artifact, it could be that she possessed her mother's prototype typewriter and used it to create her poetry. The text could then be read as a sly commentary on the embodied practice of learning how to type, a Modernist exploration of language. An alternative reading proposes that the piece is a literary prank that Doctrina created to comment upon her mother's predicament — "x-ing" out the secretary, the tycoon, and the typewriting manual on the same page.

As the story proceeds, Trina shifts between software environments, forced to make difficult choices that affect her ability to keep her job and her access to The Commons. She is bound, through her eyes and fingers, to her employer, much like Ida before her. Thus Trina's final act of defiance is to reprogram her fingers to Ida's keyboard, forcing herself to work only with the letters DCTRNFMSOIA as she communicates with one of Humanitas Inc.'s AI agents. Rather than continue to interpret texts in support of the War on Terror, Trina decouples from Humanitas Inc. and in the process exiles herself from The Commons. Trina and Ida each make life-changing choices by actively resisting the efficiency-maximizing designs of their writing technologies.

3 Writers and users

In Paul Auster's novel, *Ghosts*, part of *The New York Trilogy*, Blue is hired by White to spy on Black. Blue surveils Black using old-fashioned spy techniques, tailing him through the city from time to time but mostly watching him through binoculars from an apartment across the street. For hours on end — which turn into days and then months — Blue watches as Black sits at a desk writing. Black could be composing a hit list or a sonnet or a memo to Human Resources but through direct observation, Blue gets "nothing." Blue struggles with what to write in his weekly reports. For Blue, watching someone write is not only inscrutable, it's boring.

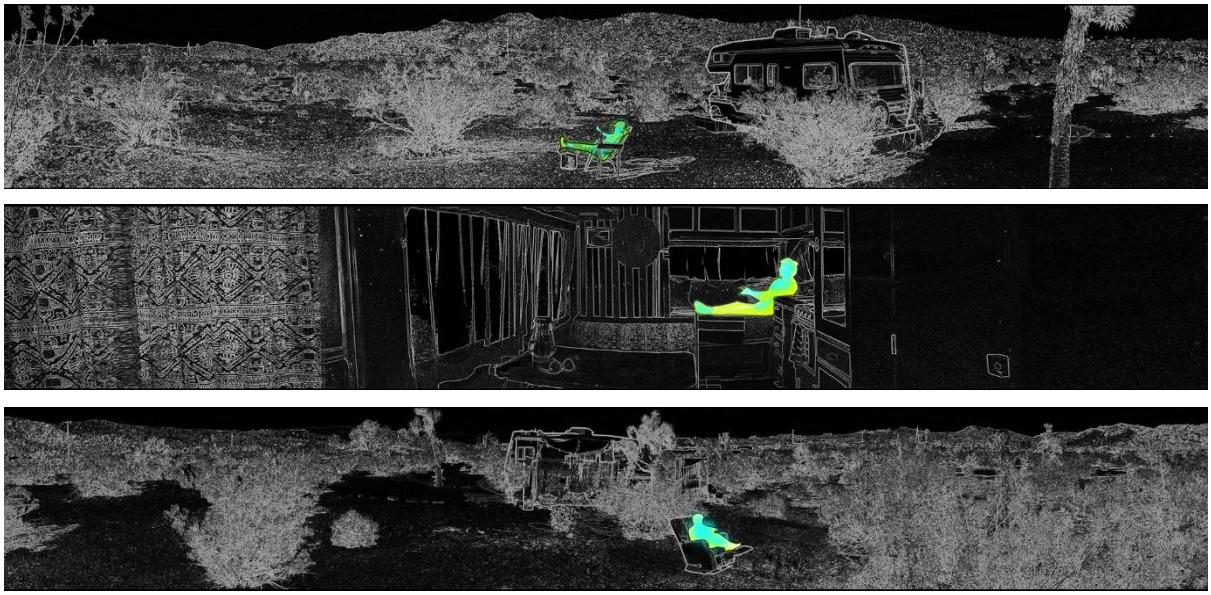

Figure 4. Details from Trina: A Design Fiction. *Panoramas show Trina writing in her favorite spots: sitting outside her RV in the morning (top); sitting on her daybed inside the RV (middle); and in her recliner outside the RV at dusk (bottom).*

But many are fascinated by how writers write, perhaps due to this inscrutability, and over the years there have been innumerable essays, columns, and interviews in which famous authors talk about how

they compose their texts. For the designer of writing technologies, these stories are rich first-person accounts but they are as varied as the authors themselves. Media archeologist Matthew Kirschenbaum brings a media theoretical perspective to *Track Changes, A Literary History of Word Processing*, (Kirschenbaum, 2016) a study launched by his curiosity about the first literary work written with a word processor. Kirschenbaum compiles stories gathered through published accounts and interviews he conducted himself. Throughout, the word processor is understood as part of a medial process, one of many different writing technologies that are configured by writers as part of their own individual working processes. Kirschenbaum seeks to understand the relationship between the technologies and the writing in an attempt to get at the materiality of word processing and the impact of the writing technology on the writing itself. "The reality, of course, is that every writer's individual habits and practices are deeply personal and idiosyncratic, and it is difficult, if not impossible, to extract patterns in support of generalizable conclusions — beyond the intense intimacy and commitment that the act of writing invariably demands." (p.22) Nonetheless, Kirschenbaum concludes that while writing technologies do not necessarily alter the content of writing, word processing software allows the writer to gain a sense of the whole manuscript that is more fluid than that of works composed on paper.

Writing literary theory and literary fiction are specialized practices laden with institutional, cultural, and social meanings and expectations. While in literate societies most people write on a daily basis, all textual production is not created equal. In her study of job printing, Lisa Gitelman makes the distinction between utilitarian forms of writing that structure transactions and literary forms that have publishers, authors, and readers. (Gitleman, 2014) Train tickets, tax forms, and letterheads stand in contrast to the bound sheets of paper that become novels or works of non-fiction. The former is writing in/as use while the latter is writing as subjective thought.

In his review of Microsoft Word circa 2000, (Fuller, 2003) Matthew Fuller claims that "the ideal of a word processor is that it creates an enunciative framework that remains the same whether what is being written is a love letter or a tax return." (p.146) And yet, he points out, the norms of writing embodied in Microsoft Word are geared toward the latter. Fuller uses the overly elaborated interface to deconstruct the model of textual management at the heart of the program, demonstrating how its templates support office work but resist literary composition. The heavily-loaded toolbar with its discrete tasks represents the programming ideology (object-oriented) and the organization of the developer workforce it enables. Within this division of labor, Fuller asserts that the user is but another object (rather than subject) who might need to spell check but who doesn't need to produce, say, "combinatorial poetry." (p.144) And yet many, if not most, authors of literary fiction use Microsoft Word as a default writing environment.

Still, authors remain who prefer the heavy physicality of the typewriter over the luminous fluidity of word processing — Kirschenbaum cites Cormac McCarthy, Joyce Carol Oates, Don DeLillo, and Paul Auster, among others. Auster begins by writing with pen and paper and then re-types the entire manuscript. Auster says "You feel that the words are coming out of your body and then you dig the words into the page. … Typing allows me to experience the book in a new way, to plunge into the flow of the narrative and feel how it functions as a whole. I call it 'reading with my fingers,' and its amazing how many errors your fingers will find that your eyes never noticed." (Kirschenbaum, p.21)

Sometimes this self-conscious relationship with the materiality of the machine makes its mark on the writing itself. In *Reading Writing Interfaces*, (Emerson, 2014), Lori Emerson looks at how the concrete poets of the 1960s to mid-1970s "sought to create concrete poetry as a way to experiment with the limits and the possibilities of the typewriter," drawing attention to the "typewriter-as-interface." (p. xix) Emerson claims that the poems "express and enact a poetics of the remarkably varied material specificities of the typewriter as a particular kind of mechanical writing interface that necessarily inflects both how and what one writes." (p.xix) This kind of writerly experimentation is what Kate Hayles (Hayles, 2002) might call a *technotext*. "When a literary work interrogates the inscription technology that produces it, it mobilizes reflexive loops between its imaginative world and the material apparatus embodying that creation as a physical presence." (p.25)

“The best writers have always understood that to write is to both grapple with, and to some extent, allegorize the very regime of technological mediation without which writing wouldn’t exist in the first place,” Tom McCarthy is quoted as saying in *Track Changes*. Kirschenbaum also conjures the idea of the interface: “The technological regime McCarthy is speaking of here is writing’s interface, by which I mean not only what is literally depicted on screen (menus, icons, and windows) but also an interface in the fuller sense of a complete, embodied relationship between a writer and his or her writing materials.”

Increasingly we see writers who also code their own software to conduct their research or compose their texts, particularly in the realm of the Digital Humanities. Since 1984, author John McPhee has been working with custom software that a friend wrote based upon his paper-based process of cutting, pasting, typing, and retyping. He has two programs, one that fragments his text into discrete units and another that combines them into a single orderly file. In “Structure,” he writes about how the software emulates the structures of his own thought. His are bespoke tools created in his own image. Kirschenbaum asserts, “to know the software is to know something of the mind of the writer, however obliquely.” (p.13)

For *Reading Project, A Collaborative Analysis of William Poundstone’s Project for Tachistoscope*, (2015) Jeremy Douglass created “purpose-built tools” to enact his interpretation of Poundstone’s screen-based interactive work. Together with co-authors Jessica Pressman and Mark Marino, Douglass observed: “The work teaches us that we need to read our reading machines in order to understand how they inform our perception, comprehension, and resulting interpretations.” (p.135) Indeed, in the conclusion to *Reading Project*, the co-authors discuss how the variety of emerging methods and media of their collaboration led them to ask: “If we were to imagine an online working space that would support and promote collaborative multimodal analysis of born-digital objects, what would it look like?” (p.142) The question led to creation of a tool called ACLS Workbench. Matthew Fuller would call such a project social software — “software built by and for those of us locked out of the narrowly engineered subjectivity of mainstream software.” (p.24)

In *Reading Machines, Toward an Algorithmic Criticism*, the “algorithmic reading” of Stephen Ramsay’s title proposes “that we create tools — practical, instrumental, verifiable mechanisms — that enable critical engagement, interpretation, conversation, and contemplation.” (p.x) Central to his argument is Jerome McGann and Lisa Samuels’s notion of “deformance” in which a reader manipulates a text, for example by reading it backwards, in order to see it anew and generate new interpretations. Ramsay advocates for digital tools that “…channel the heightened objectivity made possible by the machine into the cultivation of those heightened subjectivities necessary for critical work.” (p.x) By critical work, he means the close reading of literary interpretation. How might a digital tool “heighten subjectivity” and would that be considered a kind of “use”?

4 Couplings and misalignment

As we have seen, the narrow slice of textual production known as literary interpretation and literary fiction could be seen as being so reflexive, intimate, and multivariate as to resist any kind of generalization into uses and users. Writing is frequently understood by writers themselves as an extension of their bodies, their minds, and their identities. In that sense, writers are always already cyborgs, their subjectivity distributed across a network of circuits and instruments and substrates and institutions and industries.

This is the challenge for the software designer, even the speculative software designer like myself, who is not the intended user of the tool. I am Blue, staring blankly at Black. I cannot know what the writer is thinking. The act of critical interpretation is idiosyncratic and opaque. How, then, might those of us on the outside conceive of the complicated interactions between writers, their technologies, and their texts, let alone design software that is the perfect fit? And even if we could, who is to say that the writer-subject wouldn’t defy or rework the tool to their own liking? As Kirschenbaum, Emerson, Ramsay and others have shown — and as we have seen with Trina, Ida, and Doctrina — writers design, adopt, adapt, hack, and mis-use technologies in practice in myriad ways.

"There is no solution to the problem of distance between professional design and technologies-in-use, only different strategies for addressing it," writes Lucy Suchman in *Human-Machine Reconfigurations: Plans and Situated Actions* (2006, p.204). Regardless of whether she is configured (Woolgar), scripted (Akrich), or reconfigured (Suchman), the user is a construct that is built with and into technology and its development in myriad ways. Software designers and researchers work with real people as test subjects, marketing data, ethnographic raw material, and co-participants. They also develop fictitious personas and scenarios that help structure and delimit features and functionality. Regardless of the strategy, the purpose is to ensure that new technologies will be friction-free in future contexts of use. Suchman and others also note that the user figure plays its own role within an organization as different teams — marketing or engineering, say — use it to build a mental model of the technology under development and their own relationships inside and outside the organization.

And yet Suchman cautions against oversimplification and instrumentality. Toward the end of *Human-Machine Reconfigurations,* she issues a challenge to designers and others whose job it is to do the boundary work that joins and separates humans and nonhumans:

> *The task for critical practice is to resist restaging of stories about autonomous human actors and discrete technical objects in favor of an orientation to capacities for action comprised of specific configurations of persons and things. To see the interface this way requires a shift in our unit of analysis, both temporally and spatially. Temporally, understanding a given arrangement of humans and artifacts requires locating that configuration within social histories and individual biographies for both persons and things. And it requires locating it as well within an always more extended network of relations, arbitrarily — however purposefully — cut through practical, analytical, and/or political acts of boundary making. (p.284)*

To tell a good story, design fiction narratives require "capacities for action," "specificities," "social histories," and "individual biographies." Composing a design fiction requires the concurrent design of the user and the technology as two parts of a mutually-defining whole, amplifying what happens in any user-centered technology development process: changes in one result in changes in the other. I will call this activity designing a "coupling." The human-machine coupling does not exist in isolation, rather each side is itself connected with myriad other forces and concerns.

According to Wikipedia, "The primary purpose of couplings is to join two pieces of rotating equipment while permitting some degree of misalignment or end movement or both." (Coupling. October 8, 2017) Story-world design provides an opportunity to play around with the "misalignment or end movement" of the human-technology configuration. It is a design space within which humans, non-humans, and networks are by necessity designed in one and the same gesture. While Bruce Sterling has famously placed "diegetic prototypes" — story props whose presence advances a narrative in some way — at the center of design fiction, *Trina* pushes further. (Sterling, 2017) *Trina* aimed to create what Sterling would call a "Gesamtkunstwerk, the Design Fiction as total-work-of-art": prototypes *and* people *and* action designed as a whole. (p.22)

5 Conclusion

This paper has detailed how speculative fiction complicated my attempt to design digital tools for reading and writing. Designing an entire story-world shifted my attention to where the action was: in the borderlands between technology prototypes, histories, biographies, geographies, and social and political forces. The process of designing "humans" in tandem with technologies — particularly when those humans are complex individuals engaged in a highly subjective activity such as critical interpretation — revealed the productive movement and misalignment characteristic of such couplings. Ida subverted the social practices of type writing, one female typist at a time. Doctrina interrogated the materiality of the writing machine, misusing the technology to produce texts on her own terms in the context of literary practice. And Trina remapped the alphabet into her body so that she could produce texts that were illegible to the corporate control system she was plugged into, but that were meaningful

to her. By design, *Trina*'s scenes of writing are fraught with conflict and hard choices, only some of which could be addressed by the design of software.

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Section 2.

Ethics, Values, and Designer Responsibility

DRS 2018 Design Research Society 2018 Catalyst

University of Limerick
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Editorial: Ethics, Values, and Designer Responsibility

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1 Introduction

As we rely upon increasingly complex sociotechnical systems to support ourselves and, by extension, the structures of society, it becomes yet more important to consider how ethics and values intertwine in design activity. Numerous methods that address issues related to ethics and value-centeredness in design activity exist, but it is unclear what role the design research and practice communities should play in shaping the future of these design approaches. Importantly, how might researchers and practitioners become more aware of the normative assumptions that underlie both their design activity and the design artifacts that result?

Previous research has revealed that a designer's *awareness* of ethical issues can be raised through value-centered design approaches and methods (c.f., value-sensitive design), but the broader ethical impacts of these approaches and methods are often underexplored. For example, the diversity of potential stakeholders and complexity of use contexts may not be immediately accessible to a designer, leaving their near- and long-term ethical responsibility under-developed. There is always the spectre of unintended consequences, while shifts in culture make designs not only obsolete but unfathomable.

For this special track, we invited contributions that explored the ethical implications of design activity in a wide variety of framings, including:

- Alternate framings of ethics and values in the design of sociotechnical systems (e.g., the ethics of *care*)
- The role and responsibility of the designer in designing artifacts with different media and breadth of outcomes (e.g., physical, digital, service, society)
- Approaches to ethical training in design education
- Designers' identity formation and practices in relation to ethics and values
- Designing to allow a play of values, acknowledging the need for flexible infrastructures in an evolving world

2 Track Overview

We received a wide range of submissions that addressed various framings of ethical behavior in relation to design activity, design outcomes, design practices, and motivations for designing. We briefly summarize each accepted paper below, highlighting the ways in which the author(s) engaged

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with ethical frameworks, designer responsibility, and the interplay between design intentions and outcomes:

In "*Examining the Professional Codes of Design Organisations*," Peter Buwert analyzes existing professional codes of ethics from 14 design organizations, identifying points of consensus and possible critiques of these codes in relation to ethical design behavior. Building on previous critiques of ethical codes, Buwert repositions ethical behavior within professions as a consensus of a group of designers, describing an evolving, bottom-up definition of ethically-centered design practice that must be actively nurtured in a reflexive manner.

In "*Ethical Issues in Designing Interventions for Behavioural Change*," Gyuchan Jun et al. identify factors that designers should consider in relation to behavior-focused interventions. Through a case study, the authors consider how an ethical framing of design activity facilitates the asking of questions that juxtapose undesirable and desirable behavior in relation to design interventions. Multiple questions across three ethical dimensions are considered as part of a potential framework.

In "*Ethics in Design: Pluralism and the Case for Justice in Inclusive Design*," Matteo Bianchin and Ann Heylighen leverage Rawls' theory of justice as fairness as a means of interrogating inclusive design practices. By focusing on social distribution of usability, Bianchin and Heylighen argue for an inclusive design that respects the autonomy of individuals, and leverages access to this population as part of the design process.

In "*The Ethics and Values of Visual Communication Strategies in European Advertisements in 21st Century Western and Islamic Culture*," Ilze Loza analyzes advertisements that focus on Islamic populations through the lens of ethics and values, revealing tensions among societal mores and advertiser goals. Loza argues for design outcomes that are respectful of cultural differences and prohibitions around certain gendered representations, particularly in the wake of globalization.

In "*Design for Profit or Prosperity?*," Else Skjold and Frederik Larsen argue that the innovative outcomes called for in design activity can often become a vehicle for neoliberal capitalist ideals. In contrast, Skjold and Larsen reposition design activity through the lens of ethics, using a case study to examine the productive tensions between societal engagement and responsibility and the goals of industry partners.

In "*Platform Ethics in Technology: What Happens to the User?*," Anuradha Reddy and Maria Hellström Reimer address the role of the user in large technology platforms, particularly using the perspective of the user to describe ethical tensions and dissonances present in these platforms. Using an example of street mapping, Reddy and Hellström Reimer identify multiple tensions between technological "platformization" and the visions of democratized technologies, revealing opportunities for ethics-focused interrogation of these complex platforms.

In "*Good Design-Driven Innovation*," Ehsan Baha et al. probe the nature of a designer's values as it impacts perceptions of "good design." These principles of good design were found to be important levers in empowering the designer's process, allowing the designer to be aware of and design in concordance with their identity and societal goals. The resulting values are thus seen as having a reflective value that facilitates the generation of innovative outcomes.

3 Synthesis of Contributions

These papers represent a diverse set of responses to the track focus, using case studies, content analysis, and theoretical/conceptual analysis to describe the role(s) of ethics and values in design processes and outcomes.

The majority of the contributions directly address the ethics of design engagement, such as Bianchin and Heylighen in inclusive design, Gyuchan Jun et al. in design for behavioral change, and Reddy and Hellström Reimer in taking a user-focused perspective on platform ethics. All of these contributions probe the nature of ethical involvement in design, using ethical frameworks to interrogate the nature of design(er) responsibility, and the interplay among design intentions, behaviors, and outcomes.

Other submissions address the notion of ethics primarily from the perspective of the designer herself, foregrounding their role in producing change. Baha et al. do this by describing the values

that are taken on by designers in producing innovative outcomes, while Skjold and Larsen juxtapose the goals of designers that are oriented towards innovation, and the impact of neoliberal capitalist ideals on these goals.

The final two contributions provide dramatically different perspectives on design outcomes, with Buwert arguing from the perspective of ethical codes in design organizations, and Loza describing advertisements that feature or are oriented towards Islamic populations. In these contributions, Buwert pushes the conversation from organizations towards consensus among individuals, while Loza describes tensions that designers face when confronting culturally-bound societal expectations and the desires of advertising stakeholders.

In sum, these contributions represent the broad utility of considering ethics and values in relation to design activity. Whether from the perspective of designer responsibility, professional codes of ethics, or the ethics of design outcomes, these analyses reveal many important tensions in designing equitable and appropriate sociotechnical systems in diverse contexts.

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Ethics in Design: pluralism and the case for justice in inclusive design

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The growing recognition of ethics' relevance to design fuelled the development of ethics- and value-centred design approaches. Despite their potential to address ethics in design proactively, they are criticized for failing to clarify their goals and explicate their theoretical basis. Since any ethical theory recruited in design must take seriously the fact of pluralism, only principle-based normative theories – as contrasted with value-based theories – seem fit. We explore what such a principle-based approach might look like in the context of inclusive design, where the issue of pluralism gives rise to an apparent paradox between the aim of designing for the widest possible audience and that of taking difference seriously. We show how this paradox can be addressed by applying John Rawls' theory of justice as fairness. In addition, we demonstrate that, without being explicated, elements of this theory are at work in existing inclusive design techniques, be it not always consistently. In doing so, we seek to contribute to a general framework for addressing the challenges related to ethics in design.

ethics; inclusive design; justice; pluralism

1 Introduction

Ethics and values are increasingly recognised to be highly relevant to designers and design activity. This relevance follows straightforwardly from the definition of artefacts in the context of design as "objects embedded in use plans" – a use plan being an action plan that involves manipulating some object in order to achieve the intended goal (Houkes & Vermaas 2010, p. 137).[1] This definition holds for both everyday items like tea bags and television sets, and technologically complex objects like bridges and microchips. All these artefacts are individuated by the properties agents attribute to

[1] Vardouli (2015) categorises attitudes towards human-artefact relations in design-centric, communicative, and use-centric ones. Houkes and Vermaas' definition seems to be compatible with all three.

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them in the context of an action plan in which they serve to achieve the intended ends. These ends can either relate to agents' preferences, or respond to what agents value.[2]

As a result of this growing recognition, several design approaches have been advanced as explicitly focusing on ethics and values (Vermaas, Hekkert, Manders-Huits & Tromp, 2015), ranging from "value-sensitive design" (e.g., Friedman, 2014, Davis & Nathan, 2015) to "design for values" (Kroes & van de Poel, 2015), and targeting values as diverse as

> *human dignity, justice, welfare, human rights, privacy, trust, informed consent, respect for intellectual property rights, universal usability, environmental sustainability, moral responsibility, accountability, honesty, and democracy. (Manders-Huits, 2011, p. 275)*

The potential of value-sensitive design, for instance, is well appreciated (Manders-Huits, 2011, p. 277):

- it recognises the importance of designing in a way that is conscious of human and moral values rather than considering value retrospectively, i.e., after artefacts have been introduced in society;
- it seems especially appropriate in dealing with potentially diverse users and the values they hold.

Despite the praiseworthiness of these approaches, several scholars have criticized them for being underdeveloped: they fail to clarify their goals and explicate their theoretical basis (Albrechtslund, 2007, Manders-Huits, 2011, Davis & Nathan, 2015). Starting from this critique, we argue in this paper that, since any ethical theory recruited in design must take seriously the fact of pluralism, only principle-based normative theories – contrasted with value-based theories – seem fit. Subsequently we explore what such a principle-based theoretical approach might look like in relation to design.[3] To this end, we focus on inclusive design, a context where the design challenges resulting from pluralism are particularly apparent. After justifying this focus, we investigate to what extent these challenges can be addressed by a principle-based theory in inclusive design, and how this theory aligns with other approaches advanced in this context. We conclude by highlighting the broader relevance of our exercise and outlining directions for future research.

2 From values to principles in design

In analysing whether value-sensitive design can meet the requirements associated with a (normative) methodology for implementing values in design, Manders-Huits (2011) convincingly argues that it falls short in a variety of interrelated ways. Of the shortcomings she identifies, the following are particularly relevant in the context of this paper.

The first shortcoming concerns the methodology proposed by value-sensitive design, which encompasses empirical research (c.q., surveys) to expose the values of stakeholders involved in the design. This implicitly assumes that, once one knows what stakeholders value, one knows what to do in a normative sense. "This," Manders-Huits (2011) contends, "is where [the approach] runs the risk of committing the naturalistic fallacy, i.e. of reducing an 'is' to an 'ought'" (p. 279). Indeed, collecting stakeholders' values does not solve any normative issue, as the collected values only describe what

[2] Buwert (2017) describes this intimate relation between ethics and design as follows: "design is by nature an activity which extends and transforms potentiality and that therefore, because of this, it is always an ethical activity. This foundational ethicality does not guarantee that design will always be good, but rather that it always possesses within itself the simultaneous potentiality for both good and evil" (p.1).

[3] In this paper we use 'inclusive design' (with lowercase) as an umbrella term for several design approaches (with uppercase) that aim at inclusiveness. Depending on the continent or region, they are called Universal Design (Mace, 1985; Preiser & Ostroff, 2001), Inclusive Design (Coleman, 1994; Imrie & Hall, 2001) or Design for All (EIDD 2004). While differences exist in how these approaches have evolved, the similarities are more apparent (Ostroff, 2011). In particular, all three share the same purpose.

people prefer or value; they do not prescribe how one should design for them. In a normative sense, value-sensitive design can thus be said to be a case of a value-neutral approach.

A second shortcoming is that, while the concept of values is central to value-sensitive design, its proponents remain descriptive regarding their conceptualization. As such they "avoid the meta-ethical question about the nature of values just as much as the normative ethical question concerning which values matter, why, and to what degree" (ibid., p. 281; see also Albrechtslund, 2007). This is problematic, since different people tend to hold different values which may conflict. Indeed, they can be expected to disagree about the priority different issues should be accorded as they diverge in their interests and needs, and the conceptions of the good to weigh these. This condition is what political philosophers commonly take to be characteristic of modern, pluralistic society. Although different readings exist of what pluralism amounts to, the common view is that people in a democratic society tend to be committed to different and conflicting ethical beliefs, values, and conceptions of what it is to lead a good life (Rawls, 1993; Habermas, 1996; Gutman and Thompson, 2004). Prioritizing between these conflicting perspectives requires a normative framework.

Third, and directly following from the condition of pluralism, is that value-sensitive design is missing an explicit ethical theory that outlines how to make and justify decisions in situations where values conflict or are incommensurable. Moreover, such a theory is needed to be able to make sense of the distinction between values and preferences – without which anything people value can be taken to be merely the expression of a preference – and sort out what is morally relevant. Without explicit commitment to an ethical theory, approaches like value-sensitive design are ethically neutral tools that might as well be used to operationalize harmful values (Albrechtslund, 2007).

The latter points at a fourth shortcoming – which Manders-Huits briefly mentions – that relates to the issue of autonomy. In value-sensitive design, it is unclear who makes the final decision on how to prioritize these competing values:

> *is this left up to the majority of stakeholders to decide, i.e. when a certain value is ranked as important by a certain percentage of people, or is it left up to the designers? (Manders-Huits 2011, p. 283)*

On the one hand, exposing what stakeholders value through surveys seems rather limited if stakeholders are not given voice in actually deciding about which values are given priority. On the other hand, if decisions are left up to the majority of the stakeholders, what about minorities? In either case, what is otherwise stressed as an important value – namely, autonomy – seems to be ignored by value-sensitive design.

More in general, the discourse about values in design is often cast in rather vague and indeterminate terms. Design approaches that explicitly focus on ethics and values give the impression of a moralizing attitude, yet often fail to articulate what issues are at stake in that they do not distinguish (moral) values from preferences. Normative and descriptive issues seem to be conflated, while little attention is paid to the autonomy of those who will use what is being designed. Manders-Huits (2011) therefore advocates complementing value-sensitive design methods by clarifying and explaining the overall (ethical) goals and explicating the ethical theory to be used, not only to demarcate moral values but also to provide a basis on which to make principled judgments about which values are most important to support.

While we agree with Manders-Huits' analysis and critique, we would like to add that starting from a theory of values (instead of from describing people's value beliefs or judgments) as such does not necessarily solve the problem. Indeed, if a designer settles the value theoretical issue first and assesses stakeholders' view accordingly, she may find herself either being liable of paternalism – if designers' moral knowledge is normatively privileged – or in the same condition as the people observed – if designers' moral beliefs are descriptively taken as just one among other views. Within

the specific context of ICT design, van den Hove (2010) therefore stresses that "there is no other way for moral thinking in the field of ICTS than to embrace a robust conceptual and value pluralism" and that "the conception of ethical theory or ethical thinking must accommodate the pluralist condition" (p. 61). More in general, we suggest that any ethical theory that is recruited in the context of design must take seriously the fact that people differ in their conception of the good and therefore only a principle-based normative theory – set against value-based theories – can do.

3 Zooming in on inclusive design

In exploring what a principle- rather than value-based theoretical approach in design would amount to, we focus on the context of inclusive design. Based on the premise that human abilities considerably vary and are strongly affected by design (Clarkson & Coleman, 2015), inclusive design seeks to "ensure that […] products and services address the needs of the widest possible audience, irrespective of age or ability" (Design Council, 2009).

The reason for choosing this focus is that, while the issues outlined above hold for design in general, they are particularly outspoken in inclusive design to the extent that they give rise to a paradox (Bianchin & Heylighen, 2017): inclusive design prescribes to address the needs of the widest possible audience in order to take into account human differences, yet taking human differences seriously seems to imply that nothing can be designed that meets the needs of everyone, so that "the widest possible audience" may turn out to be severely restricted.[4]

This paradox is naturally connected with the condition of pluralism sketched above in that it results from the need to answer different and potentially conflicting needs. More specifically the very purpose of designing for the widest possible audience faces two connected problems, insofar as a moderate scarcity of resources can be taken to be common in human affairs:[5]

1. "many users with severe functional impairments require solutions that would hamper other users" (Keates, 2015, p. 392);
2. "[i]t is often hard to prioritize which issues are the most important to fix and, occasionally, which ones may actually harm the overall usability and accessibility of the product" (Keates, 2015, p. 398).

A classic example used to illustrate these problems is that of sidewalks flattening into the street: while required by people in a wheelchair, these curb cuts may hamper vision impaired pedestrians who rely on a sharp curb to detect the edge of the sidewalk. Which of both is more important is not immediately clear.

Addressing conflicting needs and prioritizing issues is difficult enough where users are homogeneous, yet in the case of inclusive design, they are often very heterogeneous. Keates therefore concludes that organizations and designers need assistance to help prioritize issues (ibid.). This acknowledges that in a condition of pluralism issues do not order themselves according to a naturally shared system of priorities since people tend to disagree about the priority different issues should be given.

A moderate scarcity of resources and the fact of pluralism prototypically design the conditions under which a conflict of interest raises questions of justice: they require fixing some principles for

[4] Moreover, in aiming at inclusiveness, inclusive design seems connected with an attitude according to which design processes should include all who are affected by their output, which is consistent with a deliberative approach (Heylighen & Bianchin, 2013) and with paying respect to stakeholders' autonomy.

[5] The idea of moderate scarcity in this context is not meant to suggest a condition in which resources are subject to especially severe limitations. Instead it is meant to convey the rather uncontroversial view that human agency is constrained by the fact that resources are insufficient to satisfy all possible needs and/or desires. This is paradigmatically the condition under which a demand for justice arises (Hume, 1738-49; Rawls, 1999).

distributing goods in situations where conflicting claims arise about the priority to be accorded to satisfying specific needs and interests.

4 Exploring a principle-based approach

In addressing the questions of justice raised in the context of inclusive design, we are investigating to what extent a solution is offered by the theory of justice as fairness advanced by John Rawls (Bianchin & Heylighen, 2017, 2018). Rawls' work for the first time gave rise to talk about design in ethics (van den Hoven 2010, p. 76). The main reason to look at this theory in the context of this paper, however, is that it is principle-based: it explicitly aims at justifying the principles of justice that govern the distribution of benefits resulting from social cooperation among agents differing in their capacities, social position, and conception of the good. Below we introduce Rawls' approach and summarize how some conceptual tools it provides may offer a way out of the paradox of inclusive design.[6]

4.1 Justice as fairness

Rawls conceives society as a cooperative venture for mutual advantage marked by both identity and conflict of interest: agents share an interest to cooperate because social cooperation "makes possible a better life for all than any would have if each were to live solely with his own effort", yet they conflict because

> *persons are not indifferent as to how the greater benefits produced by their collaboration are distributed, for in order to pursue their ends they each prefer a larger to a lesser share. (Rawls, 1999, p. 4)*

Choosing among different social arrangements thus requires fixing principles that determine how to distribute the burdens and benefits of cooperation. Those are the principles of justice.

The conceptual tools Rawls advances to confront the task are provided by the idea of the original position, conceived as the hypothetical initial situation in which agents collectively choose the principles for arranging basic social institutions. The assumption here is that social institutions crucially rest on acceptance, as no system of cooperation that is supported by coercion or "persuasion" can be stable over time (Rawls, 1999, p. 295, 1993, p. 142; Freeman, 2007, chap 3; see also Searle, 1995, 2010). Such stability requires that the principles regulating the relevant social arrangements be justified to those bound by them.

Rawls suggests that the principles of justice are justified to all if they are chosen under conditions that constrain what counts as a good reason in the deliberation process to the effect the outcome is recognizably impartial and fair. The idea is that, in order to achieve this result, agents are to choose these principles under a veil of ignorance that blinds their knowledge of their own natural assets and abilities, social position, and conception of the good, amongst others, but not the general knowledge about psychology, society, economics, and human life provided by both scientific theories and personal experience. As a consequence, the veil of ignorance screens out only the information that would lead to arbitrarily favouring a specific party – since

> *"we cannot reasonably expect our views to fall into line when they are affected by the contingencies of our different circumstances. (Rawls, 1999, p. 517)*

Rawls calls this situation "the original position" to indicate that it designs the conditions under which social institutions are designed to be fair. Agents are taken to be rational in that they are endowed with a conception of the good and the capacity for instrumental reasoning and they are assumed to be motivated to agree on fair terms of cooperation and to comply with them once they are in place. The principles of justice are the rational choice under impartial and fair conditions – they are what rational agents would choose if their choice were constrained by a veil of ignorance that removes

[6] For a more elaborate discussion, including concrete examples, see (Bianchin & Heylighen, 2018).

contingent bias and motives to the effect that reasons of each party are weighted fairly: no party is granted a privileged position.

Rawls understands the original position as a "device of representation" (Rawls, 1985) designed to convert a question of justification into a deliberative problem. The original position models the conditions under which agents that regard themselves as free and equal are supposed to reach an agreement, and therefore constrains what can be put forward as a good reason in deliberating the principles of social justice. It constrains deliberation insofar as it conveys an impartial and fair point of view that expresses agents' self-conception as free and equal rational beings (Rawls, 1999, 1985; Freeman, 2007; Barry, 1995). In other words, it conveys the idea that we cannot expect others to accept principles that favour those in our position regarding natural or social advantages and a specific conception of the good (Rawls, 1993, p. 24).

The expected result is that, under these conditions, rational agents choose principles that maximize the position of the worst off while protecting individual freedom and a fair equality of opportunity.

> *FIRST PRINCIPLE*
>
> *Each person is to have an equal right to the most extensive total system of equal basic liberties compatible with a similar system of liberty for all.*
>
> *SECOND PRINCIPLE*
>
> *Social and economic inequalities are to be arranged so that they are both:*
>
> *(a) to the greatest benefit of the least advantaged, consistent with the just savings principle,*
>
> *and*
>
> *(b) attached to offices and positions open to all under conditions of fair equality of opportunity.*
>
> *(Rawls, 1999, p. 266, see for comments Freeman, 2007, Part 1)*

A first important point to notice here is that justice is defined in purely procedural terms, since what counts as the principles is generated by a procedure of choice that is constitutive of the correct output. Justice, that is, is defined not independently from the procedure adopted to choose the principles, but rather as the output of a procedure designed to tackle the problem of justification in a situation where we cannot count on an independent standard for the output to meet and design a procedure to meet that standard (Elgin, 1996).

A second point, relating to the issue of autonomy, is that this procedure is set up such that any rational and reasonable actor accords with the outcome. Thus, if we asked who is to decide on how to prioritize competing values according to this theory, the answer would be 'everybody'.

1.1 Fairness in design

If we return to the paradox of inclusive design, the vantage point Rawls' theory of justice offers is rather obvious: there is no need to expose the values of all stakeholders involved through a survey, as the methodology of value-sensitive design foresees. Instead a procedure is provided from which can be derived whether a design is just according to the general structure of justice as fairness (Barry, 1995; D'Agostino et al., 2012), i.e., by deliberating under a veil of ignorance that blinds agents' knowledge concerning their own capacities or limitations. Once the procedure is in place, agents are expected to run their rational choice capacities. Therefore, while attention is paid to their own view in that they endorse a conception of the good and act upon values, fixing the principles of justice requires neither specific knowledge about their conception of the good, nor an assessment of the connected value judgment in terms of a normative theory of value.

Fairness, however, can hardly be applied to inclusive design issues for single artefacts. Given human differences, designing an artefact such that usability for the worst off is maximized, may severely restrict the usability for other users. Indeed, if we focus on the design of single artefacts, either fairness or inclusivity seem to fail: designers going for fairness, in the sense of maximizing usability for the worst off, may compromise the usability for other users; on the other hand, designers going for inclusivity, in the sense of addressing the needs of as many people as possible, might end up with a solution that is not fair.

A possible way out, we suggest (Bianchin & Heylighen, 2018), is considering the overall distribution of usability within a relevant social context, instead of the usability of single artefacts, as the application domain for fairness in design. Counting as a relevant social context can be any group, institution, or social relationship: a state, neighbourhood, or city, but also a transport system, hospital, or the audience of a movie theatre.[7] We suggest that the framework of justice as fairness applies not to the problem of designing specific artefacts in ways that maximize usability for the worst off, but to a different problem: that of distributing usability within a social context taken as a whole in a way that does so.

Considering fairness as a problem concerning the overall distribution of usability rather than usability of single artefacts may thus involve accepting some difference in usability. Differential access to usability can be accepted, provided that the distribution maximizes usability for the worst off. In this sense, just design does not rest on whether everyone can use an artefact in the same way. On the contrary, it can manage the fact that some will get more than others by considering a solution just if and only if relative differences go generally to the advantage of the less able or most disadvantaged. This in fact just mirrors in design the role of the second principle in Rawls' theory of justice.

This seems to provide a solution to the paradox of inclusive design. Addressing the questions of justice raised in relation to design in a procedural way, and focusing on the social distribution of usability rather than on usability of single artefacts, allows for a non-paradoxical understanding of inclusive design. According to this understanding, the apparent contradiction between the aim of designing for the widest possible audience and that of taking difference seriously can be treated as raising a question of justice, and confronted by a procedural conception of justice as fairness.

As we have argued (Bianchin & Heylighen, 2018), this helps clarifying the relationship between Universal and Inclusive Design. We can define design as "universal" if it accords with the sketched procedure, and "inclusive" according to the people who are involved in the relevant decision-making and thus whose autonomy is respected.

5 An ethical theoretical X-ray of inclusive design methods

So far, we explored to what extent the theory of justice as fairness could be applied to address the paradox of inclusive design, which is exemplary for a more general problem related to ethics in design. To conclude our exercise, we analyse to what extent this approach aligns with design techniques that have been advanced to support designers in designing inclusively. The techniques discussed below both aim at assisting designers in dealing with conflicts. Although they do not explicate which principles or theories they adopt, a closer look reveals that in the background, one or more principle-based approaches are at play.

1.2 Statistical requirements prioritization

A first technique (or set of techniques) aims at assisting designers in prioritizing design requirements by calling in statistical methods. In the context of inclusive kitchen design, Afacan and Demirkan (2010) propose to prioritise requirements by combining factor analysis with existing techniques for

[7] Identifying the relevant social context may well be a pragmatic matter: depending on the issue at stake, the relevant target of design justice may be a certain group, association, or institution, as well as the whole society.

requirements' prioritization in engineering (c.q., the planning game technique and the analytic hierarchy process using a cost-value approach). In the context of home design, Demirkan and Olguntürk (2014) combine factor analysis with multiple comparison tests to determine group differences in each prioritized factor for diverse users.

Although at first sight the authors do not explicitly refer to a particular normative theory, underlying their approaches at least some elements can be discerned. To start with, both approaches identify design requirements by eliciting user needs through a survey asking participants to score items on a 5-point Likert scale from 'least important' to 'most important'. Interesting to note is that, in the recruiting of participants for this survey, special attention is paid to include those who are expected to experience most difficulties with the design at stake. In a kitchen, for instance, able-bodied adults may experience minimal difficulties, while children, pregnant women, older people and people with a physical, vision and/or hearing impairment face diverse challenges when gaining access to cabinets and storage areas, reaching counters, using appliances and operating controls (Afacan & Demirkan, 2010). This seems to suggest that these approaches, at least implicitly, use a conception of justice as fairness. Indeed, by focusing attention on those who are expected to experience most difficulties in a kitchen or home, the mentioned approaches focus on maximizing the benefit for the least advantaged.

A second aspect that points in this direction, is their outspoken attention for differences in the degree to which a certain requirement or factor is prioritized by diverse user groups. For instance, although all user groups agreed that kitchen appliances like cook-top, oven and refrigerator should be used easily, design solutions to provide ease show some varying details depending on the user group (Demirkan & Olguntürk, 2014, 96). This suggests an awareness that addressing the needs of a particular group is likely to introduce costs for others that must be considered. Although further elaboration is absent, this implies that differences in usability can only be allowed as long as they turn out to be justified – that is, as long as reasons are provided for them that flow from some more general principles, according to what justice as fairness predicts.

The way the issue is confronted by these techniques, however, entails that addressing the needs of disadvantaged groups can only be allowed provided that it does not impose costs on all others:

> *Designers should not change their priorities according to a single user group, but concentrate on designing for all people. (Demirkan & Olguntürk, 2014, p. 99)*

Confronting the issue according to the theory of justice as fairness would entail precisely the reverse, however: difference in usability can be allowed as long as the position of the least advantaged is improved – that is, differential usability is justified if and only if it goes to the benefit of the worst-off, whatever the costs (or additional benefits) it involves for other users. By contrast, stipulating that designers need to concentrate on all people seems to suggest that such difference is not allowed and, as a result, that the paradox remains unresolved.

1.3 Exclusion calculations

A second technique is called exclusion calculations. It has been advanced in the context of product design as particularly helpful "not just to identify usability issues, but also to prioritize them so that redesign efforts can be allocated appropriately" (Goodman-Deane et al., 2014, p. 892). Exclusion calculations enable designers to specify the capability demands placed on users by each stage of interaction with the product and display how many people cannot meet those demands and thus would be excluded (Keates, 2015). To this end, the technique relies on a dataset produced by the Disability Follow-up Survey (Goodman-Deane et al., 2014, p. 892).

Calculations are considered helpful in prioritizing issues for two reasons:

- they help identifying where improvements may fail to have the expected impact because other aspects of the design are still problematic. For example, in a comparing the usability of

three autoinjectors (medical devices delivering medicine through the skin using a needle), exclusion calculations revealed that changes to the device only reduced exclusion slightly because people were still excluded by the demands of cleaning the injection site (Goodman-Deane et al., 2014).

- they allow ranking product aspects by how many people they affect, e.g., how many people cannot see a label (Keates 2015). This ranking is then used to decide where to allocate further design efforts:

> *The population exclusion figures […] are useful for assessing the numbers of people affected by design issues and determining if changes are worthwhile. (Goodman-Deane et al., 2014, p. 893)*

When looking at this technique in more detail, we notice that it focuses attention on those who are excluded by one or more design aspects of a product. As such, exclusion calculations too seem to start from an implicit conception of justice as fairness. Indeed, they concentrate on those who are the least advantaged by a product design even to the extent that they are excluded by it.

At the same time, however, exclusion calculations also seem to hold elements that resonate with a very different principle-based approach known as utilitarianism. Utilitarianism comes in many varieties, but for the sake of this paper can be taken as resting generally on Bentham's "fundamental axiom" that "it is the greatest happiness of the greatest number that is the measure of right and wrong" (Bentham 1977, p. 393, 440 footnote). Notwithstanding the (implicit) Rawlsian starting point of exclusion calculations to focus on the least advantaged, the criterion for deciding where to allocate design efforts to confront conflicting demands within the target group is the number of people affected. That is possibly conflictual demands are answered not by relying on the second principle of justice, but by prioritizing issues according to the proportion of people who are affected among those included in the exclusion calculations. This seems to align – at least implicitly – with an utilitarian approach in that it focusses on the aggregated output: the number of people whose needs are addressed sets the standard against which the resulting design is assessed. In a Rawlsian framework, by contrast, issues would be prioritized according to the position of the worst off in terms of the capability demands placed on users – not by the number of people affected.

6 Discussion

In exploring what a principle-based approach in design might look like, we considered two techniques that explicitly aim at supporting designers in dealing with conflicting claims in inclusive design. Striking about both is that they set out to offer (part of) a solution to the paradox of inclusive design without recognizing it as a paradox. First, although these techniques aim at offering a solution for dealing with conflicting claims, they do not seem to acknowledge the paradox raised for inclusive design. Second, and by consequence, they do not make explicit that any solution of the paradox entails making choices that implicitly involve ethical assumptions.

At the same time, some elements do hint at certain ethical assumptions. In particular, both techniques clearly reflect an ethical claim to take care of the worst off. These assumptions are not pursued consistently, however, and end up being combined with assumptions that may in fact be incompatible.

Rawls characteristically contrasts his conception of justice as fairness with utilitarian conceptions precisely because the solution offered crucially differs from maximizing aggregated utility. The reason is that in the original position individuals are represented as distinct bearers of interest and unanimity is required, so that the rational choice of the principles is sensible to how goods are distributed among individuals. For a utilitarian view of justice, by contrast,

> *"[…] it does not matter, except indirectly, how this sum of satisfaction is distributed among individuals any more than it matters, except indirectly, how one man distributes his satisfaction over time." (Rawls 1999, p. 23)*

Applied to inclusive design, we could say that an utilitarian approach does not take into account how usability is distributed among users, while a Rawlsian approach does.

Notwithstanding these techniques' praiseworthy aim to support designers in addressing conflicting claims in inclusive design, our analysis of their underlying assumptions illustrates the importance of clarifying and explaining of overall (ethical) goals and explicating the ethical theory to be used.

7 Conclusion

Starting from a critical reading of ethics- or value-centred design approaches, we argued for a principle-based normative approach to design and set out to explore what this might look like. To this end, we zoomed in on the paradox of inclusive design and tried to address it by presenting a broadly Rawslian approach. Subsequently, we analysed to what extent this approach aligns with other methods and techniques advanced in this context.

In doing so, we showed that what several scholars raise as a problem in the relationship between ethics and design in general – i.e., the problem of dealing with pluralism – is a matter of fact in inclusive design. By focusing on this context, we framed the problem as a paradox, and, looking for a way out, confronted it as a general question arising from the demand to meet people's needs that is placed on inclusive design. By comparing the approach we propose with techniques advanced in inclusive design, we moreover demonstrated that it partially aligns with them, but also that underlying these techniques multiple ethical assumptions are at play that are not necessarily compatible.

Several challenges remain to be addressed, however. One challenge relates to fixing the metrics of justice: once the principles of justice are in place, the question arises what is to be distributed according to them. Rawls' theory focuses on distributing primary goods, i.e., income and wealth, basic rights and liberties, the powers connected with offices and positions, and the social basis of self-respect. In design, however, there may be no purely instrumental features of artefacts that play the role primary goods because there may be no way to abstract teleology away from usability, i.e., an artefact's instrumental value from what it enables. Thus, while the standards of justice still can possibly be fixed by the tools a broadly Rawlsian approach provides, considerations about its metrics likely may need to undergo some revision (Bianchin & Heylighen, 2018).[8]

Another challenge relates to identifying the worst off in applying justice as fairness to design. Given the specific capacities and limitations affecting users in the context of design, this identification will likely require taking into account the first person knowledge to which users have privileged access from their own experience or perspective (Bianchin & Heylighen, 2018). In this respect, it has been argued that inclusive design requires a deliberative component, which allows users to participate in the design process (Heylighen and Bianchin, 2013). This moment should be fed into our account to address the problem of gathering reliable information about the relative position of the addressees. It should be seen as complementary rather than an alternative to the theory of justice as fairness in this sense, as it addresses the question of how the standards of justice are to be implemented, when the veil of ignorance is lifted and the information about specific personal, social, and environmental conditions is provided for them to apply in a specific context. While involving users' first person knowledge is not new in design – it is at the core of endeavours in participatory and co-design – justice as fairness offers a way to frame their involvement by fixing the standards and specifying the question to be answered in the deliberation.

In addressing these challenges, we are exploring a set of real-world design examples as a way to get a grip on the conceptual tools a Rawlsian approach provides and the ways it may open for empirical analysis (Heylighen & Bianchin, forthcoming). By focusing attention on its empirical relevance, we

[8] For the time being we would argue that usability measures the degree in which agents can convert a design into a functioning. These conversion factors have to do not only with functional aspects such as affordance (e.g., accessibility), but also with meaning making (e.g., hominess, stigma) (Heylighen & Bianchin, forthcoming).

seek to help designers in making sense of the approach as a viable way to think about design rather than as a piece of theoretical work or philosophical speculation about design. In addition, we hope that the approach we came up with in the particular context of inclusive design by the same token may be relevant for the discussion on ethics and design in general, and contribute to a general framework for dealing with pluralism in design.

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Good Design-Driven Innovation

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Radical innovations are designs that alter the meaning of our life experiences. In order to realize such innovation, a designer needs a vision, a strong personal view on the world. The identity and values of designers however, are often denied in modern design processes. Consequently, (junior) designers have difficulties in connecting with their values and standing for their ideals, especially when designing within a corporate setting. We report a case study that demonstrates how nurturing a designer's personal understanding of 'good design' and integration of this understanding in his work, influences a design-driven innovation project and outcome. Our findings suggest that a designer's principles for good design, enable him to design more in tune with his identity and related ideals. Personal principles for good design empowered the designer's creativity, decision making, process planning, and drive to design and promote the acceptance of a radical idea within a corporate setting. We hope to inspire designers to use personal values and identity for design-driven innovation, and would like to start a discussion with design research and education communities to ponder on how designers can be supported in this journey.

design-driven innovation; good design; principles for good design; designer's identity

1 Introduction

The lecture has ended. Students are walking out of the lecture hall. The lecturer is shutting down the projection system when a student approaches and says the following:

> *Hi, I find the lecture you just gave quite inspiring and feel this way of designing has synergy with how I see design and how I want to design. Would you be interested in collaborating on a graduation project? (G. Dawdy, personal communication, December 5, 2016)*

This is how the collaboration of a MSc graduation project and eventually this paper was initiated. The lecture was on meaningful design, given by the first author as part of a series of lectures in a MSc course at the Industrial Design Engineering Faculty of Delft University of Technology. The student was the second author, back then pondering what MSc graduation project he wants to do

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and with whom. The third, fourth, and fifth author, are colleagues of the first author, sharing many research interests. Is this not how successful collaborations come about? First and foremost, from who we are? Second, from what connects us to collaborate on and how we want to contribute to the world?

The purpose of this paper is to express and explore how awareness of a designer's principles for good design can influence and benefit a design-driven innovation project within a professional context. We report a case study that demonstrates how awareness of a designer's personal understanding of 'good design' nurtures creativity, decision making, process planning, and drive to design and promote the acceptance of a radical product concept inside of a corporate setting.

In this world, there are many designers who design through a connection with their life experience, driven by their worldview and conception of what is good. This notion is certainly not new and can be observed throughout the history of design as a practice. Dieter Rams (1976; 2017) for example, proposed 10 principles through which he could judge the quality of his design. William Morris (1883), well known for his textile and wallpaper design, connected his work with a deep appreciation for the medieval crafts and his socialist worldview. Victor Papanek (Papanek & Fuller, 1972) devoted his life to incorporate sustainability and humanist ethics within the culture of design.

How designers work has also been well documented in scholarly works. Nigel Cross (2011) for example, describes how expert designers use their intuition, abductive reasoning, and a deep concern for 'appropriateness' to fuel their ability to be creative and come up with innovative applications in ill- defined situations. In specific, highly innovative solutions seem to occur especially when there is a conflict to be resolved between the designer's own high-level problem goals (their personal commitment) and the criteria for an acceptable solution established by client or other requirements (Cross, 2004; Lawson & Dorst, 2009).

In the recent decade however, human centered design has seen a massive increase in popularity in business, and it could even be considered the status quo of how design is taught at universities. Within human centered design, we find that the designer is expected to meet the role of an administrative actor or process facilitator that helps to identify, understand, and address problems that are found within the world. A designer is then expected to guide its stakeholders through a process that reaches a solution that spans the spaces of human needs, technological feasibility, and business viability through iterative cycles of development and testing (Manzini, 2016, p. 58). The human centered design approach is however, criticized for leading mostly to incremental forms of innovation; improvements that are made on existing products or problems (Norman & Verganti, 2014).

The radical form of innovation on the contrary, introduces new affordances of use through the introduction of new technology or a change in the aesthetic experience (how we experience a meaningful event) of a product. Radical innovations are game-changing, even disruptive within entire industries. Notably, Verganti (2016) places a big emphasis on the individual, and how radical innovation often results from a strong drive and vision of individuals instead of formal user studies. The potential utility of a radical idea is seldom clear at the start but is still pursued because it deeply resonates with the individual (Baha et al., 2012; Norman & Verganti, 2014; Verganti, 2016).

It is only recently that design researchers have begun to explore the relationship between the personal awareness of a designer's personal values and their ability to bring about meaningful innovation. Van Onselen & Valkenburg (2015) for example, have found an early indication of this relationship and report how a lack of awareness of personal values can block creativity, especially among junior designers.

2 Theoretical Background

2.1 Design-Driven Innovatio

Design-Driven Innovation (D-DI) is a concept that finds its origins within innovation management literature but has close links with the work that designers do (Norman & Verganti, 2014). Verganti (2009), states that there are four types of innovation strategies, defined by incremental and/or radical change in technology or in meaning, as the two main dimensions of innovation – Figure 1. In his new book, Overcrowded, Verganti (2016) further explores that more than often, innovation is solely seen as problem solving. However, Verganti argues that radical innovation, which often defines entire new markets, does not start from the notion of evident needs or problems. Instead, individuals pursue seemingly trivial ideas because it deeply resonates with them, they see value in their vision and use an ongoing co-reflective process to bring this vision to the world. The purpose of such a vision is to bring new meaning in the life of others (Baha et al., 2012). Verganti (2016) compares this envisioning of new meaning to the act of making (or choosing) a gift for someone else. It is an act of responsibility, and highly meaningful for the individual, because it concerns something 'they would love others to love'.

Verganti (and others like Krippendorff 1989; 2005), sees design as a profession that makes sense of things. Moreover, he states that if designers want to achieve radical innovation, they should be concerned more with the meaning of their vision than with user needs. This is because people can find it hard to imagine the value of something new, even when they are in constant search for something new that is meaningful (Verganti, 2009; 2016). Of course, that does not mean that user research has no place in this process, it is still used to incrementally refine the products stemming from a vision for new meaning (Norman & Verganti, 2014). Through criticism, an expanding and reflective dialogue refines the vision towards a product that allows others to see the value of the vision and consume the new meaning, something Verganti calls the 'Inside-Out' process – Figure 2.

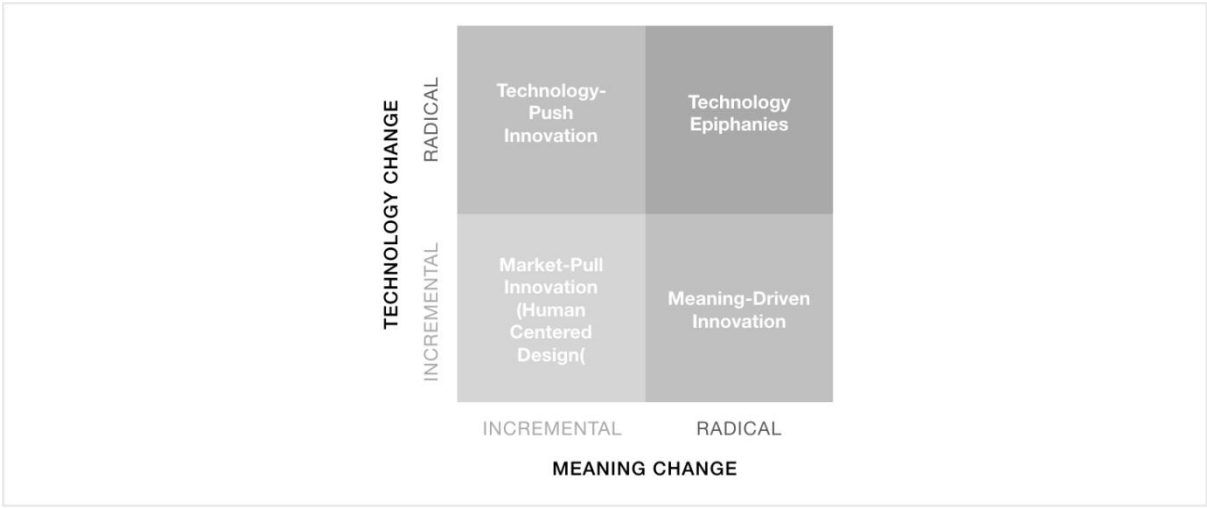


Figure 1 The two innovation dimensions and four related innovation types. Source: Norman & Verganti, 2014

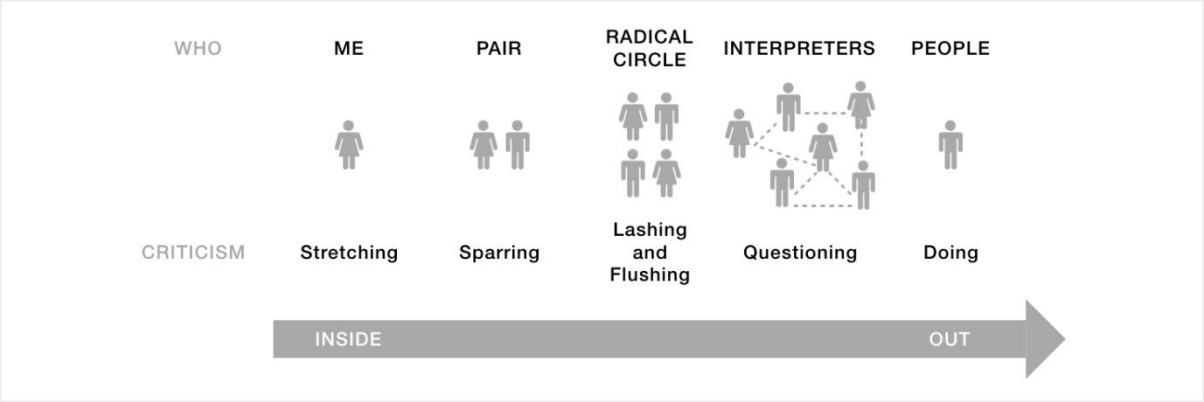


Figure 2 The (inside-out) process of innovation of meaning. Source: Verganti, 2016

D-DI therefore starts with the individual. At the first stage (me), the individual envisions something that they would love others to love, a phase where they postulate a new interpretation of a life experience, which goes through a process of critical reflection on why that interpretation is valuable and how it could change the experience of others in a meaningful way. As said before, junior designers often have difficulties in eliciting the values that drive their work and stay true to them, which hinders the design outcome (Van Onselen & Valkenburg, 2015). Verganti acknowledges in a similar fashion that shaping and refining the designer's vision & guiding principles is very difficult, and therefore considers the most powerful aid in this process to be another person. Someone to reflect with but specifically a person that will both challenge one's vision and not kill the idea in order to make it more robust; a person of deep trust. Along the way, we get a better understanding of the vision through an expanding and reflective process. Eventually, the value of the final proposition of meaning gets clearer and interpretable for others, who are able to then use user centered research methods to define and refine the concept towards a successful outcome.

This expanding process of the Inside-Out has been incorporated in our case study, meaning a design coach (partner) has helped the student (visionair) to become aware of his personal understanding of good design, what he finds meaningful (his values), safeguard it and allow the student to refine his vision within a corporate setting.

2.2 Good Desig

In order to create a vision, Verganti wants us to look towards ourselves and define what principles define our love for something. The visionair designer finds these principles so meaningful that they are highly motivated to bring them into existence, because they are good and they make life better.

But what is good? And what is good design? In the past, these questions were typically answered by the best and bravest designers of their respective times. We can refer here to the promotion of a good life - in good taste - to consumers and business managers at the start of the 20th century. Important sources of such promotion in europe were the arts and crafts movement in Britain, and the many professional societies for design and industry that had come up in various countries (such as the early German Werkbund, see Bürdek, 2005). Another role was laid out for publicists on interior and industrial design who were writing about good taste in design, such as Edith Wharton, or about a design "that shall inspire a new era," such as Norman Bel Geddes (1932, p. 5). In a move towards post-modernity another conception of good design was developed in the 1950s and -60s by the post-war German Werkbund and the Ulm School of Design. Here the idea arose that design would contribute to a good society by finding the right form ('gute Form') to the values of a social, post-fascist democracy. Although the latter group already stood for the emancipated and individualized needs of users, the idea was still that an elite force of designers would systematically provide the best solutions for them (Betts, 2004).

After the 1960s, the term ‘good design’ has mostly stood for these two periods in design history where designers were professing their superiority, whether it was in their taste or in their intelligence for solving problems for users. These two approaches have later been coined ‘big-ego design’ and ‘solutionism’ by Manzini (2016), stressing how, in the past, ‘good design’ was based on a misplaced normative stance towards users. Indeed, it is only in the last decade that an appreciation for leadership by design has revived, with D-DI taking a central, and much debated (and debatable) position in this.

In D-DI, Verganti’s stress on criticism and visioning hints to the importance for designers of bringing their personal beliefs and values to their work. We thus return to the notion of good design, to elaborate on how design can embody personal values and beliefs of designers. A starting point for describing this relation between design and personal values and beliefs is the work of the American pragmatist philosopher John Dewey. Dewey (2005) shows how personal values (and what these meaningfully relate to) can be seen as continuously changing personal beliefs that are in constant dialogue with society. These values and beliefs can become clearer by learning, acting, and reflecting upon them. As such, they are capable of guiding new visions about the possibilities in a situation (e.g. Vink, Wetter-Edman & Aguirre, 2017; Wetter-Edman, Vink & Blomkvist, 2018). Fahey (2002), who studied Dewey’s work on values writes: “In being sensitive to the ideals of virtuous action, it senses the possibilities in a situation, what is absent” (p. 19).

Through Dewey’s work we learn that there is an aesthetic dimension to everything we do, when we reflect upon and pass judgment on one’s experiences in life. By reframing our embodied experiences, we can thus derive a sense of new values, and of new opportunities for aesthetic expression. In a more direct application of these thoughts to design, Schön (1983) pointed out that design can be seen as a knowing in action, which we interpret here as a sensing of values through the act of designing. In relation to D-DI, we find that, over time, a designer might come to understand better why she feels the need to pursue a particular vision through acts of design. In other words, she develops personal principles for good design.

Becoming conscious of, and stating one’s principles for good design is important because D-DI takes the individual designer as the starting point for potentially radical ideas. Within D-DI, designers move from personal principles and vision towards a shared vision with other stakeholders, reinterpreting and refining this vision without letting go of its underlying principles (see Verganti, 2016, p. 143). Principles for good design refine the idea on how we might support (junior) designers in the act of D-DI; it goes beyond rational principles of human centred design, it elicits what a person loves and values in life, and it supports the embodiment of these values in design. In this sense, the notion of principles sits close to what Vial (2015) calls an idealect: “concepts in the form of ... rationally achievable ideals” (p. 64). Consequently, we believe (junior) designers can become more focused and gratified in the process of designing, increasing their commitment to what they feel constitutes a good design.

Our case study concerns generating a D-DI product concept, by a designer who has become aware of his personal values, and who has defined a set of personal principles for good design.

3 Research

3.1 Research context

The context for the research was a six-month graduation project of the second author in fulfilment of a Master’s of Science degree in Integrated Product Design. The project was a collaboration between the Faculty of Industrial Design Engineering of Delft University of Technology and Bang & Olufsen (B&O). B&O is a high-end Danish consumer electronics company that designs and manufactures audio products, television sets, and telephones. The graduate student deliberately approached B&O to become the client of his graduation project. This choice came about from his passion for music and appreciation of B&O as a company with good products. The project had an

open design brief that was scoped to initiating a product concept that combines the future of 'music' and 'autonomous driving'.

The graduate student was mentored by two university lecturers; a graduation coach (the first author), and a project chair who oversees the graduation process. Next, the student was accompanied by two company experts (one from B&O Automotive and one from B&O Home Audio). From here on, we refer to the graduate student as the designer.

3.2 Research approach

A case study was done using a Research Through Design (RTD) inspired approach (Yin, 1994; Frayling, 1993 cited in Godin & Zahedi, 2014). In RTD, knowledge is being created based on design action and reflection in- and on action. The design outcomes are then considered as physical proof of the generated knowledge as well as the material with which the researcher advances investigations (Schön, 1983). Both reflection in and on action are considered highly relevant for identity development as they allow for acting mindful in immediate moments and for dynamic narration and interpretation of past experiences (Hughes, 2013; Tracey & Hutchinson, 2016).

Within our case study, the designer reflected in and on his actions. These reflections occurred during the project and during weekly project coach meetings. Shared reflections in form of dialogues with the project coach, allowed the designer to receive constructive criticism while being in a trustful, hence failsafe environment. The project coach would, for example, prompt the designer to reflect about different designed concepts and indicate which concept was more aligned to his personal believes. Not knowing what to answer then would not have immediate consequences for the designer, but works more as an opportunity to develop his identity and/or the concept. Both the designer and the project coach used a notebook for recording the main points and conclusions of the reflections.

3.3 Case study setup

One of the wishes of the designer at the outset of the project was to end up with D-DI product concept that he would consider as good design. It was this wish that lead into defining what he would consider as good design. Therefore, the project started with a 'principles for good design' exercise. In this exercise, instructed by the project coach, the designer performed a couple of activities with the intention to become aware and sharpen his sense for good design. Eventually, a personal set of principles for good design were defined. Once the designer became aware of his principles for good design, these were used for and within the D-DI project process and for envisioning a product concept. In this paper, our main focus and study regards the effect that the designer's principles for good design have had on the D-DI project and outcomes.

4 Results

4.1 The designer's principles for good design

The principles for good design exercise resulted into three main principles for good design. These were: 'Principle 1: good design is simple (one thing, do it well)', 'Principle 2: good design is meticulous', and 'Principle 3: good design is timeless'. A fourth principle, 'Principle 4: good design is magical', revealed itself from the project context while the designer went through the project. All four principles are described and expressed visually using a product example in Table 1.

4.2 Designing based on the designer's principles for good design

Awareness of personal principles for good design influenced: the designer's creativity, the project planning, the decision-making process, and the focusing of the D-DI product concept. For showing this influence, we start by describing and exploring the project outcome first. Next, we continue by explaining whether or not, to what extent, and how each principle for good design of the designer, was integrated or had influence.

1.3.1 The D-DI product concept: Bring Your Moment

The D-DI product concept was called 'BYM', acronym for Bring Your Moment. BYM is a car audio system based around bringing your music into the car and taking music with you after the ride. Listeners can seamlessly transfer the music on their B&O headphones to the car audio system and the other way around. Once in the car, listeners can choose between listening to their own music by flipping their headrest flaps forward, or a shared music with other passengers, by flipping their headrest backward. At the end of the ride, listeners just put their headphones on to continue the listening experience they were in when leaving the car – Figure 3.

Table 1 The designer's principles for good design and related product examples.

Principle for Good Design	Description	Product example
1. Good design is simple (one thing, do it well).	In contrast to products with many functions and controls, the designer enjoys products that do one thing and do it well. The BeoSound Essence by B&O is a prime example. A product that is essentially one knob which gives people simplified controls over their music. That is, a simple interaction point to control the music from anywhere in the house in a simplified wat. It is simple, highly useful and leaves out the fuss of unnecessary functions or interactions.	 BeoSound Essence by B&O. Source: Bang & Olufsen, 2014.
2. Good design is meticulous.	The designer likes products that are designed meticulously. He believes, attention to details make a product interesting and gives it a sense of quality that is otherwise not present. Second generation advanced sound system speakers for Audi A8/S8 by B&O Automotive is a good example of a product with great attention to detail that keeps the product interesting to look at long after first purchase.	 Second generation advanced sound system speakers for Audi A8/S8 by B&O automotive. Source: Bang & Olufsen, 2017.
3. Good design is timeless.	Design that stands the test of time, that does not look old after one, five or ten years can be considered timeless. The designer likes designs that stand the test of time, and stay relevant long after their inception. A good example is the Beogram 4002 designed by Jacob Jensen for B&O. First designed in 1972, it continues to look beautiful and modern.	 BeoGram 4002 Turntable by B&O. Source: MoMA, 2017.
4. Good design is magical.	Products that surprise people in a delightful and mysterious way are seen as 'good design' for the designer. Whether it is interacting with an object	

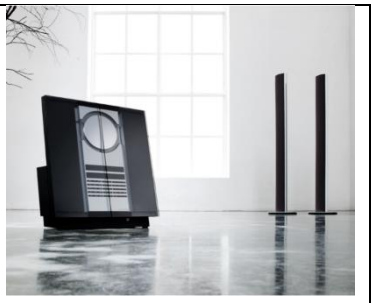
	in unexpected and useful ways or affording people to look at the world in a new way, these products induce a feeling of magic. This can be seen in the Beosound 3000 mkII CD/Tuner by B&O. As soon as the product is approached, when one waves their hand in front of the device, the doors open mechanically, allowing one to place in a CD. This is a simple interaction that creates an unexpected reaction in the product that delights the user in a mystical way.	 BeoSound 3000 mkII by B&O. Source: BeoWorld, 2012.

Figure 3 The BYM product concept and video QR code.

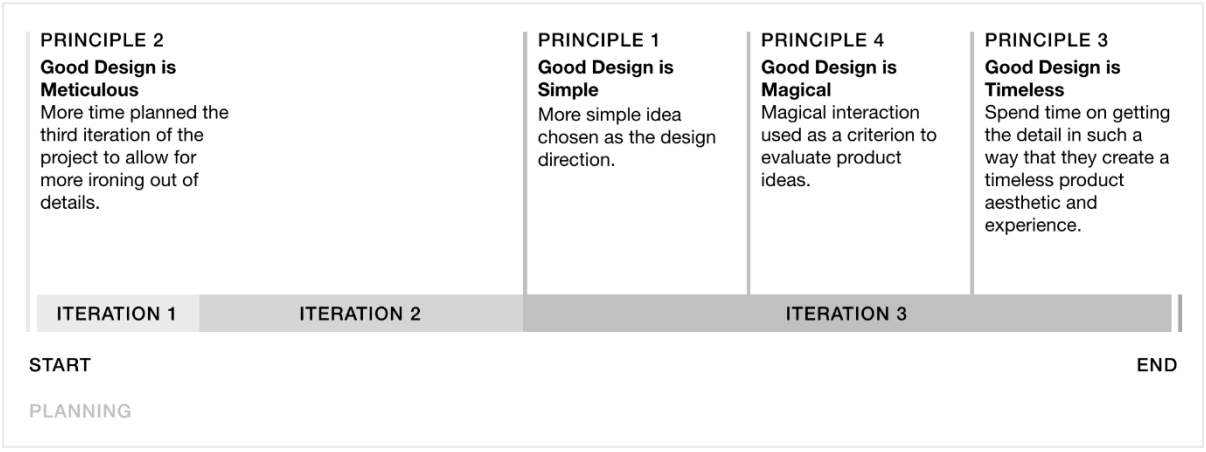


Figure 4 Pragmatic overview of the designer's principle for good design, for and within the D-DI project process.

1.3.2 Project planning, decision making, and focusing of the concept

Inspired by the 1-10-100 method, the project was planned and executed in three iterations that covered twenty-six weeks of time. The first iteration took one week, the second five weeks, and the third twenty weeks. At the end of each iteration the designer reflected upon the process and evaluated the achieved results. Reflections of each iteration, were used for setting up the following iteration. 1-10-100 is a method for better aligning research and design activities, specially in projects

that are not problem oriented and do not have a specific direction from the beginning (van Turnhout et al, 2011; Luminis, 2017). Figure 4 provides an overview of the project plan including the three iterations, activities, and where the designer's principles for good design played an important role and how. Below we explain how each principle influenced the D-DI project planning, decision making, and focussing of the concept:

1. Principle 1: good design is simple (one thing, do it well)

Simple design was manifested during the conceptualization phase. Design intrinsically involves making decisions where the best outcome is not known. In such an instance, the designer was faced with the decision of choosing between two concepts: one concept with a singular, simple purpose and the other with multiple functionalities and modes of interaction. Both concepts appeared good on paper and had done equally well in user testing. So, the designer ended up choosing the concept that aligned more with his principles for good design during that instance, the simpler concept.

The designer also used this design principle directly in the design of the product and experience. The concept could have incorporated many features when it comes to music in the car. But he chose to focus on creating a seamless experience and perfecting that experience as best as possible, while removing any unnecessary details and features from the concept.

2. Principle 2: good design is meticulous

Knowing that he wanted to include this principle in the project, the designer actively planned ahead to include this principle in the product concept. During the initial planning phases of the project, the designer allotted more time for the detailing phases of the project. This was done in order to give the full attention to detail he admired in other B&O products. Having planned enough time allowed him at the end of the project to spend more time on things like the pattern of the holes on the speaker grill, which ended up consuming about two full weeks of design time – Figure 4, Figure 5.

A large amount of time was also spent on the final experience. The form of the product is a direct result of this meticulousness. The designer spent a large amount of time on making a seamless experience fit with all passengers in a wide variety of social situations. A seamless music experience in a social context does not work without addressing the issue of privacy versus social listening experiences. The designer found a way to create a seamless listening experience through a long process of conceptualization and testing until he found a way to create this experience that was holistic.

3. Principle 3: good design is timeless

Timeless design manifested itself in the detailing phase of the project. After the concept was generated and elaborated, it was time to give the product a physical form with design details. Rather than looking at trendy design details that could make the product look good in the short term, the designer tried to create a more timeless look. This involved keeping the details to a minimum and using basic geometric forms for details such as the speaker holes – Figure 4.

The experience is meant to be simple and timeless, not bringing in any features grounded in current technologies, but rather staying basic on an interaction level to allow for an experience that fits in well with the future. Flipping a headrest forward and backward is an interaction that has been used in airplanes for the last half century.

4. Principle 4: good design is magical

Magical design was something hoped for but is not something that the designer felt he was able to intentionally design. However, during the user testing of the individual concepts, the designer kept this principle in mind as a way to rank his concepts. The final concept was chosen based on these

results seen in user testing. People reported a feeling of magic and wonder when testing out the prototype.

The interaction portion was where the designer chose to incorporate this principle the most. The designer spent a large amount of time examining the switch from a private listening experience to a social listening experience. He used this as an opportunity to create something that was intuitive but surprising. Using the headrest as a way to incorporate a switch from a social to private listening was the way he chose to do it. A flipping headrest is already something quite ordinary on long distance

Figure 5 Detailed rendering of the hole pattern of the headrest.

flights, normally used as a way to support the head when sleeping (and thus create a feeling of privacy). The designer changed the meaning of this interaction by making it a way to interact with the music, and he made it magical by allowing passengers to easily switch between their private music and the car's social music.

5 Discussion

5.1 Implications for the designer

We found that by being aware of his good design, defined as a set of principles, the designer was more proficient in eliciting his identity and actively engage with it throughout his D-DI project. Personal principles for good design, in our case study, empowered the designer in designing more in tune with his ideals and potential. This is a matter of becoming aware of who you are, what kind of world you want to design for, and sharing your worldview through design and participating in the design culture discourse (Manzini, 2016, p. 54). For example, with regard to the interaction aspects of the BYM concept, the designer actively chose a simpler interaction against a more complicated one because the simpler interaction aligned more with his first principle for good design. Another

example is that the designer's fourth principle for good design arose during the project as a more project context specific principle for good design.

Designing with principles for good design in mind, the designer felt more content with his work, felt he could better reach his potential as a professional, took responsibility for at least some of the personal influences in his work, and continuously evaluated himself to refine his ideals (sense of good design). For example, by being aware of his bias towards products with a 'magical' quality (fourth principle for good design), the designer was able to have dialogue about this quality with the client as a goal within the project. He was able to use 'magical' as a criterion for the prototype evaluation and improve his sense for this quality based on the feedback received from his radical circle (mentoring team) and other interpreters (e.g. a car dealer). In sum, his principles for good design, helped the designer in understanding and eliciting his designerly intuition, which made him more confident in his ability to share and communicate his vision for music in autonomous driving to the project client and other stakeholders.

5.2 Principles for good design for D-DI

In this project, we found that the designer's principles for good design did not stop at shaping the D-DI product concept. The designer's principles for good design also influenced the project planning and formal decision making.

Awareness of one's principles for good design is also useful for safeguarding the radical innovation of meaning (essence of the innovation) by the envisioning designer. McDonnell & Lloyd (2014, p. 349) describe this act by the designer as a gatekeeper and protector of his terms of the design concept. Safeguarding was done by taking more time for certain activities, for example, such as detailing of the D-DI product aesthetics of form and interaction and collaborating with specific people; such as a graduation coach who is experienced with D-DI and someone who keenly supports designers to stand for their ideals.

Furthermore, the designer's principles for good design also manifest themselves in the product form, the interaction aesthetics, and the envisioned experience. In our case study, the designer deliberately used his principles to design the aesthetics of form and interaction of the D-DI product concept, being aware that these are not so-called value-free (Bürdek, 2005, p. 323). For example, the designer spent two weeks detailing out just the hole pattern on the design to adhere to his second principle of good design.

5.3 Implications for the design discipline and education

Personal principles for good design, can bring a valuable new dimension to design. For example, designs designed by designers who are responsible based on awareness and recognition of their biases. Designers who use their biases to envision, rather than being unaware of or merely suppressing them. Yet this is not easy, as designing based on one's principles for good design, one's identity, is not considered as a standard norm within our current design culture which is rather limited or limiting due to a lack of debate (Manzini, 2016, p. 52). To go beyond the current design culture, designers, in particular junior designers, could benefit from being supported in defining their personal principles for good design. It is in becoming aware of their identity that (junior) designers can realize the importance of their ideals and start daring to express and protect them when designing for a client within a corporate setting.

5.4 Limitations of the study

The research insights of this paper are based on one single case study in which a creative exercise was used for supporting the designer to become more aware of his principles for good design. Although this study resulted in valuable insights, there is more research needed to further explore the implications of principles for good design for and within D-DI.

With regard to principles for good design, we would like to emphasise that a designer's personal principles for good design are not and should not be seen as a set of generic guidelines for producing good design. Rather, they are meant as a tool to help a designer to become more aware of his ideals and identity. This awareness opens opportunities for designers to take responsibility for the normative influence in their work and further develop their identity as a person and a design professional.

6 Conclusion

The inspiration for our paper started when we read Manzini's (2016) call for a culture of design, one that cultivates ideas and visions of designers in a dialogic conversation with the world, where speaking (the designer's vision and ideals) are as important as listening (what others need). This design culture, can be seen as a countermovement against our current context of practice, where designers are expected to be neutral facilitators within a problem-solving process and neglect if not suppress their own ideas and responsibilities as an expert.

In this paper, we have outlined that there is a need for both incremental and more radical forms of innovation (Norman & Verganti, 2014). Radical innovation in particular, seems to be linked to highly creative solutions that aim to change the meaning of life experiences and are driven by a deep, personal commitment. These solutions cannot be found within evident problems that are already recognized in the world. Rather, such solutions come to be by radically changing the meaning an status quo experience. Here, we find a place where speaking and listening both have a place of importance (Manzini, 2016, p. 58). Still, there is a gap between designing meaningful innovation and the ability to execute it within a corporate setting, especially among junior designers (van Onselen & Valkenburg 2015).

We hope this case study demonstrates that radical innovation need not only follow design methods such as D-DI (Verganti, 2009), the Reflective-Transformative Design Process (Hummels & Frens, 2009), or Vision in Product design (Hekkert & Van Dijk, 2011). While such methods all provide crucial pieces of the puzzle in achieving radical innovation, we feel that the focus on design process shifts attention away from the design practitioner himself (Dorst, 2008, p. 8). What to us seems equally essential for radical innovation is that designers are aware of their identity, and acknowledge that their identity flows from and through their work and actions. This allows designers to confront themselves with their personally held values and beliefs, and start a dialogic process of speaking and listening that helps to develop their sense of ethics and aesthetics, and thus their expertise in designing.

With this work, we hope to inspire design researchers and educators to consider how the design ability of (junior) designers can be nourished for proposing radical innovations within corporate settings while designing in tune with their identity. Design researchers and educators need to rethink how designers themselves can become more active participants in a debate about design culture. Principles for good design can be a way to support (junior) designers to participate in this debate by designing based on their own authentic process of project planning, creativity, decision making, and proposing novel ethics and aesthetics. Principles for good design can thus positively influence a designer's ability to create potential technological epiphanies that are 'good'. As design researchers and educators, let us restart the debate with our students on our design culture by uncovering our own authentic ways for making gifts for the world.

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Ethical Issues in Designing Interventions for Behavioural Change

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This paper reflects on fundamental ethical issues concerning designing for behavioural change, in order to raise questions about the factors that should be considered by design practitioners when developing interventions. It draws on existing literature on philosophical ethics, moral psychology and design. It proposes a list of ethical questions and considerations to be made throughout the design process. A case study addressing behavioural changes in antibiotics prescriptions (for Urinary Tract Infections) was carried out to demonstrate how the ethical questions identified are asked and considered. We provide a framework for addressing these issues with the hope that it will help minimise the risk of problematic and unethical intervention design processes.

behavioural change, ethics, healthcare, design participation

1 Introduction

Behavioural insights have been successfully applied to narrow the gap between 'desirable' and 'undesirable' behaviour in various health and public services (The Cabinet Office Behavioural Insights Team, 2010; Perry, Chhatralia, Damesick, Hobden & Volpe, 2015; Hallsworth et al., 2016). The field of design has been shown to make substantial contributions to this area, as it offers a variety of methods and tools that can facilitate the creation of effective interventions which can narrow the gap (often in unexpected, nudging, ways). However, the process of designing for behavioural change can be unethical or counterproductive if a set of important issues – pertaining both to the practical and the philosophical realms – are not carefully considered.

The primary questions that arise as a result of considering the potential ethical dimensions of designing for behavioural change are:

1. Why do people persist with 'undesirable' behaviour? (Questions of moral psychology)
2. What is 'desirable' behaviour? (Questions of philosophical ethics)

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3. How can the gap between ‘undesirable’ and ‘desirable’ behaviour be narrowed in an ethically acceptable way? (Questions of design ethics)

Figure 1 maps the primary questions into the main components of designing for behavioural change: undesirable behaviour; intervention; desirable behaviour.

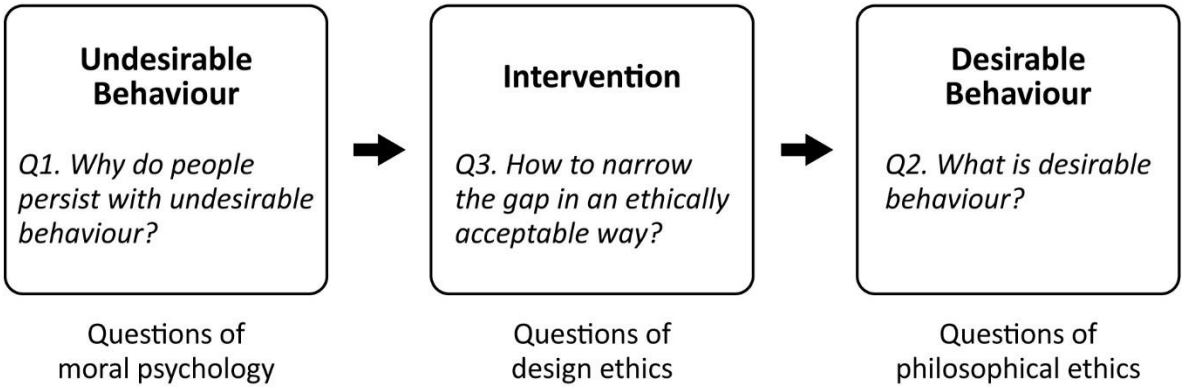

Figure 1: Primary ethical questions in designing for behavioural changes

The purpose of this paper is to explore these questions and the considerations relevant to answering them, based on existing literature on philosophical ethics, moral psychology and design. We aim to develop a provisional framework for ethical considerations in designing interventions for behavioural change. A case study addressing antibiotics prescription (for Urinary Tract Infections) is described, to demonstrate how the ethical questions are asked and considered.

2 Approach

This paper consists of two parts: analysis of existing literature and a case study. The literature analysis involved the purposeful identification and choice of the literature relevant to the primary questions addressed in the paper. The process was supported and informed by the authors’ expertise in philosophical ethics, human factors and design for behaviour change. This first study informed the development of a provisional ethical framework for designing for behavioural change.

The subsequent case study aimed to demonstrate how the framework would work in an ongoing behaviour change field study in a clinical setting. In this way, we explore the overarching ethical concerns influencing behavioural change intervention design.

The rest of the paper is structured as follows. In section 3.1, we consider the issue of why people persist with undesirable behaviour and discuss a key role played by environmental, social and historical factors. In section 3.2, we draw on existing work in both design studies and moral philosophy distinguishing four key questions that must be examined in any particular attempt to address the issue of identifying desirable behaviour. In section 3.3, we consider ethical ways of narrowing this gap, and identify two key requirements which ethical interventions must meet. In section 4, we apply the theoretical considerations developed in section 3 to a case study. The case study looked at the ethical implications of the processes of designing interventions for antibiotic prescription behaviour change for Urinary Tract Infection (UTI) treatment in older adults within the Emergency Department (ED) of a hospital in England.

3 Literature Analysis

3.1 Why people persist with undesirable behaviour?

There are many models that help shed light on the determinants and mechanisms of human behaviour. Most comprehensive models recognise that behaviour is the result of an interplay of factors, some of which are individual-based in nature, some of which relate to social norms or environmental variables. Such models improve on a traditional ‘individualistic model’ (sometimes

called the 'medical model') according to which 'bad' behaviour is simply the consequence of bad choice. In line with Ecological Theory, they incorporate environmental, historical and social factors – external to the individual – as partial influencers of the personal behaviour (Guttmacher, Kelly & Ruiz-Janecko, 2010; Niedderer et al., 2016). The importance of such contextual variables, especially in clinical settings such as the one providing the case study here, is reinforced by Dixon (2016). Dixon notes that changes in clinical practice can take any number of years: from a discouraging average of seventeen years up to the unfathomable span of a couple of centuries – as is shown in the case of translating the knowledge that handwashing reduces infections to routine practice. Empirical research in moral psychology also supports these findings: according to Doris (2002) traditional moral theory has systematically overplayed the influence of stable character in determining behaviour, to the detriment of environmental or 'situational' factors. As Doris puts it: "behaviour is extraordinarily sensitive to variation in circumstance … The experimental record suggests that situational factors are often better predictors of behaviour than personal factors" (2002, p.2).

One model which considers both individual and situational factors is the COM-B model introduced by Michie, van Straten & West (2011). The model describes human behaviour as being the product of the dynamics between capability (psychological and physical characteristics of individuals), opportunity (social norms and environmental factors that influence and circumscribe people in society), and motivation (emotional responses and reflective plans that drive action). Following this rationale, we can presume that the reasons for persisting with undesirable behaviour may be due to a number of determinants, pertaining to one or more of the three components of the model. As also suggested by the aforementioned authors, it is only through analysis of the specific context and the people in question that we can reach reliable conclusions about why people consistently 'misbehave'.

Hale and Borys' approach (2013) as to why people violate safety rules (i.e. desirable behaviour) can also provide a complementary account of the reasons why some (mis)behaviours are persistent. Four factors found to be relevant to violation were: (1) individual characteristics, e.g. personality; (2) organisational factors, e.g. lack of monitoring, culture, leadership; (3) hardware factors, e.g. poor ergonomic design; (4) rule-related factors, e.g. poorly designed, out-dated, and conflicting rules.

Summarising, the two fundamental messages to bear in mind here are that not all bad behaviour is the result of bad choice or poor individual capacities and that, if behaviours can be understood and explained, they can also be intentionally influenced and changed.

However, existing ethical discussion concerning behavioural change interventions does not always take these comprehensive perspectives into account, partly because the traditional individualist model gives diminished importance to environmental factors and social context in determining or constraining individual and collective behaviours. Welsh (2016) concurs: he is emphatic in his criticism that most behavioural change approaches assign too much responsibility to agency and self-efficacy without much consideration to variables of a social or contextual nature. He supports his contention by evidencing the inability of these approaches to distinguish the extent to which the specific behaviour of individuals is pre-encapsulated within a broader spectrum of acceptable, appropriate behaviours that are historically determined and socially embedded. His illustration makes use of a previously identified distinction between 'practice as performance' and 'practice as entity' (as in Spurling, McMeekin, Shove, Southerton & Welsh, 2013) to criticise what he calls the 'portfolio model' of behavioural change, "wherein the subject is presumed to possess a more or less stable portfolio of values, attitudes, norms, interests and desires, and selects from them to decide on the course of action" (Welsh, 2016), regardless of context. Welsh's resolution advocates, in turn, a deeper focus on the systemic, sociotechnical, and organisational factors that act as preconditions for individual behaviour. Following this perspective, one could raise questions about whether certain contexts, instead of individuals, are more favourable to ethical practices than others.

Therefore, to establish, with a reliable degree of certainty, the reasons why people persist with 'undesirable' behaviour, even when it causes prejudice to themselves (for example with unhealthy habits like smoking) is a task that demands caution and attention to factors that go beyond personal characteristics, and thus can point to determinants beyond the reach of individual agency (such as environmental, historical and social factors).

3.2 What is 'desirable' behaviour?

Defining whether a particular type of behaviour is 'desirable' immediately raises more questions. Assuming that a type of 'behaviour' is desirable (or not) primarily on the basis of its effects on people, we need to ask:

(i) Who is affected by the type of behaviour?

(ii) What are the interests of those affected?

(iii) What are the conflicts between those interests?

(iv) (In light of those conflicts:) What is collectively desirable?

Desirability in designing for behavioural change is usually indexed to a group (e.g. 'users'), but behaviour that is desirable for a group of individuals may be so only under certain conditions and may not be desirable to another group. For example, it may be desirable for a single individual to graze their cattle on common land (or access a database at a particular time), but if everyone does the same, the common land will be eroded (or the database will crash), resulting in undesirable outcomes for all. This is the well-known tragedy of the commons (Hardin 1968). In other cases, what is desirable for one individual may be undesirable for another, again resulting in situations where what is desirable for individuals cannot be simply aggregated into a single desirable outcome for the group.

Tromp, Hekkert & Verbeek (2011) suggest that the principal reason for the existence of a gap between 'undesirable' and 'desirable' behaviour may rest on a mismatch between the concerns of the individual and those of the group – "the individual does not always embrace or prioritize collective concerns." Tensions between individual and collective perspectives on priorities, and on the desirability or pertinence of certain behaviours over other competing alternatives, certainly pose a major challenge.

What these approaches suggest is the need to distinguish clearly between issues of desirability for individuals, and issues of desirability for groups or collectives. It is here that philosophical ethics can help, for philosophers have developed theories of both types of value, as well as views on the connections between them.

Begin, then, with desirability for individuals. J.S. Mill famously argued that 'the sole evidence it is possible to produce that anything is desirable, is that people do actually desire it' (1861, ch. IV). But this cannot be correct since it is commonplace that individuals desire things which they themselves do not consider desirable for them (e.g. smokers who are struggling to quit). A natural response to this problem (exemplified in Halpern et al.'s focus on well-informed choices, see below §3.3) is to idealise: what determines desirability for an individual is not what they actually desire, but what they would desire under some idealised conditions (the *locus classicus* of such 'ideal observer' theories is Firth, 1952). In this vein, Railton (1986) has argued that something is desirable for an individual just in case an idealised counterpart of that individual would want her non-idealised self to desire that thing. So, for example, an inoculation injection is desirable for an individual just in case an idealised version of that individual would want her non-idealised self to want the injection. According to Railton, the idealised individual is idealised insofar as she possesses "unqualified cognitive and imaginative powers" and "full factual and nomological information" about the desirable object. In this case, she knows about the possible effects and side-effects of the injection,

the rationale linking injections to susceptibility of disease, she can vividly imagine both the pain caused by the injection and the effects of contracting the disease it inoculates against, and so on.

This gives an account of desirability for individuals, but can also be the basis of an account of desirability for groups. The guiding thought is that whereas desirability for individuals is the result of idealising an individual perspective, desirability for groups is the result of idealising – or constructing – a collective perspective. One way of doing this is to imagine an idealised individual who, in circumstances of full and vivid information, and again with full cognitive and imaginative powers, considers equally the interests (that is, individually desirable objects) of all potentially affected individuals. What would be rationally approved of by such an individual is what is desirable for the group (Railton, 1986, p.198). In particular, this individual is fully informed insofar as she is aware of the potential consequences of group action (such as the negative effects of everyone performing some action in tragedy-of-the-commons situations) and of the potential conflicts between what is desirable for distinct individuals.

The upshot is as follows. Where design interventions concern the potentially conflicting behaviour of a group of individuals, we define what is desirable behaviour in terms of what would be approved by an ideally informed rational individual considering equally the interests of all potentially affected individuals. In turn, the interests (desirable things) for those individuals are defined in terms of what idealised – fully-informed – counterparts of those individuals would want them to want. So, there are two steps of idealisation: one individual and one collective.

What this means in practice is that design practitioners should consider a series of the following questions prior to intervention design:

(i) Who is affected by the type of behaviour?

(ii) What are the interests of those affected?

(iii) What are the conflicts between those interests?

(iv) (In light of those conflicts:) What is collectively desirable?

In answering these questions, scientific and empirical investigations (concerning the causes and effects of particular behaviours, collective patterns of behaviour, their cost and benefits and so on) will be relevant but not decisive. The two stages of idealisation (individual and collective) require full awareness of relevant empirical facts, but also require a deal of empathy and moral judgement in balancing competing considerations. The framework we propose does not provide simple algorithms for answering these non-scientific questions (and indeed there would be something unnervingly robotic if there were such algorithms – see Hursthouse, 1998). Rather its aim is more modest: to provide better solutions by providing a clearer framework of questions to ask.

Desirable behaviour is often highly contextual, since what would be desired and approved of in idealised conditions must be sensitive to the particular features of the situation being judged. Defining desirable behaviour will also involve canvassing the views of those potentially involved (as is common, for example, in the subjective, survey-based discipline ‘happiness studies’), but will not simply defer to present concerns – rather it will defer to concerns as revealed by idealisation. In this regard, Halpern et al. (below §3.3) are correct to focus on well-informed choices. Simultaneously, our approach suggests an inclusive perspective concerned with engaging perspectives of all potentially involved groups.

Hence, according to our approach, a strategy for advancing knowledge of ‘desirable behaviour’ requires trustworthy evidence that can provide the hard data to elucidate facts, an informed understanding on the nature of the problems in question, and qualities of empathy, imagination and judgement to discern and balance competing concerns. A potential strategy to achieve that will be further discussed in the next section.

3.3 How to narrow the gap?

There are many occasions when the only way to narrow the gap between 'undesirable' and 'desirable' behaviour is to devise an intervention to intentionally change behaviour. Interventions can be effective because they help people achieve more desirable behaviours by properly acting on the specific determinants of bad behaviour, whether they concern individual components (skills, beliefs, habits etc.) or external factors (rules, time constraints, lack of resources, social or cultural norms) that obstruct or prevent the performance of the desirable behaviour.

The Design for Socially Responsible Behaviour approach (Tromp et al., 2011) fosters a practice within which one of the central efforts is to align the behavioural objectives of persons and the larger group through design processes. This approach provides a number of tactics which aim at 'bridging the concerns' of individuals and community so as to facilitate the desirable behavioural outcome. Depending on the intended level of influence, designers may choose approaches that range from persuasive (reason-based) to coercive (threatening), and from seductive (providing *pro tanto* reasons) to decisive (providing conclusive reasons). However, although promising this approach does not specify a method for determining individual group interests and seems to conflate psychological concerns with desirability – a mismatch between the actual concerns of the individual and the group need not entail a mismatch between what is desirable for each, since our actual concerns do not always map onto what is truly desirable (see above, in connection with J.S. Mill).

Another possible strategy to address the conflict between individuals and groups is suggested by Halpern and colleagues (2004) in their perspective of a shared responsibility between people, community, and the state. Halpern et al. propose a set of conceptual tools that can aid in case-by-case decisions regarding the definition of what is 'desirable behaviour', in conjunction with who is to act upon it. They present a view in which individuals have responsibilities over their well-informed choices, whereas governments should account for the factors that extrapolate individual possibility; both of which can be assessed when the causes of behaviour are at stake. Alongside, sometimes in spite of unclarity on the causes and responsibilities of a behaviour, assigning ultimate responsibility can be further considered on the basis of the possible impacts on third parties (people that cannot account for their own decisions, children, animals) or the environment (nature, public spaces, the workplace). All of these occur under the overarching perspective that there are a priori, value-based judgements on the rights and responsibilities of individuals that are empirically reinforced or challenged by the values of society at large (Halpern et al., 2004).

Interventions can be put to action by the means of varied Behaviour Change Frameworks, which suggest stepwise stages to enable the systematic development, piloting, implementation and evaluation of a set of activities. Such frameworks aim to eliminate barriers and provide the means necessary to narrow the gap between 'undesirable' and 'desirable' behaviour. The reviews by Darnton (2008) and Niedderer et al. (2016) have identified numerous approaches developed for a range of purposes.

Interventions, in order to be ethical, would need to combine two core aspects. First, they must be based on trustworthy evidence that feeds into well-informed opinions, meaning that the determination of the ultimate ends to which the intervention is aiming would have to be based on the best available evidence to describe the relevant facts in question. Second, they must enable the views and voices of the multiple stakeholders involved in, and impacted by, the intervention to be properly represented and embedded in the processes of change. Most frameworks do a good job in accounting for evidence. However, in our view, they do not provide the means to address stakeholder participation to the proper extent, so as to assure that not only outcomes are effective, but the processes to achieve the results are not ethically objectionable.

A review by Lilley and Wilson (2013) focuses on the ethical dimensions of existing approaches to the field of designing for sustainable behaviour and reveals that "there is little or no integration of

ethical considerations into these design process models and the provision of suitable tools to aid in prompting ethical reflection is lacking".

Lilley and Wilson's contribution substantially adds to the intervention process by the means of two mechanisms. First, they call attention to the fact that most existing approaches will only include stakeholder input later in the design process, when the purpose of the intervention has already been mostly defined (i.e. when desirability has been already established). Secondly, they explicitly include 'ethical reviews' that should be sought at three key moments of the intervention design process – when identifying the behaviour, when formulating the intent, and when evaluating the outcomes.

Lilley and Wilson focus on the work process of designers, putting the morality of decisions in their hands, which is reasonable if the resulting outcome is the development of products, because such activity depends on technical expertise which could be seen as exclusive to professionals. There are well-defined standards of desirability integral to each product (e.g. the aim of a coffee machine is to make damn fine coffee). There might be, however, a tendency to wrongfully position products (and design) in relative isolation from social context while the importance of user input might be recognised throughout the intervention process.

In order to encompass ethical approach to behaviour change, it is important to make sure a broad range of stakeholder participation is considered and engaged whenever decisions need to be made, regarding both the dynamics of the process in itself (how to do things) and the intended outcomes envisioned as desirable (what things to do). Particularly when design interventions focus on external environmental factors as the determinants of action, the mechanism of that change may not be processed through the conscious deliberation or reasoning of the affected agents. In such cases designers need to make sure that participants, who are information providers, are also provided with well-balanced suitable information for rational and considered thinking so that they would consent to having their actions influenced in such ways (the requirement for such consent being one of the key insights of Kantian ethics, with its focus on respecting individual autonomy – see Kant, 1785). In sum, in order to be fully ethical, intervention design processes need to be truly participatory.

There are different levels of participation. User input, which is central in user-centred design, can be interpreted as mere consultation. There could be two different levels of participation from having a voice (having an opinion about something) and having a say (affecting the outcome of an activity with what you say) (Bratteteig, Bodker, Dittrich, Mogensen & Simonsen, 2013). Hence, full participation is hardly achieved by means of consultation only.

Designing for behaviour change is not necessarily to devise objects (products) or even services, but to discuss the very processes that enable the development of change, in which case the distinction between experts and lay people no longer holds much distinctive value. Robertson and Simonsen (2012) claimed that:

> *[…] the question of how participation is being negotiated and defined (and by whom) is fundamental to distinguishing Participatory Design from the more common user-centred approaches. Participatory Design projects are always driven by ongoing and systematic reflection on how to involve users as full partners in design and how this involvement can unfold throughout the design process.*

Balka (2010) goes even further to say that it is within the democratisation processes of people being able to influence change in organisational structures that authentic participatory results will be found. And, that a dual emphasis on process and outcomes is necessary to give rise to true participation; by themselves, neither 'feel good processes' that do not deliver good results, nor 'good outcomes' that did not come from an engagement process are sufficient to constitute real, and, hence, ethical participation. However, participatory design, which might be essential to

designing behavioural change interventions in an ethically acceptable way, has many practical challenges to overcome.

To demonstrate how the proposed framework and questions (Figure 2) can be utilised, the case of a behavioural change project concerning antibiotics over-prescription behaviour is presented in the next section.

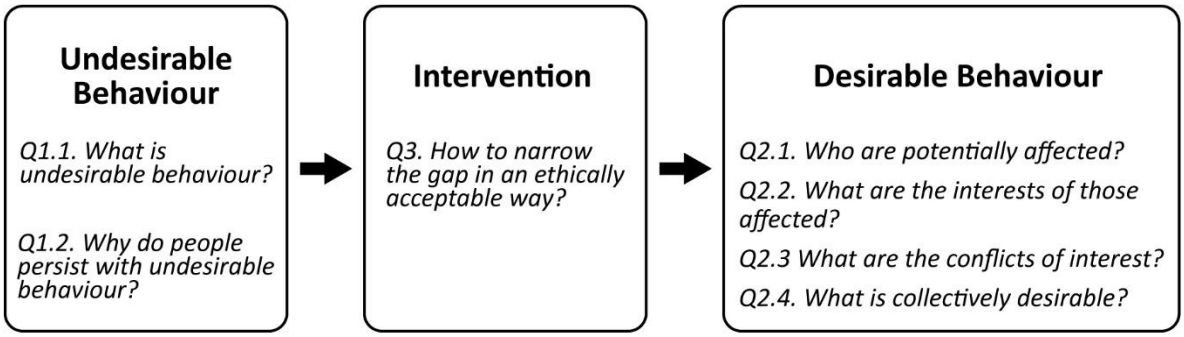

Figure 2 Framework proposed for exploring ethical questions in designing interventions for behavioural change

4 Case Study

The National Institute for Clinical Excellence (NICE) in England recommends prescribing antibiotics for adults over 65 years only in the presence of pathogens in the urine and clinical signs and symptoms (groin pain, confusion, difficulty passing urine etc.). However, evidence has indicated that staff often inappropriately diagnose Urinary Tract Infections (UTI) in older adults because they are more likely to have bacteria in urine, without any clinical symptoms of infection (Woodford, 2009). Recent qualitative research on hospital physicians has observed that prescribing of antibiotics for patients without symptoms of UTI (asymptomatic bacteriuria) is driven by overreliance on laboratory test results, difficulties in interpreting symptoms, anxiety about complications and peer culture (Eyer, 2016).

Antimicrobial resistance is a global public health concern caused mainly by “the systematic misuse and overuse of drugs in human medicine and food production” (WHO, 2015) and it has been observed in all regions of the world. In medicine, the causes for the persistent adoption of non-optimal practices regarding the prescription of antibiotics is manifold and it has been identified in the management and treatment of various conditions and illnesses, as well as in different contexts, ranging from the GP office to the Emergency Department of hospitals worldwide. There is urgent need to design interventions to change staff behaviour on infection management and antibiotic prescription, but various ethical issues and questions need to be carefully considered prior to or during the intervention design process. Table 1 is created to demonstrate how the framework, aforementioned in this paper, can be applied for clinical staff behaviour change on Urinary Tract Infection management and treatment.

Table 1 Application of the framework for understanding ethical questions and the main issues at stake concerning Urinary Tract Infection (UTI) diagnosis and management at the Emergency Department

Stages	Questions to be asked	Example from case study
Undesirable behaviour	What is undesirable behaviour?	- Inappropriate diagnosis of UTI - Over-prescription of antibiotics for UTI
	Why do people persist with undesirable behaviour?	- Individual factors: knowledge, skills, beliefs, motivations, experience and self-efficacy - Environment factors: maximum four-hour wait target at emergency department, conflict with a sepsis protocol, wider organisational culture and NHS pressure
Desirable behaviour	Who are potentially affected?	- Staff, patients, carers, tax payers and public
	What are interests of those affected?	- Staff: treat patient within 4-hour target - Patients: get well soon - Tax payers: effective use of health budget - Public: antimicrobial stewardship (appropriate use of antibiotics)
	What are conflicts of interests?	- Conflict between efficiency (4hr A&E target) and public health (antimicrobial stewardship) - Conflict between short-term goal (4hr A&E target) and long-term goal (antimicrobial stewardship) - Conflict between sepsis management (quick antibiotic prescription) and UTI management (careful antibiotic prescription) - There are multiple conflicts regarding both one single stakeholder, and between multiple stakeholders
	What is collectively desirable?	- Need to take into account all the conflicts at multiple levels and dimensions - Need both hard data to elucidate facts, an informed understanding on the nature of the problems in question, and qualities of empathy, imagination and judgement to discern and balance competing concerns
Intervention	How to narrow the gap in an ethically acceptable way?	- Trustworthy evidence: new guideline adopted by the National Institute for Clinical Excellence in England - Well-informed opinions: competing concerns including the possible impacts on third parties (people that cannot account for their own decisions, children, animals) or the environment (nature, public spaces, the workplace) - Participatory design: engage staff, patients, carers, tax payers, and public

Defining an ethical approach to address UTI diagnosis and management in the Emergency Department requires a holistic understanding of the multiple factors at play. The first stage is to define what is undesirable behaviour. This case has two behaviours: inappropriate diagnosis of UTI, and inappropriate antibiotic prescription. Complex interplay between individual and environment factors are found concerning why staff persist with the undesirable behaviours. The second stage is to ask questions around stakeholders, their interest and conflicts. Multiple stakeholders for this case include staff, patients, carers, tax payers, and the general public. It helps to clarify diverse interests

and identify conflicts at multiple level and dimensions (within one single stakeholder, and between multiple stakeholders; short-term and long-term; productivity and safety etc). the question on conflicts really helps to clarify complex dynamics, but it is still very challenging to decide what is collectively desirable. The third intervention design stage require participatory design approach based on trustworthy evidence and well-informed stakeholders. Behaviour change interventions can then be developed to tackle the multiple determinants of undesirable behaviours by applying the best available evidence and theory and by means of participatory processes. Active participation of the stakeholders can be enabled throughout the entire intervention cycle. This approach would account for effective outcomes and ethical ways of intervention design and implementation. Moreover, this approach is generalisable beyond this particular case: wherever design practitioners face circumstances characterised by an existing gap between desirable and undesirable behaviour, the questions and methods outlined in this paper can help those practitioners both identify more clearly what the desirable behaviour is, and identify means to bridge that gap in effective and ethically appropriate ways.

5 Conclusion: How can Design for Behavioural Change Be Ethical?

The purpose of the study was to reflect on fundamental ethical issues concerning designing for behavioural change, in order to raise questions about the factors that should be considered by design practitioners when developing interventions for change. This research has identified three potential ethical dimensions (moral psychology, philosophical ethics and design ethics) and provided a framework consisting of seven questions across three dimensions. The case study demonstrated the utility of the framework in systematically considering ethical issues around designing interventions for clinical staff's UTI diagnosis and antibiotic prescription behaviour. How to practically address complex ethical issues identified from the framework remains to be further explored in additional cases on a variety of design interventions.

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The Ethics and Values of Visual Communication Strategies in European Advertisements in 21st Century Western and Islamic Culture

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This research analyses interaction of graphic design, advertising and visual communication strategies between Middle East and Europe. Economic, political, and globalization processes from the Middle East have migrated into Europe by way of Muslim immigrants and asylum seekers, while social and cultural integration of minorities has been a primary focus of Western 21st century culture. This research provides an analysis of the ethics and values of visual communication strategies in advertisement design in Europe based on Western and Islamic cultures, taking into consideration the principles and ethics used to communicate with Islamic audiences. Emphasis was placed on advertising design and the differences among the design ethics of various communities to determine how values and design ethics have caused visual communication and advertising to fail between the east and west. The impact that such failures have on theoretical and practical artistic research and visual communication and advertising strategies are also explored to discuss how the shifting functions of artistic practices in graphic design and theoretical research form the basis of successful visual communication. In this way, a potential strategy-building system incorporating the design ethics of the western world and Middle East is proposed.

advertising, visual communication, western/islamic culture, globalization

1 Introduction

Globalization unites nations and cultures and has created a world that is closely interconnected. It manifests as increasing flows of goods and services, as well as capital and populations, between countries. For example, free movement of labor and war in the Middle East have contributed to the rapid increase in immigration from this region into Europe. According to Eurostat (2017), migration to the European Union (EU) has rapidly increased; asylum applications from citizens of nonmember countries began to increase throughout 2012, within the EU-27 and later the EU-28. Since 2012, the

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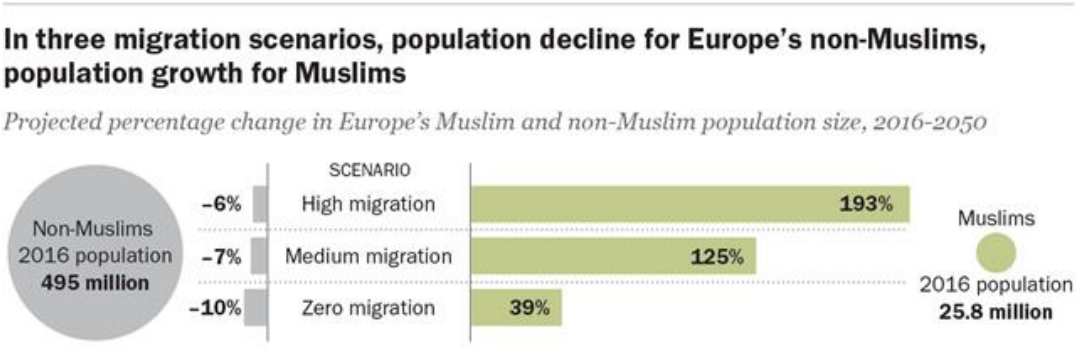
number of asylum seekers has continued to increase from 431,000 and 627,000 thousand applications in 2013 and 2014, respectively, to 1.3 million applications in both 2015 and 2016 (Eurostat Statistic Explained, 2017). The number of applications made in 2015 and 2016 was approximately double the number recorded within the EU-15 during a previous immigration peak in 1992 (Eurostat Statistic Explained, 2017).

Many of these immigrants and asylum seekers are Muslim, and in 2010, there were 4.8 million Muslims in Germany (5.8% of the country's population), 4.7 million in France (7.5% of the population), and 14 million in Russia (10% of the population; Pew Research Center, 2010). Between 1990 and 2010, the Muslim share of the European population grew by one percentage point per decade, from 4% to 6%. This pattern is expected to continue through 2030, when Muslims are projected to make up 8% of Europe's population (Hackett C. , Pew Research Center, 2016). According to a new Pew Research Center (2017) analysis of demographic data, if migration to the continent continues at medium or high levels, the share of Europe's population that is Muslim could more than double between now and 2050, according to the analysis, which defines Europe as the 28 European Union member states plus Norway and Switzerland (Lipka, 2017). There are three different projections for the coming decades with zero migration, medium migration and high migration scenario.



Count estimates and projections

IN MILLIONS	2010	2016	2050 zero migration	2050 medium migration	2050 high migration
Muslims	19.5M	25.8M	35.8M	57.9M	75.6M
Non-Muslims	495.3M	495.1M	445.9M	459.1M	463.0M
Total	514.8M	520.8M	481.7M	516.9M	538.6M

Figure 1 Three migration scenarios, population decline for Europe's non-Muslims, population growth for Muslims. Source: (pewresearch.org, 2017)

Last analysis of Pew Research Center (2017) predicts,

> *current circumstances of regular migration combined with some reduced numbers of refugees continuing to arrive, the most realistic endpoint for Europe may be somewhere between the medium and high migration scenarios – meaning Muslims could make up between 11.2% and 14% of Europe's population in 2050 (Lipka, 2017).*

The size of the European Muslim population in 2050 depends largely on the future of migration

Estimated and projected Muslim population shares

Country	2010	2016	2050 zero migration	2050 medium migration	2050 high migration
Cyprus	25.3%	25.4%	25.5%	26.6%	28.3%
Sweden	4.6	8.1	11.1	20.5	30.6
France	7.5	8.8	12.7	17.4	18.0
United Kingdom	4.7	6.3	9.7	16.7	17.2
Belgium	6.0	7.6	11.1	15.1	18.2
Norway	3.7	5.7	7.2	13.4	17.0
Netherlands	6.0	7.1	9.1	12.5	15.2
Italy	3.6	4.8	8.3	12.4	14.1
Denmark	4.0	5.4	7.6	11.9	16.0
Finland	1.2	2.7	4.2	11.4	15.0
Europe overall	**3.8**	**4.9**	**7.4**	**11.2**	**14.0**
Germany	4.1	6.1	8.7	10.8	19.7
Austria	5.4	6.9	9.3	10.6	19.9
Switzerland	4.9	6.1	8.2	10.3	12.9
Malta	0.2	2.6	3.2	9.3	16.2
Bulgaria	11.1	11.1	12.5	9.2	11.6
Greece	5.3	5.7	6.3	8.1	9.7
Spain	2.1	2.6	4.6	6.8	7.2
Luxembourg	2.3	3.2	3.4	6.7	9.9
Slovenia	3.6	3.8	4.3	5.0	5.2
Ireland	1.1	1.4	1.6	4.3	4.4
Portugal	0.3	0.4	0.5	2.5	2.5
Croatia	1.5	1.6	1.8	2.0	2.1
Hungary	0.1	0.4	0.4	1.3	4.5
Czech Republic	0.1	0.2	0.2	1.1	1.2
Estonia	0.2	0.2	0.2	0.8	1.0
Romania	0.3	0.4	0.4	0.8	0.9
Slovakia	0.0	0.1	0.1	0.6	0.7
Latvia	0.1	0.2	0.2	0.2	0.4
Poland	0.0	0.0	0.0	0.2	0.2
Lithuania	0.1	0.1	0.1	0.1	0.2

Figure 2 The size of the European Muslim population in 2050 depends largely on the future of migration. Source: (pewresearch.org, 2017)

As such, Europe is experiencing cultural conflict due to rapid growth among immigrant populations and their economic and social impacts on European culture. Crawford explained that

> *Europe's uneven ability to integrate its immigrants, combined with the steep social ladder, the rise of the xenophobic right, and resistance to immigration have created a volatile mix of resentment, hatred, and rancor on the part of the native population that can translate into violence. (Crawford 2007, p.18).*

2 Materials and Methods

This analysis compared modern advertisement designs from the Middle East and Europe based on ethical values, cultural and religious principles, and differences between communities. Exploring practical graphic design examples from print and digital media, the analysis was based on the theoretical design research of Ilze Loza, «Influence of Globalization and Islamic Culture on the European Advertising Design 21st Century» (unpublished).

The language of graphic design is an important topic in the context of globalization processes because it reflects changes within cultural environments. In particular, advertisement design is indicative of modern globalization because through such design, researchers can identify social processes, changing cultural environments, and influences and interactions between eastern and western cultures as well as between Christianity and Islam. Contemporary graphic design conveys messages that are often unique to different countries. There are several factors that influence regional graphic design, such as views of society, political structure, and culture. Art is an accumulation of culture that is unique to the society in which it is created, and advertising has become a global phenomenon with critical influence on both commercial and political or intercultural communications.

Culture is the cornerstone of national identity and includes everything that a society creates and values. Due to globalization processes, homogeneous culture may begin to appear. For example, Europe, as a geopolitical entity, is subject to strong globalization processes both internally and externally, and cultural mixing has occurred here between global and regional cultural elements. Schuerkens (2003, p.21) stated that such elements include "television series, Western consumer articles and values introduced by migrants [that] can become elements of the local daily life, often in changed forms and adapted to the local context". The cultural environment in Europe is diverse, and

> *Within a given culture are generally found smaller groups or segments whose beliefs, values, norms and patterns of behavior set them apart from the larger cultural mainstream. These subcultures may be based on age, geographic, religions, racial and/or ethnic differences. (Belch & Belch, 2011, p.137).*

Successful coexistence or integration of cultures depends on interactions between people. Cultural intelligence is needed to avoid social exclusion that promotes radical attitudes and leads to extremism. Understanding and interacting with people of other cultures is a requirement of modern media communication and among individuals involved in migration processes, who help immigrants become part of society within their new home countries as active members of local economies, which creates an ever-expanding audience for advertisers.

Today, advertising is a global phenomenon with a critical impact on commercial, political, and intercultural communications. Globalization processes are merging cultural barriers created by historically incompatible intercultural connections. Globalization manifests in global international organizations and marketing strategies that can create conflict between social values and commercial ethics, especially within the interaction between eastern and western advertising. For example, acceptance in the east of symbols of western consumerism does not necessarily mean acceptance of western values. A survey in 1997 found an attachment to technology and consumerism among young men in Saudi Arabia and the United Arab Emirates but did not indicate

Western liberal attitudes among these men, who were “still stalwartly conservative in their social outlook” (Rice & Al-Mossawi, 2002).

3 Ethics and Values of Visual Communication Strategies in Western and Islamic Culture in the 21st Century

One of the most basic dimensions of culture is religion. Pargament (1997, p.34) described religion as: “… the habitual expression of an interpretation of life, which deals with ultimate concerns and values. Institutional religion formalizes these into a system which can be taught to each generation”. Thus, religion defines ideals, which in turn are reflected in the values and attitudes of societies and individuals. These values define behaviors, practices, institutions, and overall cultural ways of existing.

Religion and culture in Islam are a complex and inseparable whole, and religion is a part of every aspect of life through the Koran. Asad (2007, p.445) stated that “Islamic values are [a] set of beliefs and morals, a social doctrine and a call to righteousness among all members of society”. Abbasi (2010) explained is as “a complete, self-contained ideology which regards all aspects of our existence—moral and physical, spiritual and intellectual, personal and communal—as parts of the indivisible whole which we call ‘human life’”. When religious authorities object to advertising, usually it is because of disagreements with western icons and culture. Advertising can be used by religious scholars to study Islamic ideals, representation of woman in 21st century, appetence or rejection of controversial ideas in design.

In contemporary business environments, corporations are involved in promotional activities that adversely affect the social and cultural norms of the Islamic ethical system. For example, Islam defines ethical behavior as adhering to restrictions on human actions that are detrimental to society. Defiance occurred when the social and cultural norms of Islamic business ethics carried over to 21st century, as the Koran was written from 610 to 632 A.D., when contemporary marketing and advertising did not exist; thus, it conflicts with trends in globalization, global market, multiculturalism, and contemporary marketing. As per the Islamic ethical system, emotion, sexual attraction, romantic language, minimal dress, and images of young girls are unacceptable, which runs counter to advertising trends in Europe that emphasize all of these subjects.

Rice and Al-Mossawi (2002) suggested that because Muslims in the Middle East share the same beliefs, advertising messages within these countries are the same. However, guidelines are interpreted differently in different countries; for example, in the United Arab Emirates local advertisements rarely include pictures of women, while in Malaysia, models must cover their hair.

> *Therefore, all parties shall run advertisements triggered human thinking in terms of fulfilling the command of Allah. Only with the right advertising contributes to enforce the Islamic economic system. Islamic advertising is consistent with the concept of Al-Bayan which is describing all details of the product with full disclosure to consumers (Nagata, 1994, p.191).*

Numerous studies have investigated the impact of unethical advertising on consumers. Marketing materials that use advertising techniques that do not conform to Islamic cultural norms and values are considered controversial and offensive to consumers from minority Islamic groups. Fam, Waller, and Erdogan (2004, p.114) found that “differences in religious affiliations tend to influence the way people live, the choices they make, what they eat and whom they associate with,” while Wilkes, Burnett, and Howell (1986, p.114) found that “[a] strong relationship is apparent between religion and a variety of social factors such as a greater concern for moral standards and having much more traditional and conservative attitudes.

Figure 3 Gliss advertisement. Source: (yabiladi.com, n.d.)

Figure 4 Sunsilk advertisement. Source: (malaysiafreesamplegiveaway.com, n.d.)

Figure 5 Schwarzkopf Gliss Kur Campaign 2011. Source: (Schwarzkopf, 2011)

Visual communication that includes characters and symbols varies by culture. An image may be positive in one culture but be offensive in others. Using an inappropriate visual communication strategy will create negative effects and simultaneously influence social behaviors. Andrade (2005, p.559) suggested that "[t]he word 'offensive' is highly associated with the subtleties of relational and situational context. Whether a word or an image is perceived to be offensive depends on the relationship between the parties involved and the occasion/situation where it occurs." Offensive advertising is culturally specific and is perceived and judged by different criteria across cultures (Boddewyn, 1991).

Religion influences consumption patterns by restricting certain foods and beverages; for example, Jews and Muslims do not eat pork. The pictures below represent advertisement campaigns from the Middle East and a western food chain. The first example shows a keffiyeh-wearing desert nomad as

he warms his hands over a sandwich from Kudu, a chain restaurant. In contrast, a McDonald's advertisement for the bacon Big Mac emphasizes the meat rather than story. Kudu advertises product without mentioning the type of meat because pork is *halal*—forbidden in the Middle East.

Additionally, advertisements often evoke emotional responses among target audiences by using cultural references. In Islamic culture, a sensitive topic in visual communication is gender role, particularly women's role, which is strongly influenced by religion. This, in turn, affects advertising and social media, which must be sensitive to cultural and religious beliefs and traditions. Gokariksel and McLarney (2010, p.72) discovered that "gendered identities are critical both to expressions of Islamic piety and to the operation of consumer cultures," while Deng, Jivan, and Hassan (1994, p. 537) wrote that "[i]n Islamic countries, both men and women must cover their torso and upper legs at all times and in the case of women only their faces' skin may be exposed."

Figure 6 Kudu advertisement. Source: (Eduards, 2013)

Figure 7 McDonalds advertisement. Source: (Beltrone, 2017)

Muslim countries disapprove of lascivious displays and indirect sexual references. One of the most common tropes in Western advertising is sex. Harris and Sanborn (2013, p.126) stated that. "[a]lthough some products such as perfume and cologne are sold almost exclusively through sex appeal, practically any product can be marketed through associating it with a beautiful person." The examples below are perfume ads, and the composition and points of interest are focused on the sexual appeal of the models. Product photography is secondary in this type of design, in which the focal point is the body of the person being displayed. Such advertisements are wide spread in western society.

Figure 8 Miss Dior advertisement. Source: (Dior, n.d.)

Figure 9 J'adore advertisement. Source: (Dior, n.d.)

Figure 10 Dolce & Gabbana 'light blue' advertisement. Source: (Fashiongonerogue.com, 2017)

In contrast, in perfume advertisements from the Middle East, the focal point is the perfume bottle, and in most cases, models are not present or are covered in long, usually black dresses. Thus, favorable attitudes toward advertisements using female sex appeal are significantly higher among western subjects than among Muslim subjects.

Figure 11 Bramble Perfumes advertisement. Source: (Bramble Perfumes, 2017)

Figure 12 Eternity Summer advertisement. Source: (pinterest.com, n.d.)

Figure 13 Givenchy advertisement. Source: (pinterest.com, n.d.)

Figure 14 Bling advertisement. Source: (Ajmal, n.d.)

The Islamic Affairs Department (1989, p.74) has declared that "[i]n the Islamic tradition, the female form is treated very differently than either the male form or the Western female form, a main difference being that the role and the physical form of women is not accepted as public." Publicizing female images in the Middle East amounts to being irreligious and disrespectful; however, images of Arab women in advertising seemingly violate long-held traditions within the Islamic private and public spheres. Kraidy (2006, p.75) explained that, "[s]pace is extremely important in Islamic social order, and spatial divisions regulate male–female relationships. The main objective is to prevent gender mixing." During the twentieth century in the Middle East, it was strictly forbidden to use local women in photography for advertisement campaigns, and it is only recently that a shift has been observed toward more open attitudes about this matter. For example, Dailymail.co.uk (Akbar, 2017) recently published an article about the censorship of adverts featuring a white woman in a swimsuit in Saudi Arabia.

> *"The photo was changed by Saudi hardware retailer Saco, who have edited other ads to publicize their Ramadan sale. The women appear to have been edited out completely in other adverts. Women in Saudi Arabia, which is governed by strict Sharia law and has previously come under fire for its gender segregation laws, are required to cover up their face and body when they are out in public. (Akbar, 2017)*

A beach ball had been digitally added to the image to cover her because the photo broke the country's strict Shari'ah laws about women covering their skin in public. The photo circulating on social media shows a man and three children, all wearing black t-shirts, playing in a swimming pool with a Winnie the Pooh beach ball in the corner. However, the original version of the image was made to advertise pools by Intex, an American country, and had featured the woman lounging by the edge of the pool instead of the inflatable ball.

Figure 15 Intex advertisement. Source: (Akbar, 2017)

Figure 16 Intex advertisement. Source: (Akbar, 2017)

Messaris concluded that misrepresentations and debasing representations of women in advertising should be rectified:

> *Things are beginning to change. As more and more women become employed in the industry, more positive and realistic images of women are coming to light. Yet the old tensions between the West and the Middle East, the modern and the traditional, the secular and the sacred, sexual freedoms and privacy, and appreciation and objectification remain and have resulted in an ambivalence in much of the media depicting the Arab woman today (Messaris, 1997).*

After extensively examining Middle Eastern advertisements that increasingly include local women in marketing campaigns. Such ads depict Arab women in modest dress (i.e., *abaya* [long dress] and *shailah* [scarf]) without reference to sex appeal; although the women are shown, these ads strictly follow Koran rules about visual appeal and modesty. Both men and women wear local clothes and cover their torsos; in the case of women, only their faces and wrists are exposed.

Figure 17 Bank Sohar advertisement. Source: (bloganubis.com, 2012)

Figure 18 Anantara Residence advertisement. Source: (Mohammad, 2013)

Figure 19 Print Campaign. Source: (iaauae.org, 2011)

In the following comparison, featuring mineral water advertisements, significant differences are apparent between the Islamic and western ads. Both advertisements include female models to examine the ethics of sexual appeal in advertisements, which reveals that western ads focus viewers' attention on the beauty of the model rather than the product. The opposite compositional approach is used for the Islamic ad, in which the mineral water product photo placed at the center of the ad.

Figure 20 Al Ain Water advertisement. Source: (Al Ain Water campaign, n.d.)

Figure 21 San Pellegrino advertisement. Source: (San Pellegrino, n.d.)

Figure 22 Aquafina advertisement. Source: (pinterest.com, n.d.)

International brands should change how they promote products to different target audiences. For example, a marketing specialist could be employed to develop communications that are effective within a target group using simple techniques, such as choosing minority models or including principles from the Koran. In a Knorr's advert for an Islamic target audience, the designers took into account cultural differences and advertisement ethics.

Figure 23 Knorr advertisement. Source: (Knorr, 2004)

Figure 24 Knorr advertisement. Source: (Knorr, 2004)

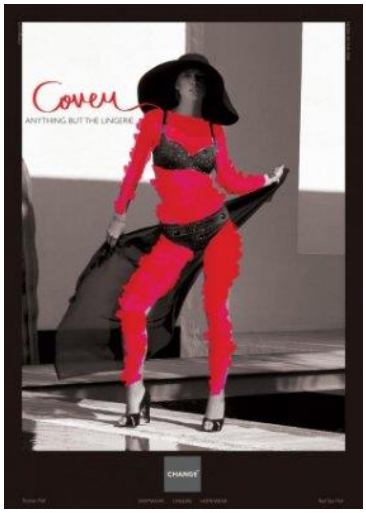


Figure 25 Change advertisement. Source: (Ogilvy, 2008)

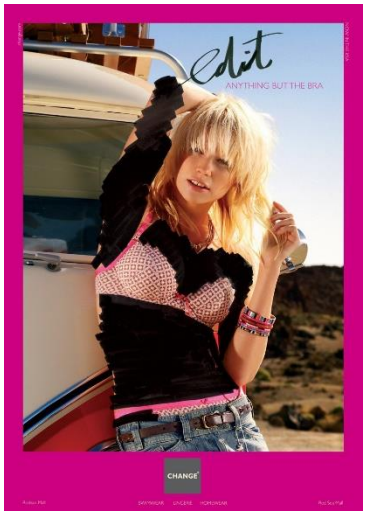


Figure 26 Change advertisement. Source: (Ogilvy, 2008)

Designers must make complex choices. As globalization continues, designers who can create advertising for a multicultural target audience are becoming increasingly important, especially in the Middle East, which has a significant expatriate community. Advertisement studios are coming up with increasingly creative and unexpected solutions to Islamic advertising rules that still target expatriates from all over the world.

> *Change is an international upscale brand providing quality lingerie, swimwear and home wear. The objective of the ad was to announce the launch of CHANGE in Jeddah, Saudi Arabia. The ads' focus is to utilize the concept behind censorship in Saudi Arabia to pull focus on the Brand's product line and to transform censorship into art. The ads are all in English, as they target an upscale bilingual audience. (Ogilvy, 2008)*

In the following advertisement for a resort, described by Eduards (2013) as "an excellent example of the tightrope that advertisers walk in Islamic countries," the female is dressed modestly in the long, body covering dress. In the second example, depicting an advert for the Gran Melia Hotel and Resort in Spain, the model is instead dressed in a bikini.

Figure 27 Maydan Beach advertisement. Source: (Eduards, 2013)

Figure 28 Gran Melia advertisement. Source: (pinterest.com, n.d.)

According (Badran, 2005) gender issues are one of the complication of the globalization processes in the countries of Muslin Culture:

> *Gender issues are one such complication when trying to address adaptations in a rapidly modernizing society. Thus, questions about whether media are damaging Islamic values or the representation of women in a media-rich Islamic culture are also questions about a division in UAE society between tradition and modern, or the sacred and the secular. (Badran, 2005, p.27).*

4 Visual Communication Strategies in Europe Influence by Islamic Culture

In Europe, there are very few ethical rules applied to advertising; thus, Islam-related marketing campaigns take one of two paths. Brands targeting Islamic minorities tend to respect and understand Islamic cultural ethics and values. In the first advertisement example, a campaign for Kushbu, which is a fashion line based in the UK that sells Islamic wear, is depicted.

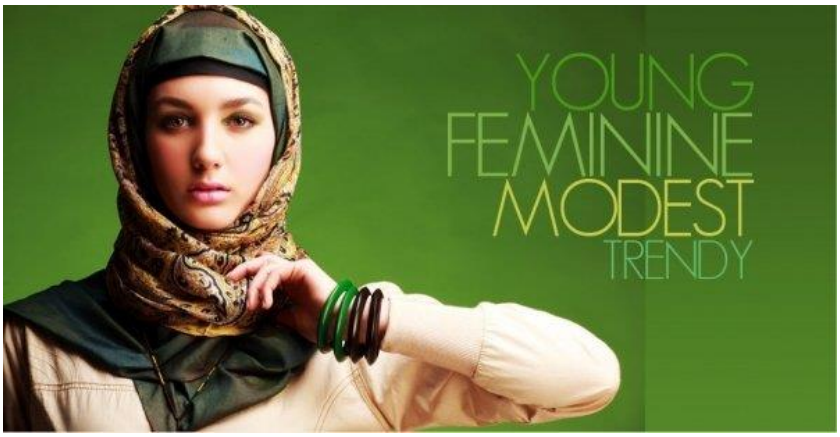


Figure 29 Kushbu advertisement. Source: (pinterest.com, n.d.)

The second example is for H&M, which is a western brand that targets Muslim minorities and is expanding sales into the Middle East. In 2015, H&M featured a Muslim model wearing a hijab, which was a first for mainstream advertising, in a video designed to encourage consumers to recycle their clothes. The advert made headlines as well as business sense; Muslims spent $266 billion on clothing and footwear in 2013 (Reuters).

Figure 30 H&M advertisement. Source: (hijablicious.com, 2015)

Figure 31 H&M advertisement. Source: (Elliott., 2015)

Similarly, sportswear brand, Nike, launched a revolutionary sportswear line for Muslim woman in 2018 to integrate Muslim sportswomen into the global sports world. The advertisement released in the Middle East featured five female professionals from different parts of the Arab world pursing their athletic dreams.

Figure 32 Nike advertisement. Source: (Uwumarogie, 2017)

Another approach is to use shock advertising, in which designers play with Islamic values and ignore ethical principles of Muslim culture to attract attention. One example is Diesel's 2013 "Reboot" advertising campaign. Shock advertising is a common practice in the western world. It is not designed to offend minorities, but it often does. Many Muslim women spoke out, mainly against the ad.

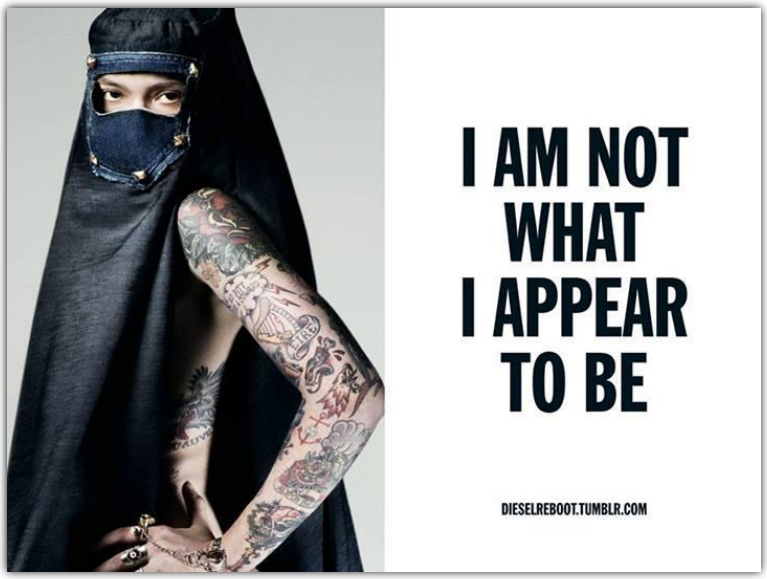


Figure 33 Diesel advertisement. Source: (Elboubkri, 2013)

Arianna (2014) also found that "[d]esigner Kenneth Cole is another famous seeker of controversy. Cole sees his fashion-maker status as an opportunity to get people talking, and his detractors see him as exploiting international crises and news items to drive sales."

> *The Diesel denim niqab ad really isn't shocking in comparison. But the reaction to it is illustrative of a change in the psyche over the last couple of decades. In 1992, print adverts for Bijan perfume appeared in Vogue magazine. These showed two female faces close up and side-by-side. The first woman—meant to represent a Muslim woman—was veiled, serious, and sober looking. Although the woman's face was heavily made up with cosmetics, the impression was of a nun-like woman. A caption next to the face read: "women should be obedient, grateful, modest, respectful, submissive, and very, very, serious." The face of the woman next to her was completely different. Carefree, this woman was smiling or laughing, with her mouth wide open. She was wearing a baseball cap, but had let her hair hang down at the same time. Next to her was a small American flag, and the caption: "women should be bright, wild, flirty, fun, eccentric, tough, bold, and very, very, Bijan." (Millar, 2013)*

Figure 34 Bijan advertisement. Source: (pinterest.com, n.d.)

Figure 35 Bijan advertisement. Source: (nancyfashionfancy.blogspot.ae, 2011)

The understanding of ethics in graphic design and marketing has become a source of broad discussion among designers and within society. Michael R. Hyman, Richard Tansey, and James W. Clark (1994, p.6) wrote an article on the evolution and progress of researches on advertising ethics and the found out that advertising ethics is still a mainstream topic and it is not an exhausted topic. (Hyman, 1994). Nevertheless, every conceptual decision in advertising should be ethical, which requires designers to be morally responsible and understanding of the cultures and values of their target audience, in this era of globalization and multiculturalism. The need to understand how personal beliefs, religions, socioeconomic classes, and other differences affect visual messages is a key part of professional graphic design. If these differences are not recognized, then the messages generated can provide incorrect information or inappropriate graphical compositions.

5 Conclusion

Technology has created a global culture and provided unprecedented communication to all corners of the world. Understanding cross-cultural conversations and providing fresh perspectives are important to ethical graphic design and visual communication that must take into account globalization processes and intercultural influences. Particularly sensitive ethical issues include racial stereotypes and religious ethical standards, especially those of Islam.

Advertising both forms and reflects social life, and marketing activities are widely affected by intercultural processes. New ethical values are emerging in the 21st century, based on various nationalities living in close proximity. Mass migration from Middle East to Europe has influenced the way target audiences respond to ethically sensitive topics in Islamic culture. Thus, advertising communications must create hybrid identities to negotiate between eastern and western cultures. While western advertising ethics follows very few rules, Islamic culture has many rules based on business ethics present in the Koran. Principles of Islamic business and ethical considerations must be taken into account when marketing to Islamic audiences to avoid controversy, negative publicity, or obviation of brands.

Value principles and design ethics in visual communication and advertising for Islamic audiences should include the following but are often interpreted differently in various Muslim countries.

- Business ethics and advertising should be based on Shari'ah laws and the Koran.
- Islamic advertising should be aestheticized, modest, based on the story and emotional.
- Sex appeal cannot be used in Muslim countries, nor indirect sexual references.
- The female gender is treated very differently from that male gender, based on cultural and religious traditions, with the main difference being that women's physical form cannot be presented for public viewing.
- Both men and women must cover their torsos and upper legs at all times, and in the case of women, only their faces may be exposed.
- *Haram* products forbidden for use in advertising include gambling, liquor, pork, interest in money, blood of animals, and meat from dead animals scarified.

Research has shown that Islamic and western cultures influence each other. Every year, more international brands target Islamic audiences and move into Middle Eastern markets, while intercultural processes between the east and west increase globalization. Advertising strategies in the Middle East tend to adapt western advertising styles without losing connections to Islamic cultural traditions. Most European advertising and communication strategies in the Middle East are based on cultural understanding and respect for Islamic values and ethics, although there are a few examples of controversial advertising.

Gender issues are the most complicated to address when creating adaptive advertising strategies, although globalization has caused modernization in within tradition-based Middle Eastern societies. Therefore, media are often questioned for damaging Islamic values or representing women inappropriately, and Islamic culture also questions the division between tradition and modern. Despite such obstacles, marketing strategies that strictly follow Shari'ah laws about female visual representation and women's roles in society, that combine western style with cultural traditions or Islamic values, and westernization of marketing tools and adverts can be successful.

Globalization is the process in which local events are induced by widespread events and vice versa; thus, globalization has created new social relationships, in which politics, economy, culture, and ecology are united in a single interdependent network that influences every society and individual. Education reforms are needed to encourage respect and tolerance of other culture, religious beliefs, traditions, and habits.

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Platform Ethics in Technology: What Happens to the User?

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In recent times, the design of technology platforms has been largely driven by the optimization of data flows in large-scale urban initiatives. Even though many platforms have good intentions, rising expectations for data efficiency and reliability, the configuration of users and user's interactions inevitably have ethical consequences. It has become increasingly difficult to foresee how a wide diversity of users fares against a spatially complex and materially incomplete management and distribution of data flows. Through the logic of platformization, we explore how this plays out in the context of open mapping platforms - in the case of an individual elderly street-mapper, Stig. Drawing from design anthropology, we present an anecdotal account of Stig's experiences of street mapping, showcasing his attempts to adapt to the demands of the mapping platform sometimes at the expense of his own well-being. Opening up to the complexity of the situation, we discuss the ethical dissonances of platforms, hence questioning the role of design in such complex modes of data production and consumption.

ethics; technology; platforms, design anthropology

1 Introduction

> *When the traffic on Timothy Connor's quiet Maryland street suddenly jumped by several hundred cars an hour, he knew who was partly to blame: the disembodied female voice he could hear through the occasional open window saying, "Continue on Elm Avenue…." (Traffic-Weary Homeowners and Waze Are at War, Again. Guess Who's Winning? The Washington Post n.d.)*

The disembodied voice the car driver was hearing in the quote above, was none other than Google's own voice assistant on the smartphone app called Waze. The application, owned by Google, provides turn-by-turn navigation guidance by combining its map database with real-time data gathered from drivers. According to this excerpt from The Washington Post, what used to be a quiet suburban neighbourhood quickly turned into a monstrosity of cars jammed in traffic, loud honking,

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and drivers looking down into their phones, updating the map. Whenever someone reports a traffic jam or a construction site on Waze, the application automatically redirects drivers through routes passing by side streets and silent neighbourhoods. As a consequence, residential streets that were perhaps only accessible to locals suddenly become public, and the numbers of cars in those streets significantly rises over time. In continuation of the jamming of Maryland Street, Timothy Connor took the matter to the public works department and the police, who could do nothing. Then he went rogue by performing counterattacks and reporting fake accidents to drive away traffic from his street. He was, however, discovered and penalised for his actions, barred from further use of the application.

Primarily, Waze is in the logical interest of efficiently managing traffic in crowded areas of a city, but in doing so, it configures the relationship between the systemic and the situated, the public and the private, in a specific way. Waze, thus, presents what could be described as 'the platform dilemma;' the increasingly recurrent clash between general utilitarian values of flexibility and flow, and social virtues such as domesticity and spatial coherence. While Waze is known to have dissolved harrowing traffic jams that could have lasted for several hours, presenting proud moments of networked big data, the long-term consequence is that of overturning or bypassing locally planned or negotiated efforts. In general, geographical data processing innovations like Waze operate with good intentions to support participation and societal development. Yet as exemplified by the Maryland Street incident, their capability to foresee how the processing will play out in situated ways under specific circumstances, both in the short and long-term, is limited. Furthermore, such platform technologies are based on the idea of free movement and self-regulating data flows that eventually pave the way for the total automation of urban traffic flows. As a result, they drive expectations on individuals to source and provide large volumes of 'reliable' data to continuously solve societal problems beyond the scope of the technology.

This paper takes mapping platforms as its point of departure to explore how the individual fares against the inevitable, changing, and incomplete distribution of data flows. In focus are the ethical issues of a supposedly automated system, which nevertheless is in constant need for human engagement, updating and maintenance. Presenting an anecdotal account of an individual actor, exploring ways of engaging with a mapping platform, the article aims to bridge the big data and design discourses with ethics, in order to discuss the dissonant interaction effects created in the encounter between systemic demands and user expectations. In focus is the account of Stig, an elderly mobility scooter-bound street mapper, for whom contributing to a mapping platform is more than about producing data; it is something that instils in him a position and a self-worth in society. In some ways, as will be clear, Stig was the perfect user of the platform in question. However, the mapping platform gradually exposed its limitations (and asymmetries in terms of interaction) by failing to address Stig's specific expectations for long-term social interaction with mapping, especially in his condition of failing physical and psychological health. The paper thus attempts to question if and how an ethical disparity manifests between the logic that dominates platform-technologies and that of situated and embodied contexts of use.

In essence, this paper is divided into three parts. The first part attempts to describe the logic of *platformization*; the business expectations on application platforms to both source, analyse, manage and further derive data, and how those expectations reflect on the user through excessive focuses on values like 'smartness' and 'efficiency.' This is further discussed through the case of open mapping platforms and their specific way of drawing together people, locations and events, with a special emphasis on their configuration of the user and the user's interaction with the environment. The second part of the paper begins with the methodological framing of this issue and then goes on to describe in fair detail the story of Stig and his experiences with street mapping. While exposing the dissonant expectations between the mapping platform and the mapper, Stig, the third part of the paper is a discussion that analyses Stig's account in the light of ethics around his expectations for

long-term interaction through key issues such as ‘codes of conduct’, reality effects and open data that are raised in the paper.

2 Driving expectations through platformization

The widespread significance of the Internet across the world has become central to everyday life and work, presenting opportunities for digital economies, policy makers, technologists and societies to bring an ensemble of technological innovations into being (Dutton, 2013). In that, digitalization has restructured the way in which material is stored and accessed, thereby promising increased speed, scope and accessibility to digitalized information (Featherstone, 2009). With digital innovation platforms on the rise, service providers no longer find value in standalone enterprise data-models as a sustainable or robust way to serve the needs of businesses. Instead, they have identified the need for cross-organisational data-sharing standards like the Common Information Model (CIM) to support the integration of individual enterprise data into big-data models, which would facilitate keeping up with data flows and driving change in expanding businesses. In this way, ‘platformization’ becomes the dominant infrastructural and economic model, which entails the extension of existing platforms to make all kinds of resources, human and non-human, available for meeting cross-organisational needs and management choices (Helmond, 2015). ‘Platformization’ therefore operates by optimizing corporate needs with vast sets of resources that cannot be met by standalone enterprise models.

Today ‘platformization’ is visible in the way technology frameworks like the Internet-of-Things (IoT) are deployed in concepts like that of the Smart City; a concept that aims to optimize city management, in terms of interconnecting vast information resources available on building, energy, environment, transport, mobility, health, education and so on (Perboli et al, 2014). The concept of ‘smartness’ builds on the idea that by automatizing and distributing the management of data flows everyday needs can be met in the most resourceful, democratic and sustainable way. As a result, there is an underlying expectation on ordinary users of platforms to engage and take part in this vision by providing information, often private and sensitive, to be harvested and used in algorithmic processes (Beer 2009). As a result, vast amounts of data are produced, where any thing, person or item can be mapped, mined and sorted for the platforms’ use. Following Katherine Hayles (2009), these processes, on the one hand, demonstrate the power of ubiquity in managing large-scale data sets, but on the other hand also draw attention to a certain “data boosterism” (Kitchin 2014, p. xvi); the definite but also problematic assumption that amplified and networked data benefits both organisations and ordinary users for making smarter decisions in everyday life.

For instance, the notion of ‘smartness’ in technology is inherently problematic because social systems do not necessarily base their activities on the efficiency of information systems alone (Jucevicius et al, 2014). By distributing the management of data flows across different platforms, service providers rely on users to produce data in exchange for services, where ‘smartness’—as a constantly adapting notion—becomes a feature but not always a necessity for the user. For the service-provider, however, achieving ‘smartness’ and competitive advantage through the realisation of “untapped capital” (Kitchin 2014, p. 119) becomes a priority. As a result, there is an underlying expectation on users to provide ‘reliable’ data by performing on both a creative and corrective level of the platform-system. Every bit of data produced is aimed at improving and updating the system. Waze, for instance, expects its users to “outsmart traffic” by producing volumes of reliable data, which are meant to benefit drivers through automated voice-based guidance. However, the consequence of traffic and honking in quiet neighbourhoods, as discussed earlier, and the dissatisfaction of residents living there shows that people expect in return some sort of continuance and personal influence in the system, even though their specific local requirements are not being encoded into the platform’s algorithm. On the one hand, this points to an emerging gap in the expectations between platform-systems and their users, and on the other hand, on the increasing importance of situated and local ‘codes of conduct’ in the potentiality of bridging this gap.

In the following section, we approach this issue by exploring further the *logos* or rationale of platformization through mapping technologies and the ways in which they configure the *ethos*, the character of use and users in their attempts to meet or handle encoded potentials and demands.

3 Platformization of mapping technologies

Mapping technologies carry expectations that are inherent in the characteristic nature of the 'map' itself. According to digital media scholar Jason Farman, maps are typically thought to be reliable, useful and somewhat essential to our everyday navigation of lived space (Farman, 2010, p. 874). However, the shift from traditional cartography to digital implementation of maps, notably in the form of Geographical Informational Systems (GIS), has severe implications in the way maps have been put to use and how that ties to expectations of *reality*.

> *The connection of maps and GIS to 'reality' is typically an inherent expectation of map users and is implemented through something as simple as charting your route to work to something as deadly as the al-Aqsa Martyr's Brigade's use of Google Earth to map out targets for missile attacks into Israel (see Johnston, 2007). The main problem with this expectation of maps and GIS 'representing reality' is that it assumes such representations are neutral and outside of cultural interpretation. (Farman, 2010, p. 874)*

Today, multi-device GIS platform-applications such as Google Maps, StreetView and OpenStreetMaps further reinforce the expectations of 'reality' and 'ground-truth' in them [see Figure 1].

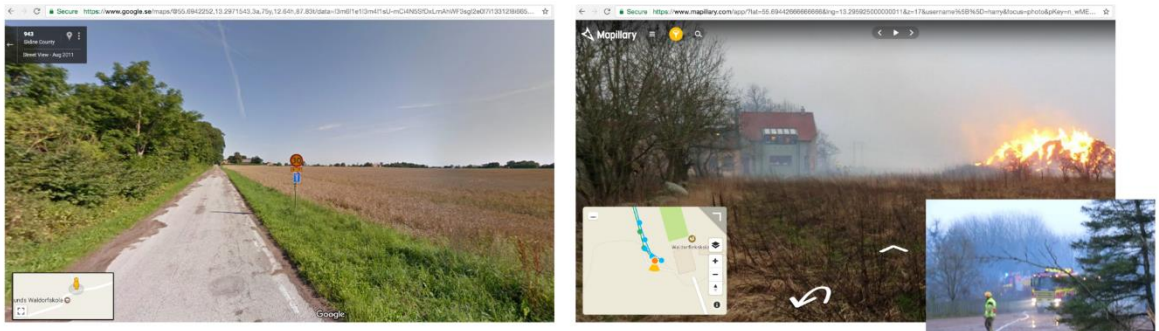

Figure 1 Meeting expectations of reality: The same exact GPS location captured by two separate mapping platforms – Google and Open Street Maps/Mapillary. The image on the left depicts a beautiful landscape whereas the one on the right showcases a fire incident.

These reality expectations drive individuals to use mapping technologies for everything from keeping track of weather patterns to tracking the whereabouts of a loved one. In 'keeping track', there are regulatory practices that dominate the use of mapping technologies. At the application level of the software, mapping technologies grant access to different types of map data including user location histories alongside weather or traffic data. On the one hand, the possibility of correlating user location histories with, say, weather data has benefits for both the user and the application provider. But on the other hand, the processes in place for analysing the two data sets are typically outside the user's control, which becomes problematic on several levels. Foremost, these data sets emerge from widely different codes of conduct; while weather data are representative measurements, furthermore an open resource, user location histories are implied and derived; yet considered as

'reliable' data samples for further analytical processes. Secondly, the processing takes place in a network layer outside the confines of the user's device, which potentially exposes itself to latencies, privacy breaches, secondary uses and also discrimination (Kitchin, 2014). Put in another way, information management scholar Daniel E. O'Leary (2016) emphasizes that although seemingly harmless, such data interconnectivities can easily produce "ethical interaction effects." These effects are ethical because they are manifested in the way the user's data are mined out of networked data streams for secondary uses and targeted feedback; an analytic and anticipatory process that becomes highly critical to 'who' the user is, 'what' the user will do, and 'how' the user's reality can be inferred.

As a direct answer to this dominant aspect of data configuration, open mapping platforms emphasize openness and accessibility. In the case of open street maps, platformization entails democratization, in that the control over the map is more broadly distributed, autonomous and participatory. With accessibility, there are new levels of interactivity and user agency, and the ability for non-experts to participate in maintaining and improving the map (Farman, 2010, p. 872). As a result, vast amounts of data are gathered through new device configurations and strategies that mobilize communities to support a democratic and sustainable use of mapping platforms. For the participating individual, the user-generated map unfolds the lack of a central authorial gaze; that which is represented on the map is acted upon, changed and replaced continuously (p. 880). This 'freedom' to change and replace data is made possible through easy-to-use interfaces supported by automated algorithms that greatly reduce the complexity in editing and managing digital maps. The algorithms are programmed to operate with built-in cameras and GPS sensors in mobile devices that ensure the mapper provides reliable map data in the least number of steps, notably in a single-easy click of a button [see Figure 2].

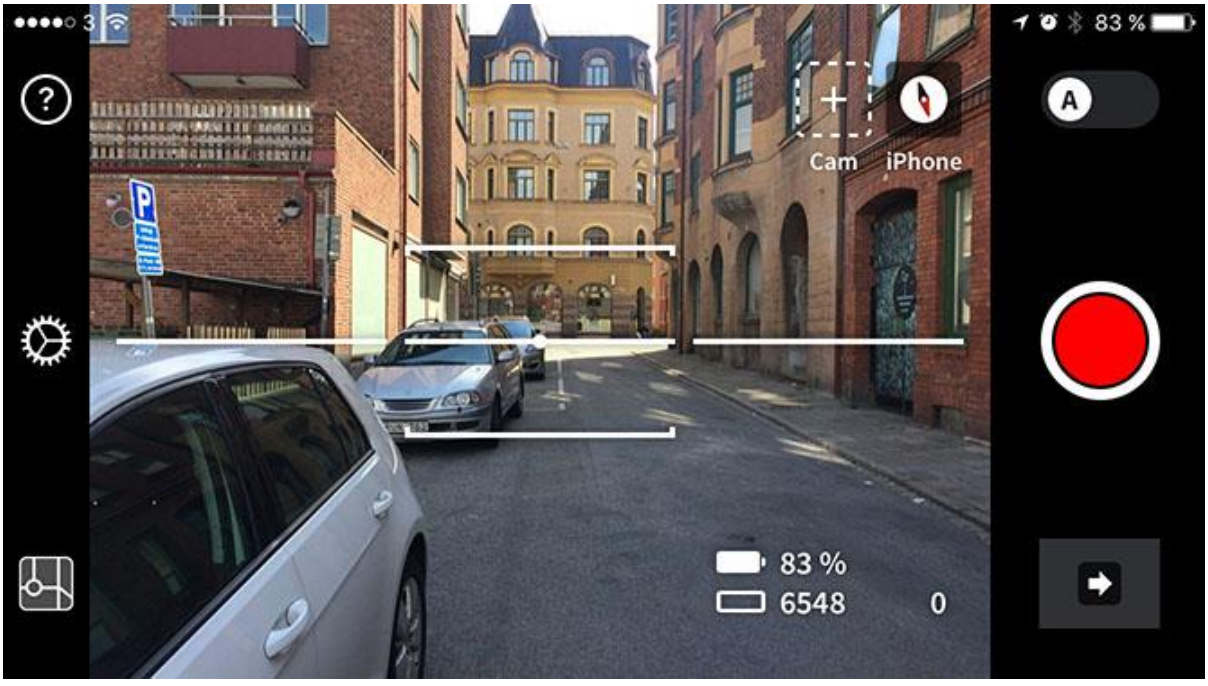

Figure 2 An example of a mobile interface for street level mapping – the red button is the trigger for algorithms to control the use of the camera and the GPS sensor. Image source: http://blog.mapillary.com/img/2017-06-09-start.jpg

Here the question of usability becomes crucial, as it is the operational arm of design that contributes to the development of a just society (Keinonen, 2017). On the one hand, easy to use interfaces make it very convenient for a wide range of individuals to take part in the open street mapping, but on the other hand, the algorithms used to run the interfaces become closely guarded secrets of mapping platforms, despite their claims to openness and accessibility. As a result, the user's engagement with

the map is reduced to that of being a systemic actuator rather than an 'inter-actor' in contributing to the conduct of the processing system. This makes the role of interface designers extremely challenging as they are expected to solve dissonant needs of users and the businesses through interactivity and usability. In her book Hamlet on the Holodeck, Janet Murray (1997) suggested that the user's ability to interact is not directly predisposed to the will or act of participation, further that it certainly cannot be reduced to the mere ability of clicking a mouse or moving a joystick (p. 128). Considering this early critique of interactivity, one would expect more from participatory modes of mapping, something that draws upon qualities from recreational mapping activities such as Geocaching, Orienteering or Pokémon Go.

Nonetheless in street-level mapping, there are some qualitative aspects being played out, mainly by incentivising users to be creative and adventurous in exploring urban areas in exchange for open visual map data. In doing so, it motivates the assumption that there is 'truth' captured in such experiences, driven by expectations of 'reality.' The question then becomes to what extent does street mapping, as a form of combined urban exploration and cartographic servicing, meet the expectations of 'mappers' who are configured as agile and humble producers of map data? To answer this question and clarify the underlying assumptions, we contend that exploring the qualitative aspects of how mapping plays out in specific localized contexts of a user might allow us to discern user experiences potentially at odds with the use and user configuration, or the implicit *ethos*, of street mapping platforms.

In the following sections, we describe the methodological framing for attending to the ontological as well as epistemological issues raised here. The framing provides the motivation for the fine-grain, narrative or anecdotal approach, realised through the account of Stig and his experiences of street mapping over a period of 4 months. With this account, we attempt to show how Stig's engagement with street mapping plays out in otherwise localized, embodied and under-utilized forms. In doing so, we expose weaknesses in the mapping platform for being unable to retain Stig's long-term engagement with mapping. The goal is to be able to reflect and discuss ethical issues arising out of the platform mind-set on individuals taking part in it.

4 Methodology

Exploring concepts like platformization and its relation to mapping technologies, the aim has been to draw attention to a potential ethical dissonance in the expectations of reliability and efficiency as well as that of participation and emancipation among users. The methodological framing for addressing this condition must attempt to bring a unique sensitivity to capture the situated aspects of individuals taking part in the visions of platformization. Design research holds a long tradition of bringing together widely different disciplines to create shared frameworks of understanding for changing existing realities. While design itself is a future-oriented process and product—not the least as played out in the design of mapping platforms—disciplines like anthropology bring to design the tradition of theorizing concepts like platformization through the context of its usage and its configuration of 'reality.' Gunn et al (2013) further propose a 'design anthropology,' which is able to "include the critical use of theory and contextualization; the extension of the time horizon to include the past and long-term future to ensure sustainability; and sensitivity to and not least incorporation of the values and perspectives of the people whose worlds are affected by design." In that, design traditions entailing visual prompts, probes and anecdotal evidences are able to bring rigor into this kind of critically engaged theory and practice through their acknowledgement of non-human agencies, their relationalities and the emergence of new materialities (Lury and Wakeford, 2012). This kind of framing of 'design anthropology' thus offers the critical, practical and temporal lenses to adequately address the questions we put forth in the paper.

Relying on this frame, we approached the issue of platformization supported by a 'design-anthropology' practice that included inquiries into open mapping platforms and corporate enterprises; interviews with platform developers, open street map (OSM) ambassadors and, most

crucially, the ‘street mappers.’ Based on the interviews conducted with the platform developers, it became evident that the vision for open mapping platforms was to support a large community of mappers to create the ‘best’ photo-representation of the world. This accumulated bulk of open street images are then sold off to corporate enterprises that are in the business of improving the accuracy of self-driving vehicles, while being consolidated for other secondary uses. The expectations of the platform, in this regard, is to engage as many people as possible to take part in street mapping, as long as they are able to generate a constant flow of data. The retention of individual mappers is thus not a priority for the mapping platform.

For the purpose of developing our argument, we have chosen to present a part of this material through an anecdotal account of Stig, an elderly street mapper, with whom we have conducted a series of interviews over a period of 4 months. Our choice of an anecdotal representation is motivated by an understanding that anecdotes are not mere reflections of research practice but rather they shape how certain events in the research come to be understood. Through the anecdote, the extraordinary event serves to illuminate the ordinary flow of events, allowing for the study of difference and gaps that are deviating from ‘normal’ expectations of reality (Michael, 2012). The account, in this sense, is presented in a manner that can support the aim of exposing the gaps in platformization from an ethical point of view.

5 Stig the street mapper

Stig is an elderly street mapper living in Malmö, the third largest city in Sweden. At the time of conducting this study, he held the second largest contribution of street-level images in Malmö, uploading around 116,000 images and covering 800 km of the city [see Figure 3]. These striking numbers would make one think of Stig as some kind of street mapping specialist, but as we will soon find out, his story is much more layered than what is apparent on the surface.

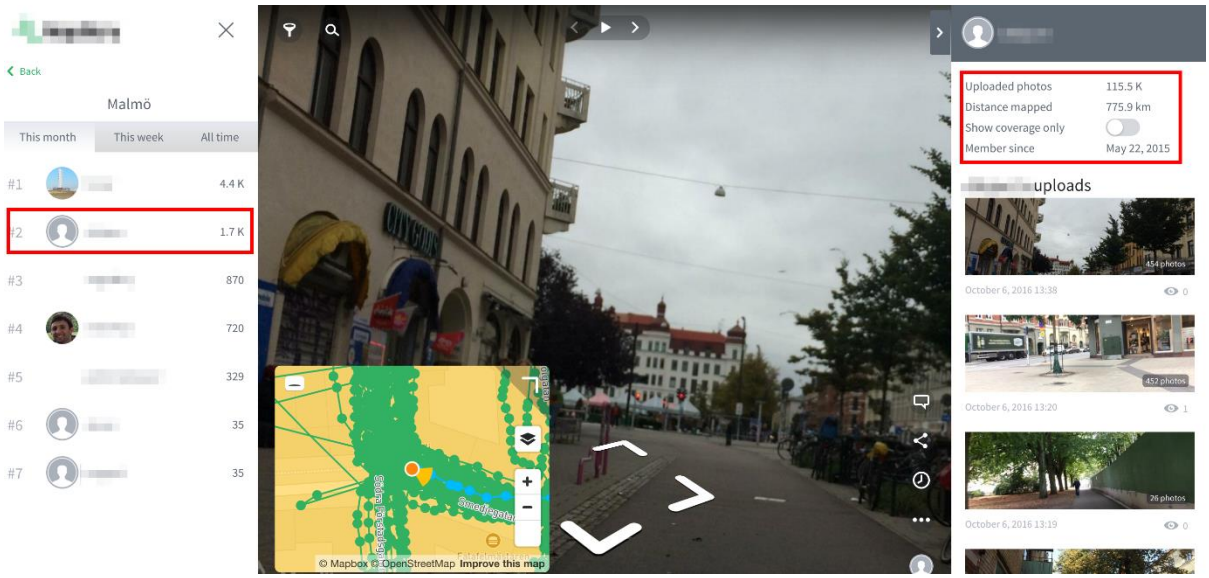

Figure 3 Screenshot showing Stig’s uploads on the street-mapping platform.

Stig is 69 years old and he is a retired surgeon. He now lives in an elderly home facility in Malmö. As someone who has offered medical service for many years, Stig longs for contributing to society. However, Stig suffers from a disease that has affected his spinal cord, making him entirely dependent on his rollator walker and mobility scooter to support his daily movements. He otherwise comes across as an independent individual with a youthful spirit for experiencing new cultures, stimulating conversation, and travelling the world.

Stig's introduction to street mapping occurred by chance at a dinner table conversation. During the dinner, there was a mentioning about street mapping by someone who worked at a firm producing software for street mapping, while advocating for the societal benefits of contributing to a democratic vision of digital maps. Tickled by curiosity, Stig downloaded the application to his iPhone with some help from them. Stig claimed the application was rather simple to use because all that it demanded of him was to click the 'automatic capture mode' button and it took care of everything.

I simply wanted to contribute because I had a lot of fun doing it.

In the beginning, Stig enjoyed mapping so much that he prepared a fix for the left handle of his mobility scooter, which held his iPhone in place for capturing images [see Figure 4]. The fix could move left or right to suit whichever direction he wanted the camera to face. In that, the mobility scooter offered great advantage for capturing 'non-shaky' images, which other mappers did not share. Stig was proud of his arrangement and also proud of contributing many images without the trouble of manually operating the iPhone.

Figure 4 Stig's mobility scooter parked inside his apartment. There is an iPhone rig visible on the left handle of the scooter.

Here on we describe different kinds of adaptations Stig undertakes to capture map data, and in doing so, we reflect how this comments on certain weaknesses of the platform, which resulted in Stig's ultimate withdrawal from street mapping:

Coming from an older generation of users, Stig is not entirely comfortable with new technologies. Nonetheless, as opposed to many of his generational peers, he likes to think that he *can* use them, and in his possession are one Nokia phone and two iPhones. His primary phone is the Nokia, which he wears in a neck-strap. He calls it his 'safety phone' because he has all his emergency contacts saved there. The other phones he sparingly uses them for taking photos or for video chatting with his family. Beyond these basic applications, Stig has difficulty navigating mobile interfaces that requires him to remember a sequence of interaction-flows, such as the procedure for downloading media content from a virtual store or attaching images to an email or a text message. Further, clicking mobile interfaces can be an everyday challenge for Stig, which requires him to find resourceful fixes for the problem. Stig said he had once carved up a clicking tool from a twig of a tree to ease his burden of clicking. When he is at home, he uses conductive metal ends of pens for interacting with the touchscreen on his iPhone devices. The ease of capturing map data through a single click of a button was ideal for Stig's use, which in turn portrays him an ideal user of the mapping platform.

According to Stig, he used to map on a routine basis but soon realized that he took the same routes every day to the supermarket, the physiotherapist, or the cinema. This was true because 800 km of Stig's coverage of Malmö was a recurring chain of photos from the same locations. When Stig raised this issue with the mapping company, he was surprised to learn that images from the same locations greatly improved the accuracy of the map, and he was thus encouraged to continue mapping the same way. To the contrary, Stig decided to reduce his mapping frequency because he did not "feel good" capturing the same locations repeatedly.

When Stig is not out mapping, he is busy with his three translation projects. He claims that carrying out these projects feed his daily dose of intellectual stimulation. The first is an advanced Swedish translation of a Thai recipe book, the second is a translation of a Buddhist meditation book, and his final project is a dictionary translation of ancient Pali language into Swedish. On a regular day, he most looks forward to learning Thai by video chatting with a friend in Thailand.

> *Viewing someone via Line [video chat application]. Most attractively learning Thai taught by a friend in Thailand.*

Stig's conscious decision to map less frequently highlights how the literal translation activity offered him something more stimulating to do than the repetitive task of capturing the same images on a daily basis. To make mapping interesting, however, Stig tried to increase his breadth of coverage by traveling longer distances of about 20-30 miles from his home. Although he said he was mostly concerned that his scooter would run out of battery if he travelled too far.

> *I went too far once […] and my scooter ran out of battery. There was nobody on the street, and I called for help. Someone dropped me off at a nearby fuel station where I waited for a couple of hours for the elderly service-bus to pick me up and drop me home. I read magazines and bought some snacks while I waited […] it was embarrassing.*

Stig suffers from anxiety over his physical disability. He tries very hard to overcome his anxiety by ensuring the scooter's battery is charged everyday and that his Nokia phone is strapped around him in case he needed help. Since that incident, Stig chose to make longer trips on mini-buses instead of driving his scooter. It becomes easy to notice how Stig goes out of his way to keep himself engaged in street mapping, even if that meant putting himself in risky situations, ignoring the difficulties in mobilizing himself.

When Stig was asked what he mostly does while mapping, he replied, "nothing, because my attention is set on the road and my iPhone does the mapping." He did, however, bring to notice that his attention tends of drift to his iPhone for ensuring the battery lasts the entire mapping activity. Every time he went mapping, Stig connected the iPhone to two power-banks that he put in his backpack, partially closed, in the front basket of the mobility scooter. When he was back home, he needed to recharge all the electronic devices, including his scooter, to make sure he could continue mapping the following day. This was not an easy task, especially for Stig because he struggles to remember things. To this day he maintains a notebook with a list of to-dos. Even then, Stig tends to blame himself, calling his brain "stupid" for not being active any longer.

> *I am empty in my head. I put everything on paper; I don't even remember which day it is.*

As a countermeasure, Stig exercises his mental capacities by practicing daily meditation. According to him, meditation sharpens his mind's focus and helps him pay more attention to his daily activities.

> *I practice Vipassana [insight meditation] for about 30-40 minutes everyday. This style of meditation focuses on abdominal movements. I use a tea light for the atmosphere and close my eyes.*

As such, the task of connecting and recharging multiple electronic devices for mapping everyday seems daunting. To that extent, we can notice how Stig consciously tries to adapt himself by

performing remedial practices like meditation to meet everyday demands of maintenance, especially those required of mapping devices.

At the same time, Stig mentioned that he is lonely and craves for meaningful company. On the one hand, the Nokia phone allows him to be as close as possible to his daughters and their families. Stig says his daughters' families are his closest friends, further claiming he is too old to make new friends. On the other hand, he was very clear that he does not enjoy small talk with his neighbours. Stig attends community events where he socializes, sometimes contributing with vegetarian food. In addition, he volunteers at the city library about once a week, offering Swedish lessons to newcomers in Malmö. Stig enjoys talking to people from other parts of the world and tries to learn their reasons for learning Swedish.

> *A man from Lebanon once told me how much Swedish he had learned quickly and most of it he could translate to Arabic. He must have made up some of the things he had done, very suspiciously according to me and also some others at SpråkCafé.*

Stig's 'suspicions' about this man from Lebanon hints at some of his efforts to find meaningful social interaction as he tries to adapt his daily activities to fulfil this need. Even though it sometimes requires him to speak to complete strangers, he sees it as an opportunity to keep him active and engaged.

With the automated software upgrade on his iPhone, Stig could no longer access the mapping application the same way he did before. According to him, he could not locate the 'capture' mode on the application's interface, which then led him to withdraw from street mapping altogether. He said he did not want to take anyone's help because he got tired of having to deal with the technology. In his daily life, he dislikes being helped because it puts him in an uneasy relationship with his more 'abled' caretakers from the elderly care service. Stig said he sometimes becomes upset when his caretakers do not listen or if they do not engage in his specific needs. He further claimed that he gets depressed just lying in bed every morning until help comes. When he is dressed for the day, Stig prefers to shop and prepare food on his own rather than to depend on his assigned help.

> *Some [of the caretakers] pretend like they really don't care.*

On an abstract level, the relationship between caregiving and mapping platforms can be explored here. The caretakers in Stig's everyday life are real and visible with the ability to express his feelings directly to them. With street mapping, on the other hand, there is no one behind the screen with whom Stig could share his needs and difficulties, which eventually led to his frustration. However, one could argue that the reason for Stig's adoption of street mapping in the first place was because it supported his well-being, as it offered him a kind of physical and mental therapy. The mapping platform can then be seen as a form of care provider, as in Stig's case, but only within certain limits. This would then beg the question of 'systemic care' or the automated configuration of systemic and individual expectations as well as the relationship between the developer and user. Who is caring for whom or what, and to what extent?

5.1 Reflections

The attempts by Stig to engage with street mapping for as long as he could while meeting the demands of maintenance and accuracy of the platform reveals several tensions inherent in its visions to democratize technology and support platformization. The account indicates the persistence with which Stig met these demands by virtues of compliance and commitment to the mapping activity. In one sense, mapping played a role in offering some therapy and boosting Stig's confidence and self-worth in society, but it was limited by assumptions that took for granted his mobility and engagement, in spite of the sometimes embarrassing and frustrating situations he encountered while taking part in it. Further, it also shows how his lack of interaction with the technology during mapping was compensated by the task of attending to multiple devices, ensuring they were fully charged and maintained for routine mapping. At the same time, the account brought

to light under-utilized resources in Stig's life that allowed him to overcome the shortcomings of the mapping technology, where the twig, the 'safety' phone, translation activities, social encounters and Buddhist meditation practices began to take more prominent roles in his daily life. In many ways, the problems faced by Stig in street mapping were not entirely his own. They are more telling of the demands placed by the platform on Stig than the weaknesses in him for meeting them. Furthermore, the 'reality' in Stig's experiences while mapping remains unacknowledged and under-represented on the map, thus exposing the complication of platformization behind any claims to systems of care.

6 Discussion

The reflections above highlight some of the hidden gaps in mapping platforms, which shall be discussed here in the light of ethics. In so far, our reading of platformization has drawn attention to the emerging gap in its double agenda of meeting expectations of reliability and efficiency as well as that of participation and emancipation. Following Kitchin (2014), the concern around this kind of platformization is three-fold. First, it promotes the privatization of public services purely administered for profit making, and second, that it creates 'technological lock-ins' that encourage a monopoly of technology platforms for long periods of time, and third, that it gives rise to 'one-size fits all' solutions that do not take into account the unique contexts and situations of people, locations and events (p. 222). Taking these concerns into consideration, the goal is to explore how it plays out for individual users in the context of mapping platforms, highlighting the ways in which map data is made lucrative for big data analytical processes, and further how users of the platform are configured to support such processes.

Through Stig's account, it becomes clear that his attempts to meet expectations of street mapping came at the cost of his well being, exposing tensions that are ethically problematic. Stig's withdrawal from street mapping signifies that the platform was not configured for his use, but rather made for a younger generation of users whose code of conduct differs widely from that of Stig's. For individuals like him, street mapping is less about the pleasures of urban exploration and more inclined to the virtue of meaningfully contributing to a democratic vision of maps. Configuring the user as someone who is only there to seek anticipatory pleasures catered by a single user-experience model thus becomes critical to design of the technology. The single button-click interaction, for instance, reflects this model by enforcing a conduct that supports momentary satisfaction out of urban exploration, while overlooking other forms of conduct, such as Stig's, that deviate from it. The deviation is played out not only at the interface level, but goes deep into the algorithmic level of conduct. On the one hand, automatizing mapping through closed algorithms that do not take into account local requirements limits the extent to which the user can influence the map. On the other hand, by allowing the user to influence the map freely, it opens up to the risk of polluting existing data sets with meaningless data that cannot be harvested for future uses. The map is thus a complex determination of 'encoded' forms of conduct that entails regulatory, prescriptive as well as discriminatory aspects, deeply seated in the algorithms, interactions, user-experience models, and not the least, the business models of the platform.

Another manner of conduct in open mapping platforms is the users' expectation that the interconnectivities in data reflect their personal influence and continuance for meeting local requirements, but in a way that it does not produce interaction effects leading to secondary uses and targeted feedback. As discussed above, certain interfaces limit the extent to which a user can exert their influence on the data captured, but in other cases, where that is made possible, platforms tend to overpower the user in determining how their data is managed and distributed towards profitable ends. This presents an important ethical gap that draws attention to managing the social expectations of users on platforms. Even though some platforms claim to be open, accessible, and participatory, the extent to which they support the social and relational needs of its users is questionable. The data derived from open data are not driven to support users in meeting their requirements, but are instead transformed into solutions that are technocratic in nature. One

such example discussed earlier is Waze, the smart traffic application, which addresses the specific need of navigating traffic by collecting all possible open data, but without taking into account the actual needs of those producing that data. Open data, in this regard, following Kitchin (2014), are treated more like a product than a service, where the data are simply made available for others to reuse (p. 82). Further, he argues that open data should be more service-oriented by attending to the needs and expectations of the ones who produce the data, the ones who would potentially bear implications for resourcing (p. 82). Achieving such a service-orientation would thus require entering into the narratives of the producers of open data whose social expectations and relational needs may be different from what platform technologies currently offer.

By entering into the narrative of Stig, it becomes possible to imagine what kind of individual he is, why he participates in open data initiatives such as street mapping, and further what expectations he might have for open mapping platforms that could support his needs. The seriousness of his participation in street mapping must therefore not be taken lightly. Furthermore, his adaptations in the form of meditation and literal translation produced 'reality effects' that made his experiences of mapping more real than what the map represents. Reality effects, in this regard, comment on the expectations of reality in mapping platforms that go much deeper than a simple digital trace on the map. These effects point to both the weaknesses of the mapping platform in failing to pay attention to those details in his life as well as the opportunity to understand the context of Stig's social and relational needs. In this sense, studying how these reality effects play out in the production of data by different individuals becomes crucial from an ethical point of view.

In addition to studying the effects of open mapping platforms, there could be other directions to consider for further development. For instance, open data in platforms could open up to the possibility for collaborative learning to take place where people learn to use the data as a shared resource to meet social needs. Feminist-geographer duo Gibson-Graham (2008, p. 15), for instance, argue that collective experimentation can potentially foster relations of interdependence that are democratically negotiated by participating individuals and organisations. Yet one needs to consider that open data is not a sound resource for gathering reliable data, leading to potential misgivings in regards to accountability and robustness. This is because open data does not necessarily have a formal structure or easily identifiable fields that are regularly maintained for harvesting and use. Kitchin (2014, p. 82) argues that even if the prospect of delivering open data as a service is agreeable, in practice it might entail a long chase for effective funding opportunities to support such initiatives. Nevertheless, these shortcomings can be potentially met in ways that are inspired by alternative modes of production based on mutual care (see Gibson-Graham, 2008). To that extent, even the open mapping platform can be seen as a way to provide mutual care, such as in the case of Stig, through his specific mis-adoption of the platform for his therapeutic needs, albeit in a limited sense and for a short period of time. It would then require further work for exploring not just how different models of care can be brought into service-based platform-systems, but also how to facilitate patterns of interaction beyond the instantaneous button level of satisfaction and support mutual learning and long(er)-term retention of the user as acknowledged participant.

7 Conclusion

The aim of this paper was not to provide a clear answer to the question of what design should do with the issues raised but rather to open up the complexity in the relations between platforms and users and to draw attention to the ethical dissonances that arise from them in their local contexts of use. The paper started out with the example of the application 'Waze' stating how many technology platforms operate with good intentions even though it is difficult for the involved actors to foresee how the technology will play out in the short and long term. Through the logic of platformization, we argued that it is not the intentions per se but rather the gap in expectations between that of driving 'efficiency' through users and the social expectations on platforms to resolve complex societal issues that becomes ethically problematic. These gaps in expectations were discussed in the context of

open mapping platforms. With the help of concepts such as 'ethical interaction effects', we raised the implications arising out of contingent aspects of big data and its use-configurations, and how these aspects are implicated in the way the open mapping platforms operate their usability strategies to produce as much data as possible from a large group of users. We acknowledge how it is made especially difficult for designers to cater to the needs of end-users, while contending with dominant regulatory aspects and the closed nature of business models.

We presented an account of an elderly street mapper, Stig, to understand how an individual like him fares in his attempts to be a 'good' data producer for open mapping platforms. The narrative describes his experiences of having to come to terms with his own 'differences' that are at odds with the anticipated user-experience delivered by mapping application. The account ends with Stig's withdrawal from street mapping, drawing attention to the adaptations he makes during his mapping to support his well being as well as meeting his needs for meaningful interaction. We believe these aspects are a part of a bigger ethical problem that is deeply set in the logic of platformization.

By opening up to this condition, what kind of questions should we be asking as design researchers? In our discussion, we expose the deviations taking place in the conduct of the mapping platform starting from the level of the user-experience model, and right down to the interface and code level of the platform. Describing the manifestation of such deviations as 'encoded' forms of conduct, we acknowledge their inevitability as well as their potential for negative consequences. One direction for interaction designers is to find alternate ways of 'encoding' different kinds of conduct into the use of the platform that might reduce deviations for end-users. To do so, we argue the need for designers to enter into the narratives of the individuals who produce data for platforms. Exploring the 'reality effects' in the narratives would then allow designers to understand the contexts of the social and relational needs of the data producers. We see this as being a valuable step towards addressing the gap in expectations. Furthermore, we also acknowledge the potential for new conceptualisations, other than platformization, using open data as a resource. Undertaking feminist perspectives, we question the need for bringing into consideration alternative modes of production that are based on notions of care-giving and mutual learning. The question for designers is then whether to continue solving the dissonant expectations inherent in platformization or to explore radically new uses for open data in ways that allow the desired changes to happen.

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Design for Profit or Prosperity?

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Over the past decade, it has become increasingly popular to position design as an excellent tool for companies and organisations to foster innovation and growth. As an adaptable practice design can be applied to serve many ends, and in the field of sustainable transition design has the potential to create new solutions due to its capacity to 'reframe' large-scale problems of a 'wicked' nature. However, as we will argue in this paper, the innovation and change promoted through design risks becoming merely a vehicle for promoting the values associated with 20th century neoliberal capitalism. We therefore want to question the role of design as a managerial tool and ask: *How might design be used as an ethical transition in organisations and not merely be hijacked as an opportunistic vehicle for streamlining, optimisation and growth?* This tension field is highlighted through a showcasing of a research programme about sustainable development, innovation and change conducted together with the world's largest player in the fur industry: Kopenhagen Fur.

design management, design anthropology, design for transition, innovation

1 Introduction

The main aim of this paper is to raise awareness of the responsibility of designers working in industry or in collaborative projects with industry and, in particular, our own role as design researchers. As the borderlines between practice, industry and research within the design community are steadily becoming more fluid in an attempt of "Creating Economic Value by Design" (title of paper by Heskett, 2008), we wish to ask the question: *How may value be created through design in such a way that it ensures critical thinking and genuine positive change?*

The responsibility that designers take on by proposing new solutions and changing practices and products has been problematized in various ways in the design literature. Papanek (2005) in particular made this a central element of his ecological critique. What often emerges is a question of what the proposed change is for and, especially, for whom. As Julier (2014) explains, over the last four decades design has aligned itself with neoliberal tendencies in consumer economies. In the =process of extending the scope of private companies, design has been used as a process of change, to optimise production, create new markets and reach new consumers. Although Julier's

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observations should probably not be taken to represent all design practices, he problematizes the role of design as a *means* and not an *end*, and establishes the connection between neoliberal economic practice and design. Consequently, different approaches have been proposed to equip design with the ability to create ideologically driven design – whether by "queering processes" to create diversity in HCI design (Light 2011), or by acknowledging the responsibility of implementing design products that promote specific values (Gray & Boling 2016).

The tendencies that Julier describes make design an obvious partner of management. Hence, the development of design management can be seen as a natural development in the interest of private companies. The main purpose of this paper is to expose this connection and to propose measures that will help designers and companies align their proposed products and services with the value of sustainability. Hence, we address the field of design research and specifically design management, and we propose elements of critical theory aimed at exposing the *false consciousness* embedded in industrial practices thus helping designers steer their products and services towards their intended goals. Subsequently we wish to open a discussion about interdisciplinary and theoretical development in design that can push actual practices within the design community. We will do so by presenting a case study that exemplifies the challenges and the need for critical reflection when attempting to use design as a tool for sustainable change.

Firstly, we present the way in which the understanding of sustainability has developed within organisational and management theories, and we outline the ongoing and growing critique from particularly consumer studies directing the issue of establishing a better link between production and consumption. We frame this discussion by focusing on positions within the area of fashion and sustainability, since this is particularly relevant for our case. Next, we emphasise how design might become a vital tool to overcome some of the barriers for sustainable development in this sector, but also warn that design might be employed as a tool for merely supporting and sustaining the neoliberal economic paradigm of the 19thand 20th centuries. Based on these considerations we move into a presentation of the overall framework and aims of the research case study, after which preliminary findings and reflections are showcased. Finally, in light of the highly complex case study, we will discuss and reflect on ways and approaches that might push more critical potential − and ultimately more sustainable − industry practices.

2 Sustainability and fashion

After decades of ignoring and actively resisting the need for change towards more environmentally and socially sustainable practices the fashion industry has gradually introduced initiatives dedicated to structural change, the annual global event 'Fashion Summit' in Copenhagen being one example of this transition. As in any industry, what constitutes sustainability is difficult to define, and a general consensus is absent. With the promise of circular economy models, however, companies are looking towards a holistic approach and what is popularly known as 'closing the loop'. Based on an economic logic that promises to deliver savings as well as the opportunity for growth, the model seems to deliver both sustainability and profit. A comprehensive discussion of circular economy models lies beyond the scope of this paper, but we will identify two aspects that are directly relevant to the discussion of design and sustainable transition in organisations, namely the relationship between growth and sustainable production and the integration of production and consumption. In this section of the paper, we will specifically focus on the discussion as it has been playing out in the area of organisation and management studies, as well as consumption studies.

In an article on 'prosumption' (2013), Ritzer describes the historical bias towards production in social research. He argues that historically throughout economic and sociological theory, production has been seen as the central sphere in terms of value creation:

> *The emphasis on production is found in the work of the classical social theorists, most notably Karl Marx (as well as Adam Smith). In the labour theory of value that lies at the heart of Marx's theory of capitalism, it is production (work, labour) that gives commodities their value. Consumption, especially the ''demand'' of consumers, plays no role in the value of commodities which is determined by the labour involved in them (Ritzer 2013, p. 5-6). And further: …to the degree that there was a concern for consumption in Weber's work on the protestant ethic, it was ultimately on the propensity of the protestants to value frugality; to consume as little as possible (Ritzer 2013, p. 6).*

The focus on production is not limited to social science studies but can be identified in management practices as well. Producing goods for consumption has been the sole focus of fashion companies, and what happens after they are sold has been of little interest to companies, at least the companies that sold the merchandise in the first place. Often unnoticed, companies belonging to another industry, waste management, have been involved in handling the goods once consumers discarded them, sometimes intersected by a third sector, i.e. organisations that collect and sell second-hand objects. The sequence of separate companies, consumers and organisations creates a linear structure leading from sourcing to landfill with very little material or informational feed-back up the commodity chain.

The role of consumption, as such, has not been identified as central to value creation, and arguably this bias has prompted very little interest in consumption studies beyond the area of marketing. Consumption studies have, of course, spurred their own areas of critical research, and the role of consumption practices in everyday life has been identified (Miller 2012, Slater 1998, Hebdige 1979), as has the essential role of consumer objects in identity work (Belk 1988, McCracken 2005) and socialities (e.g. Cova & Cova 2001). More recently, the bias towards acquisition has been problematized (Graeber 2011, Gregson et al. 2007), and even the practices involved in parting with consumer objects have been described (Gregson et al. 2007). Although some – Ritzer most notably – have approached production and consumption as interrelated, mostly production is seen as the creation of value and consumption as the destruction of this value (Marx 1976, Graeber 2011).

By introducing a circular model integrating the spheres of production, consumption and resource management the main activity becomes a consideration for the next steps in the chain, which prompts information to flow up the commodity chain. Thus, circular models are promoted as: 'restorative and regenerative by design and aim to keep products, components, and materials at their highest utility and value at all times' (Ellen MacArthur Foundation 2015). Driving on such ideas, it seems obvious that the field of design, with its shift of interest from production to use experience, has something to offer. As expressed by Yee, Jefferies and Michlewski (2017): "If the 20th century has been about the story of design and designers, the 21st century will be about the users of design." As we will demonstrate later with our study, this shift in focus bears a potential for sustainable change in a sector such as the fashion industry.

3 Design management – for profit or prosperity?

When looking at the way in which design has been developed as a managerial tool, it is an area that covers a variety of approaches. As stated by Erichsen and Christensen in a review of design management literature, the area has expanded immensely over the last few decades within design community circles and publications. Fuelled by scholarly areas such as management, design, marketing, strategy and organisational theory, design management is a melting pot of what is termed *'cross fertilization'* between practice-driven knowledge (conceptual) and design, management and theory-driven knowledge (analytical), which is being applied specifically in relation to topics such as product development, marketing management and organisational management (Erichsen & Christensen 2013, p. 110). According to Buchanan, applying design as a kind of 'thinking' and value creation appears at four different levels or *orders* of design, namely 1. *symbolic and visual*

communication, 2. *material objects,* 3. *activities and organised services,* and 4. *complex systems or environments for living, working, playing, and learning* (Buchanan 1992, p. 9-10). These levels were later transformed by the Danish Design Centre (danskdesigncenter.dk 2015) and also by Design Management Europe (here in Best, 2015) into the 'Design Ladder' model that can be directly applied as a managerial measurement tool for design implementation in companies and organisations. Elaborating on this model Miller and Moultrie argue that in order for a company or an organisation to obtain 'Design Leadership' it must be able to navigate between three levels of design management: the *operational level,* in which actual design projects are coordinated; the *functional level,* where design is integrated into all business functions, and the *strategic level,* where a design vision for a given company has been defined (Miller & Moultrie 2013, p. 164). If design incorporates such a potent formula for development and innovation, an obvious question for these aspirations of the design community is: What is design? What kinds of value does it actually create? And who are we talking about when we speak about 'designers'? This issue has recently been debated by several scholars now that design and design thinking seem to be the new buzzwords of business and management. Kimbell for one has categorised design thinking as a *cognitive style* with a focus on design as an ability to solve complex problems; a *general theory of design* leveraging various levels in which design might be understood and operationalised, and finally design thinking as *an organisational resource* whereby innovation emerges as a result of designerly ways of thinking and doing (Kimbell 2015). What she also problematizes is the idea that designers are the 'main agents in design' (ibid, p. 301) and, drawing on practice theory, she argues that design activities as *ways of practicing* can be conducted by a line of agencies (Kimbell 2012). As such, she concurs with Manzini, who defines performers of 'expert design' as "professional designers, design researchers, design schools, design-related media and cultural institutions" (Manzini 2014, p. 107). The idea that designers and 'designerly thinking' (Cross 1995) can create value in society can be traced back to the concept of "reframing" as defined by e.g. Dorst (2015). In his book of 1980: *How Designers Think – The Design Process Demystified*, Lawson elaborates on the way in which designers allegedly seek not only to solve the problem at hand, but rather to problematize the whole 'framing' of the problem through what he calls *escalation*. Accordingly, this ability to totally 'reframe' the design problem and bring it to a larger scale is here perceived as holding the very essence of the value that designers create (Lawson 1980). When looking at these texts and the body of knowledge they build on that goes back to the early writings of design scholars in the 1960s, it is obvious that a vital premise is a legitimisation and positioning of design as equal in its own right, not only in the hierarchies of the arts in general, or, as formulated by Williams, as a provider of consumer goods for industry without creative autonomy (Williams 2009), but also as a partaker of business, organisations and the development of society at large.

Hence, we will concur that in the present *transition economy*, in which ethics and sustainability are seen as a key positioning compass for companies (Gardien et al. 2014), there is an actual need to critically revise − or reframe − the aspirations of the design community. A representative example to investigate could be the 2012 report by the European Design Leadership Board, *Design for Growth and Prosperity*, that aims to "ensure the success of embedding design in innovation in Europe." What is meant by growth and prosperity in this context is defined as promoting

> *..the increased use of design in European industry to encourage synergies in support of economic growth, environmental regeneration, and the raising of social and emotional value, whilst respecting the need for renewable and endogenous resources* (Thomson & Koskinen 2012, p. 8).

However, whereas the concern for the environment seems to be only sporadic throughout the report, it seems that the central aim is to promote design as a main driver of innovation "for companies across Europe to support the uptake and integration of design and design management as a strategic tool for growth" (ibid, p. 9). Social change and well-being is also mentioned very centrally, but it does seem that the 'reframing' of business-as-usual does not automatically reach a

societal systems level; apparently, as a design community, we can question the framework and operations of a business or social sector, but we do not question the entire value system and the economic culture. Hence, in the aspirations for legitimisation, we warn that design, from this perspective, might become a mere opportunistic tool for the existing system, rather than an actual tool for questioning the status quo.

The manifest of the organisation "Danish Designers" (Grønbech & Valad-Amland 2010) states that the key role of designers and design in the 21st century is to create innovation that stimulates social responsibility, economic gain and environmental concern in the tension field of the so-called 'Triple Bottom Line' of 'people, planet and profit', defined by Elkington (1997) and later revised by e.g. Jackson (2009) to 'people, planet and prosperity'. The differentiation between the former and the latter is well expressed through the ideas of Ehrenfeld, who argues that the time has come to leave behind the idea that sustainability can be driven by the mere reduction of environmental problems, by technology or upcycling – what could be understood as design for profit or sustaining business-as-usual – and instead promote what he terms *sustainability-as-flourishing*, defined as follows: "Sustainability is the possibility that humans and other life will flourish on the planet forever" (Ehrenfeld 2014, p. 59). He further poses "the key question […] what, if any, is the role, or roles, for designers […] in any program aimed at creating sustainability-as-flourishing?" (Ehrenfeld 2014, p. 59) and promotes 'transformative design' as a key: "sustainability-as-flourishing is the epitome of a wicked problem" (ibid, p. 61).

In continuation of Ehrenfeld's statement we concur with Banerjee (2014) that if *sustainability-as-flourishing,* in Ehrenfeld's understanding, is to be obtained, there is a need to take the concept of 'reframing' and 'escalation' to a whole new level. Banerjee perceives sustainability as a "super-wicked problem," defined as having: "…most notably the additional attributes of massive scale, urgency and complex interactions between many subsystems that are themselves wicked problems" (Banerjee 2014, p. 71). Based on this statement he suggests a "fifth order of design" as a supplement to Buchanan's original categorisation, in order to stimulate sustainable development: "Design as Large-Scale Transformation," for which he argues as follows: "Given the multi-dimensional nature of scaled challenges, these new approaches and tools can only be arrived at through the strategic combination of different disciplines and agencies in order to create new paradigms necessary for scaled impact" (ibid, p. 74). Below, we will outline an example that illustrates the tension field between 'Design for profit' and 'Design for prosperity', and how we as design researchers have tried to navigate critically in a perhaps somewhat unorthodox and highly complex case study.

4 Case study

Considerations, reflections and proposed and already conducted research of the project presented in this paper must be seen as one of several outputs resulting from a larger partnership agreement between Design School Kolding and Kopenhagen Fur, which, apart from teaching formats for fur design, has delivered a series of scholarly publications as well as so-called 'artistic development projects' made by designers. All deliverables centre around the basic proposition of how design might help push a more sustainable development and effectively aid a more concise communication about sustainability for Kopenhagen Fur.

The scholarly approach and methodology of the entire programme and its various sub-projects, the overarching 'umbrella' approach, is strategic design management, looking into ways in which design might bring value to the strategic operations in terms of particularly creative development, marketing, communication and consumer relations. Of particular importance is how to develop and improve the synergy between the furrier and the design studio of the company and align it with the corporate strategy, rather than having the studio isolated and detached from the overall strategic concerns and activities. The programme also focusses on how collaborations with other companies, design schools and young design talents might better display and strengthen the overall vision and mission of the company – in this case to be the most sustainable fur auction house in the world.

Following Heskett, this could mean levering the company's approach to design from interpreting and reproducing (OEM) and expressing (OBM), to making use of design as a core part of the company's strategic planning (OSM) (Skjold & Lønne 2016).

In order to do so, the first output conducted in the period August 2014–March 2016 was a multi-disciplinary research programme mapping barriers and potentials for these propositions in the report *Fur and Sustainability – a Design Perspective* (Skjold et al. 2016). This report covered the entire value chain of fur, together with the company's existing activities at farm level (level 1 fig. 1). Also, we defined a position in the debate on sustainability that was placed in the design phase (rather than production or post-sale), as the designer makes the choices about what kinds of materials to use; it is also the designer and the brand who decide what kind of consumer behaviour the product aims to stimulate (see fig. 2).

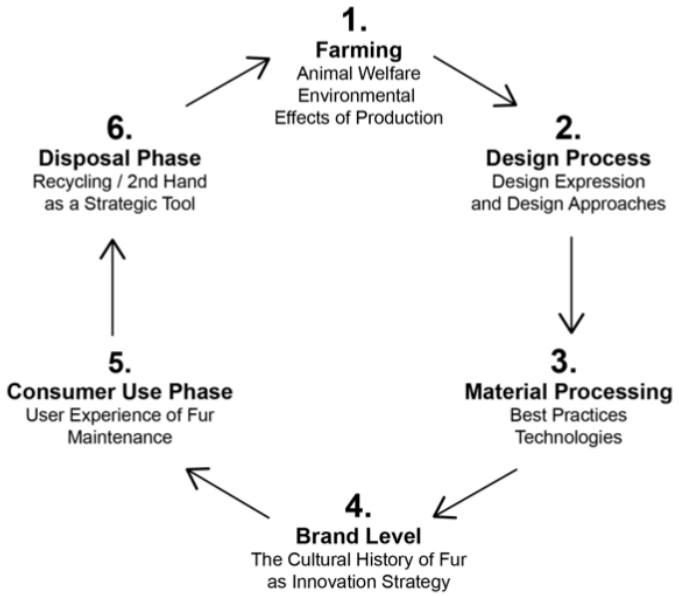

Figure 1. The report covered the entire value chain of fur from farm level (level 1) and through the subsequent levels until final disposal. Each of the levels 2-5 in the model identifies the individual scholarly interests of the four post doc.'s involved, whereas the 6th level was an area of shared interest.

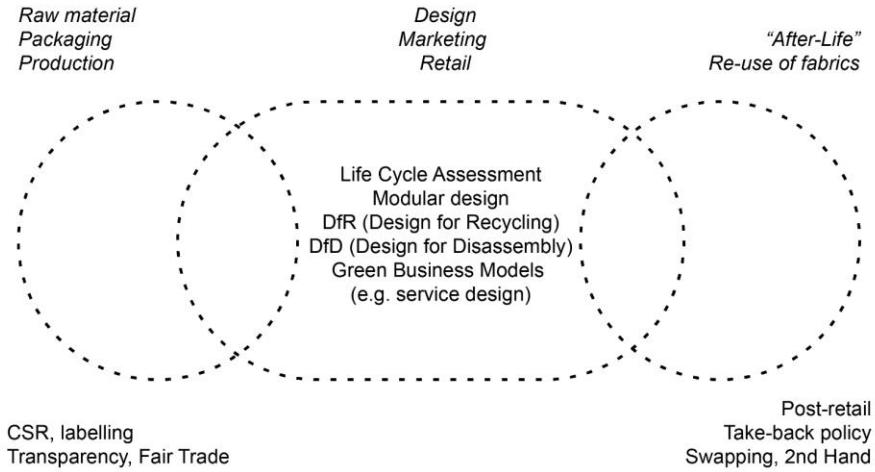

Figure 2. In the report, we defined our position in the field of sustainability as placed in the middle – the design phase – in which crucial decisions are made regarding both use of materials and products and narratives that stimulate certain kinds of consumer behaviour.

Together, the four scholars had working stations physically placed at the company premises where participant observations were made throughout the entire project period. Also, each of the four researchers made observations and qualitative interviews together covering design processes of furriers and designers in the company and in related or other companies, material processes mapping based on comparative literature studies and mappings of the various practices of the company, employees in the company and ethnographers and museologists with particular knowledge about fur and owners of inherited fur; they also participated in relevant company activities and meetings. The outcome was a series of recommendations for how to move forward with a strategy for promoting sustainability as integrated in what Heskett terms 'design as planning' (in: Dickson & Kristensen 2004). Next, we looked at the recommendations and based a new project on these recommendations of sub-project 4 on design processes.

The result was the sub-project "Re-Imagine" conducted in the period 2016–2017 (see fig. 3). The project consisted of the following activities:

- Two scholars from the first project developed a set of method cards displaying well-known design strategies for working with sustainability and dress design, conveyed into particular approaches for designing with fur that match the findings of the research report
- Two designers were hired to each make one collection of garments (a menswear and a womenswear collection, respectively) in which they tested and integrated the method cards into their design process and final deliverables.
- Seven short films were made as pilot formats for how to communicate narratives embedded in the project; one film for each of the design projects, and five films that illustrate best practice examples of existing sustainable practices in the fur industry, namely user understanding, maintenance, re-design and repair services, rental services and business models for secondary use.

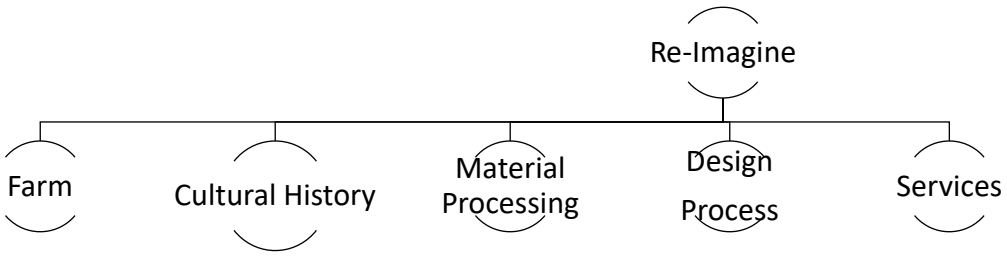

Figure 3 displays how the "Re-Imagine" project was based on particularly the sub-project on design process, but also built on the findings and conclusions of the entire report.

On top of these mentioned activities, a minimum of two design workshops with selected employees of the company has been taking place each year of the project duration, ensuring that the findings and reflections of the research team were integrated into company operations. Also, researchers from the team have participated in the development and execution of supportive marketing events together with Kopenhagen Fur with the aim of communicating the findings and recommendations of the programme to various stakeholders and to the general public. As such, the project continues to stimulate a synergy between the three levels of design management defined by Miller & Moultrie: First, the *operational level*, in which design projects are coordinated and conducted, as was the case with the two collections made by designers. Secondly, the *functional level* in which design is integrated into all business functions, as illustrated through the method cards that stimulate cross-unit and cross-employee discussions about strategic sustainability approaches conveyed by design. Finally, the *strategic level*, in which the entire project pushes to aid the company in defining its

design ‘vision’, i.e. what kinds of design approaches might be stimulated to support the company’s mission and vision to become more sustainable in its operations (Miller & Moultrie 2013, p. 164). This was further highlighted as the project led to a readjustment of a large-scale global talent competition for approx. 10 selected design schools; the “Re-Imagine” project will from now on form the basis of the concept, design briefs and realisation of the competition.

Reflecting on these deliverables, we decided, on the basis of the above reflections about sustainability, fashion, and the outlined ‘design for responsibility’ approach, to focus on the secondary use phase, as we – in line with e.g. Otto von Busch (2009) – perceive that this level of operations has been underdeveloped in the fashion industry. What we realized, however, was that this approach is very much alive and well functioning in the fur industry, and hence a series of ‘best practice’ examples might be found here that could be an inspiration for our overall concerns.

5 Fur and sustainability – the “Re-New” project

As outlined in the section about sustainability, the post-sale phase of fashion has become a topic of great debate and interest, in both scholarly and industry circles, in the investigation of potentials and business models in the so-called circular economy. The slogan ‘repair, reduce, recycle’ promises a field of innovation for businesses in the fashion sector based on the idea of prolonging the use phase of garments, or re-circulating raw materials. This ongoing project that we call “Re-New” is being conducted in the period of August 2017−June 2018. It derives from the recommendations in the report that are based on the level of use and post-use (fig. 4): the use phase and the secondary use phase (services, mending, repair, re-design etc.). The recommendations were as follows:

> *On the basis of Sub-project IV, it is recommended that the company explore existing practices in China which bear the potential of re-thinking the position of fur. This position points away from fashion's focus on standardisation and rapid turnovers and towards long-lasting design that might be adapted to the individual user over time through re-design services, taking user experiences of a more diverse consumer group into consideration.*
>
> *[level VI] …it is recommended that the company explore how recycled fur could be seen as a way to potentially engage a different group of designers and consequently a different group of consumers, since it was observed that recycled fur compensated for ethical concerns and was perceived as a more sustainable choice. Furthermore, recycled fur is a far more economically available material than new fur, which has been noted to liberate designers from inhibitions with regard to experimentation (Skjold et al. 2016, p. 52).*

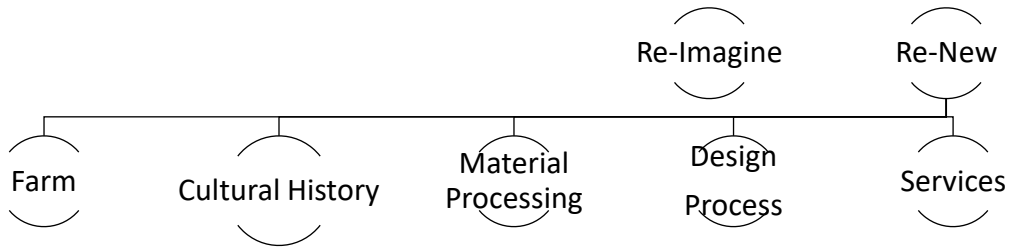

Figure 4 displays how the “Re-New” project is a continuation of the project in its entirety, particularly based on the use and post-use level of the value chain of fur.

The project will consist of the following activities:

- A design anthropological study of practices of services provided by fur retailers and furriers in China, Norway and Denmark
- Three design projects evolving around mending, re-design, repair and upcycling approaches which will each result in smaller collections of design objects
- Three pilot co-creation workshops with selected users or designers based on upcycling, mending or repair of inherited or second-hand fur garments.

At this point in the project, we have conducted a field trip to Beijing and Harbin in China on 6−7 October 2017, shared readings and finalised a pilot co-creation workshop with six designers from our school. We have also initiated the first design project – an upcycling collection of accessories made of leftover material from the fur studio of the company as well as vintage fur. In the following section the framework, preliminary findings and reflections from the field trip to China will be presented.

Part of the ongoing research conducted for this project consists of empirical research into design and maintenance practices in the fur industry in the form of different types of observations and semi-structured interviews. The methodology is mainly derived from business ethnographic approaches combined with design anthropological elements. Studying business practices from an ethnographic point of view is based on the assumption that the best way to understand cultural activities, i.e. other people's 'way of life', is by situating oneself in the physical and to some extent mental space of the people one studies (Edgerton & Langness 1974). Unlike other methodological approaches to the study of organisations, ethnography questions the boundaries of organisations by focusing on informal structures within the organisation (Garsten & Nyqvist 2013) and provides a framework that highlights their social and cultural context (Moeran 2012, Garsten & Nyqvist 2013, Baba 2012).

During the visits studies ranging from partial to engaged observations (Spradley 1979) were conducted at a total of 13 different sites. Thirteen semi-structured interviews were conducted on site, as well as additional casual conversations with employees, owners and customers. The information gathered has been recorded in written notes, audio-recordings and photographs. The findings from the visits in China will be supplemented with additional visits in Denmark and Norway. What has so far been documented is the well-functioning and thriving service system connected with the sale of fur garments in China, such as maintenance, repair or re-design. In interviews the owners of fur companies in both Beijing and Harbin made it clear that offering these services to their customers is highly important. In all of the 13 visited stores repair and re-design services are carried out, and many owners expressed pride in offering the best services (see fig. 5).

The visibility of service centres especially in Harbin is testament to their, at least symbolic, importance. Inside the service centres, whether prominently displayed in the store or separated from the shopping area, furriers and semi-skilled employees perform a variety of practices (see fig. 5). The most common repair practices are replacing buttons and jewellery embellishments popular with many customers. These can be performed while the customer waits. More extensive changes, such as dyeing or redesigning the style of the product, take longer (see fig. 6). These observations serve only as examples at this point.

Figure 5: Service centre in Harbin fur store. Located right inside the entrance, and surrounded by glass, the symbolic function of repair and redesign as part of the shopping experience is evident.

Figure 6: Fur coat that has been disassembled, re-dyed and stretched before being sewn back together.

6 Discussion

The case of fur as material is exceedingly complex, both culturally and ethically, and is far too comprehensive to be included in this paper. What is important in this context is the fact that the tension field between 'People, Planet and Prosperity' is obviously very present here. The so-called 'fur controversy' (Olson & Goodnight 1994), the anti-fur movement, which started in Britain in the early 1980s, is still causing heated discussions, as it has come to epitomise the gulf between, on the one hand the *anthroposcene* idea of the last few centuries that we as humans see nature, as Kant said, "…as a means to an end. And that end is Man" (Kant 1930 in: ibid, p. 254), and on the other hand the *ecocentric* idea that we as humans are part of nature and have no right to exploit it (Imran et al. 2014). Many reasons have been given for why fur as a material has been placed so centrally in this discussion (e.g. Emberly 1998, Skjold & Csaba 2018), but the fact of the matter is that a number of brands, design schools and consumers today choose not to make use of fur based on ethical considerations. In this paper, we want to suggest a path for design research in a case study such as this, especially in the context of management that allows for real engagement but also establishes a platform from which the role of design can be examined critically. In order to do so we turn to the cultural theories associated with the Frankfurt School.

The critique proposed by philosophers and theorists associated with the Frankfurt School is dedicated to the exposure of false ideologies. As such, it is an invasive and thorough exposure of the values and beliefs underlying contemporary society. Their critical departure continues the European tradition in critical thinking and owes much of its perspectives to Marx and Engels offering a materialist perspective that investigates the human condition in an industrialised society. What Adorno and Horkheimer, the two central figures of the Frankfurt School from the 1930s to the 1960s, propose is a fundamental critique of the way societal institutions, such as bureaucracy and capitalism, marginalise people's opportunities for leading meaningful lives (Adorno & Horkheimer 2002). The critique also includes ecological sustainability in industrialised societies, and although this is particularly relevant for this study, our main concern here is to develop a method for exposing underlying values in a design management context based on Adorno and Horkheimer's analysis. One of the fundamental points of the critique brought forward by the Frankfurt School is directed towards instrumental rationality – the form of rationality that emphasises *efficiency of means* as opposed to a *rationality of goals*. Following Julier's definition of design as a process rather than an end in itself puts design up for scrutiny, the form of scrutiny that exposes 'false consciousness' and identifies underlying motivations.

Given the vehement opposition to the development of consumerism and the culture industries that Adorno and Horkheimer expressed, introducing their critique into a collaborative project with a major industrial organisation can easily lead to a dismissive stance on the morality of the collaboration – simply that any involvement with commercial enterprises helps promote the ideologies of domination that gloss over the realities of exploitation. This oppositional view has historically dominated research on businesses and organisations, but as Gilbert (2008) argues, refusing to engage with consumer economies has not thwarted their expansion. Critical researchers need to engage, and the subsequent critique of Adorno and Horkheimer's stance on contemporary consumerised society helps identify critiques as a meaningful way to engage in complex situations. Most notably feminist critique has emerged that questions the dismissal of consumption as a meaningful practice (Nava 1996) and the discussion of the erosion of any viable position from which to criticise (Freyerhagen 2013) that is embedded in Adorno's writing. Especially in a case where the primary objective of the collaboration is to incite real sustainable change, it can seem positively immoral not to engage. The collaborative approach, however, does create a complex arena for research and design to navigate. Therefore, what critical approaches can offer in this context is a methodology, a tool for exposing values and beliefs in the industry, specifically to ask to what extent sustainable change is driven by economic interests. However, as we argue that design, seen as an

opportunistic concept, can be hijacked, so can methodologies unless they are guided by specific morals and values.

Unless objectivity is that value, such a methodology seems to oppose the conventions of scientific research. But this is precisely Horkheimer's argument: that no separation between facts and values is possible. The role of the critical social researcher is to examine and re-examine, and to accept the social role of science.

It is from this perspective that we are currently investigating the post-use sphere of fur as material. A strong argument in relation to sustainability put forward by the fur industry is that the material is strong and can last for decades (IFTF 2012). However, this is only true *if* design is placing itself in 'design for longevity' strategies (Chapman 2009) and not in fast fashion/trend-based strategies, and *if* consumers maintain their garment, have it repaired or re-designed, *or* pass it on to secondary use. Also, as fur is an organic material, it is *only* long-lasting *if* the consumer stores it appropriately, as it will otherwise deteriorate and rot (findings described in: Skjold et al. 2016).

As we have found throughout the entire programme, these practices are being conducted to a large extent on the side of production and the side of consumption and post-consumption. Therefore, we believe there are best practices to be investigated and learned from the fur industry that might inspire new and emerging practices in the entire fashion sector − practices that go hand in hand with *sustainability-as-flourishing* as they are about handling resources more respectfully than what is often taking place today.

7 Conclusion and perspectives

In the transition economy, there is a huge need and potential for the ability of design to reframe problems and embrace their complexity. However, if innovation through design is not critically incorporated, particularly in industry projects, there is a risk of simply contributing to overall systemic problems that lead to unsustainability – such as neoliberal growth based on exploitation of nature and of people. What we suggest is to pair the idea of the unveiling ideologies of the Frankfurt School and critical theory – often criticised for not engaging with society – with the idea of escalation and reframing practiced within the design community, and of having the courage to act and engage with society and industry – even if the tension field between 'People, Planet and Prosperity' is extremely complex.

In the presented project, we do not claim to have found the right balance, only showcased how we try to incorporate the overall concerns from within the field in which we operate – sustainability and fashion – into a project that highlights the delicate balance we need in order to navigate as design researchers.

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Examining the Professional Codes of Design Organisations

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Many of the professional organisations within the various fields of design activity publish professional codes of ethics in one form or another. This paper opens up a discussion of the role which professional codes might play in relation to the ethicality of design activity. A framework for understanding the roles and functions which professional codes may play is constructed using concepts drawn from the literature on professional codes. The content of fourteen professional codes issued by design organisations is presented and examined. There does appear to be a broad consensus across the content of the codes examined. However, the matter of whether this consensus reflects a profession-wide convention is debatable. The paper concludes with a discussion presenting possible critiques of the nature and operation of professional codes within the context of design, and reflecting on some of the implications of this analysis for how we might reasonably think about the relationship between professional codes and bigger questions of the ethicality of design.

design organisations; ethics; professional codes; professional ethics

1 Introduction

How can we best ensure that design activity is carried out ethically, and results in optimally ethical outcomes? The seemingly innocuous question of "how to be good" in design is in fact one of (if not the) most complex questions which can be asked of the field. Ethics is a hot topic in contemporary design discourse. One issue which makes regular appearances in the perpetual discussions and debates regarding questions of how to practice design well, is that of codes of professional ethics. Two highly visible emergences of this theme in the past year offer convenient illustrations of the typical scope and terms of the recurring debate. At the personal end of the spectrum, designer Mike Monteiro's "a designer's code of ethics" (2017) originally posted as an article on the blogging platform medium.com (and later as a series of posters in collaboration with other designers (Figure 1, left) received extensive coverage in the online popular design press. At the macro level, the Montreal Design Declaration (Figure 1, right), published at the World Design Summit, contains a "call to action" calling for the:

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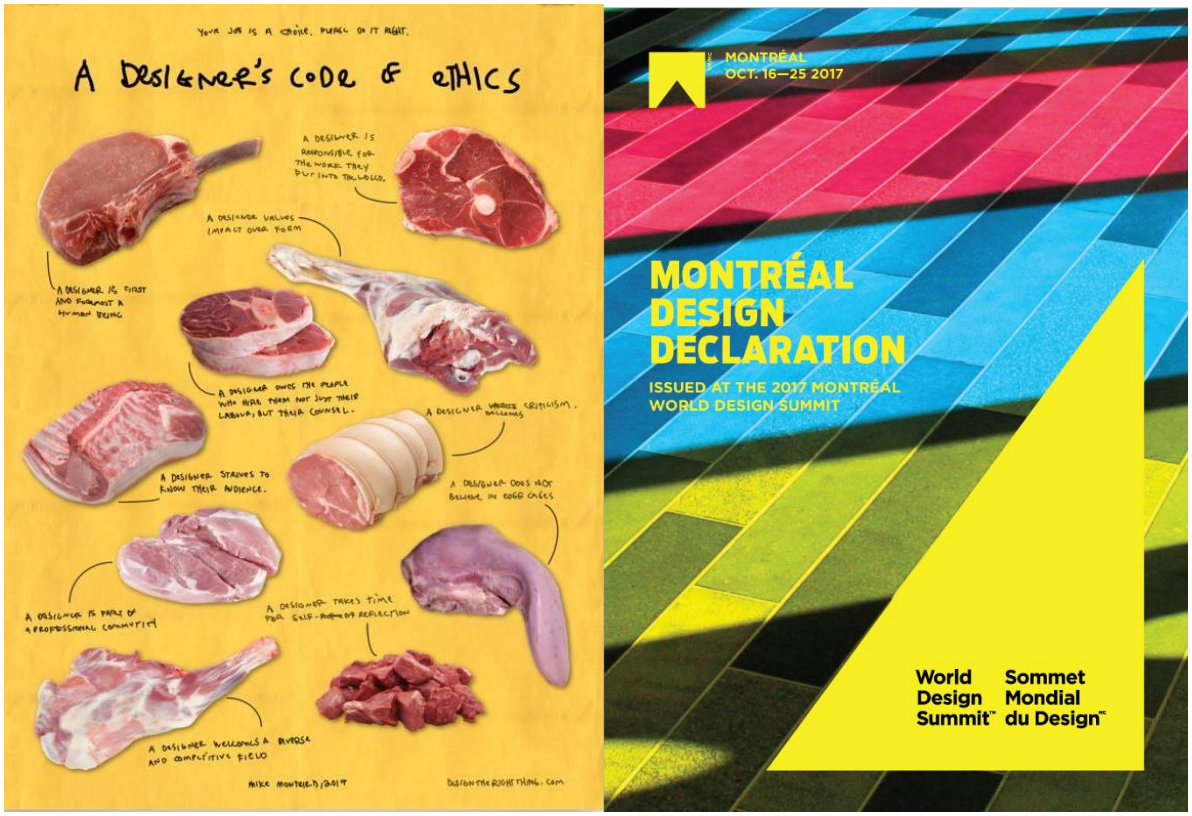


Figure 1 (Left): Mike Monteiro's A Designer's Code of Ethics Poster. Source: designtherightthing.com. (Right): Montreal Design Declaration. Source: worlddesignsummit.com

> *Development of Design Standards: support of professional design communities, the development of design industry infrastructures and development of standards, codes, covenants, best practices, legal protections and certification programs. (World Design Summit, 2017)*

Codes of ethics are a topic of sustained interest and activity in the design world. Many of the professional organisations operating within the various fields of design activity publish professional ethical codes of one form or another. The often unspoken subtext to such activities is the assumption that these documents have some contribution to make towards the ethicality of design. The modest aim of this paper is to open up discussion of the role which professional codes might play in design activity in relation to this larger question of how to be good in design.

2 Professional Ethics: Conventions and Codes

Michael Davis, professor of philosophy at the Center for the Study of Ethics in the Professions at the Illinois Institute of Technology (CSEP) describes a profession as "a number of individuals in the same occupation voluntarily organized to earn a living by openly serving a certain moral ideal in a morally permissible way beyond what law, market, and morality would otherwise require." (Davis, 2003, p.442) While an occupation can be defined according to the characteristics of the types of activity undertaken, designation of a profession involves moral value judgements about *the ways in which* this activity is undertaken. Davis proposes that a profession comes into existence not by legal institution or authority, but rather through a voluntary organisation of self-identifying individuals who operate according to a collective *convention* regarding the moral dimension of their common activities. Professional membership is gained by making the conscious voluntary choice to align oneself to a professional convention. In Davis view, an occupational group becomes a profession at the point at which members can be held accountable by the group as a whole according to their collective convention. Those who act in accordance with the convention qualify as members, while

those who fail to do so will be rejected. For example, if part of the convention among doctors is that they should do no harm to a patient, any doctor who wilfully harms will no longer in the eyes of the profession be considered to be a doctor.

Professional conventions may initially exist as unwritten sets of collective intuitions. As a profession seeks to understand, define and delineate itself these intuitions are often *codified*: formalised as written documents of one kind of another. These documents can be given many names: codes of conduct, ethics, best practice. Here, the term *professional codes* will be used to refer to all such activities of the formal codification of moral values.

The implicit claim of a professional code is that there are better and worse ways to undertake the activity in question. As Mark S Frankel, former director of CSEP, writes "A code embodies the collective conscience of a profession and is testimony to the group's recognition of its moral dimension." (1989, p.110) The moral narrative embodied by a professional code is an outward facing presentation of norms and conventions perceived by members within the professional group.

Professional codes can take many different forms in the real world. They can be created, declared, published and adopted in different contexts and at different levels ranging from individual statements (like Mike Monteiro's), to corporate policies, to regional, national and international profession-wide declarations (like the Montreal Declaration). Though they all share a common root in seeking to reflect something of the professional convention, codes can be created with a range of different purposes in mind. Once a code has been created and is released into the world, it can also be interpreted and utilised in a broad range of ways.

3 The Roles and Functions of Professional Codes

Frankel (1989) suggests that there are three types of code, not exclusive but conceived as on a continuum in which all three types are likely to exist simultaneously in any one given code: *aspirational* codes which declare ideals to strive towards; *educational* codes which seek to aid understanding and interpretation of activity within the profession; and *regulatory* codes which provide rules as a basis for monitoring and discipline. He suggests that criticism of the real-world operation of professional codes is often misdirected due to fundamental misunderstanding or failure to properly consider the multiple functions of a particular code in context. It is on this basis that he explains eight common functions which a code can perform within the continuum of aspiration, education and regulation.

The first of these functions is the use of a code as an *enabling document* "simplifying the moral universe and providing a framework for organizing and evaluating alternative courses of action." (Frankel, 1989, p.111) In this way a code can function to remove uncertainty and bring clarity in ambiguous or complex situations by enabling an individual professional to take actions based on reference to the clearly predetermined framework which has been set out and agreed by all.

The second function is as a *source of public evaluation* by which the public is informed of the expectations they may reasonably hold of members of the profession. The third function is one of *professional socialization* by which the code functions to strengthen the identity, unity and allegiance of members in regard to their profession. The fourth function is to *enhance* [a] *profession's reputation and public trust* by which the code becomes a tool which wins support and positive feeling or allays fears and lack of confidence within the public toward the profession. This is seen as necessary for the continued functioning of a profession within society. However, the potential for manipulation of public impressions as "a matter of strategy rather than morality" (Frankel, 1989, p.112) is a cause for concern. Frankel's fifth function also contains a critical edge suggesting that a code can function to *preserve entrenched professional biases* as the status quo is protected and deviant ideas are censored.

The sixth function is the code as *deterrent to unethical behaviour* by which some combination of the threat of disciplinary sanctions, and the peer pressure of fellow members committed to the conventions of the profession, functions to deter violations of the code.

The seventh function is that the code can provide a *support system* which strengthens the individual's voice against external pressure to compromise standards. It is much easier to stand against the unconscionable demand of client, colleague, employer, or society as a member of a profession defending its collective ideals, than as a lone individual.

Finally, the eighth of Frankel's functions is *adjudication* by which the code provides a pre-agreed standard by which disputes and conflicts can be resolved.

Canadian business ethics researcher Mark Schwartz also describes eight senses in which codes are understood to function by identifying metaphors invoked during interviews on the subject (Schwartz, 2001, p.255). These eight metaphors can be seen to bear some obvious similarities to Frankel's functions. Schwartz's metaphors are the code as: a *rule-book* clarifying expected behaviour; a *sign-post* encouraging consultation of others to determine judgement on behaviour; a *mirror* offering self-reflective perspective as to the acceptability of behaviour; a *magnifying glass* encouraging caution and reflection before acting; a *shield* allowing professionals to protect themselves from unreasonable requests; a *smoke detector* warning of potentially unacceptable behaviour; a *fire alarm* which allows for the reporting of violations; and finally a *club*, which encourages good behaviour through the threat of discipline.

What is important to draw from the discussion of both Schwartz and Frankel's research is the inference that any attempt to understand the role of codes in a profession must engage and acknowledge these multiple realities, motivations and functions inherent within such documents. This knowledge will help to avoid dismissing a certain code or codes in general on the basis of failure to meet a goal which they were either fundamentally unsuitable for or never intended to meet.

Placing Schwartz's eight metaphors for the operation of codes alongside Frankel's eight functions of professional codes, together with his suggestion of the three common types of professional codes, a framework can be constructed through which to examine the roles and functions of professional codes.

Figure 2 shows a simple visualisation of this framework, drawing attention to the relationships between the variously suggested aspects of the functioning of the three schemes discussed here. Bridging between the three overarching modes and the more specific functions and metaphors, six themes consisting of reputation, unity, protection, informing, reflection and discipline, have been added. Together, this forms a useful and practical framework to interface with all three schemes in this investigation of the specific design context.

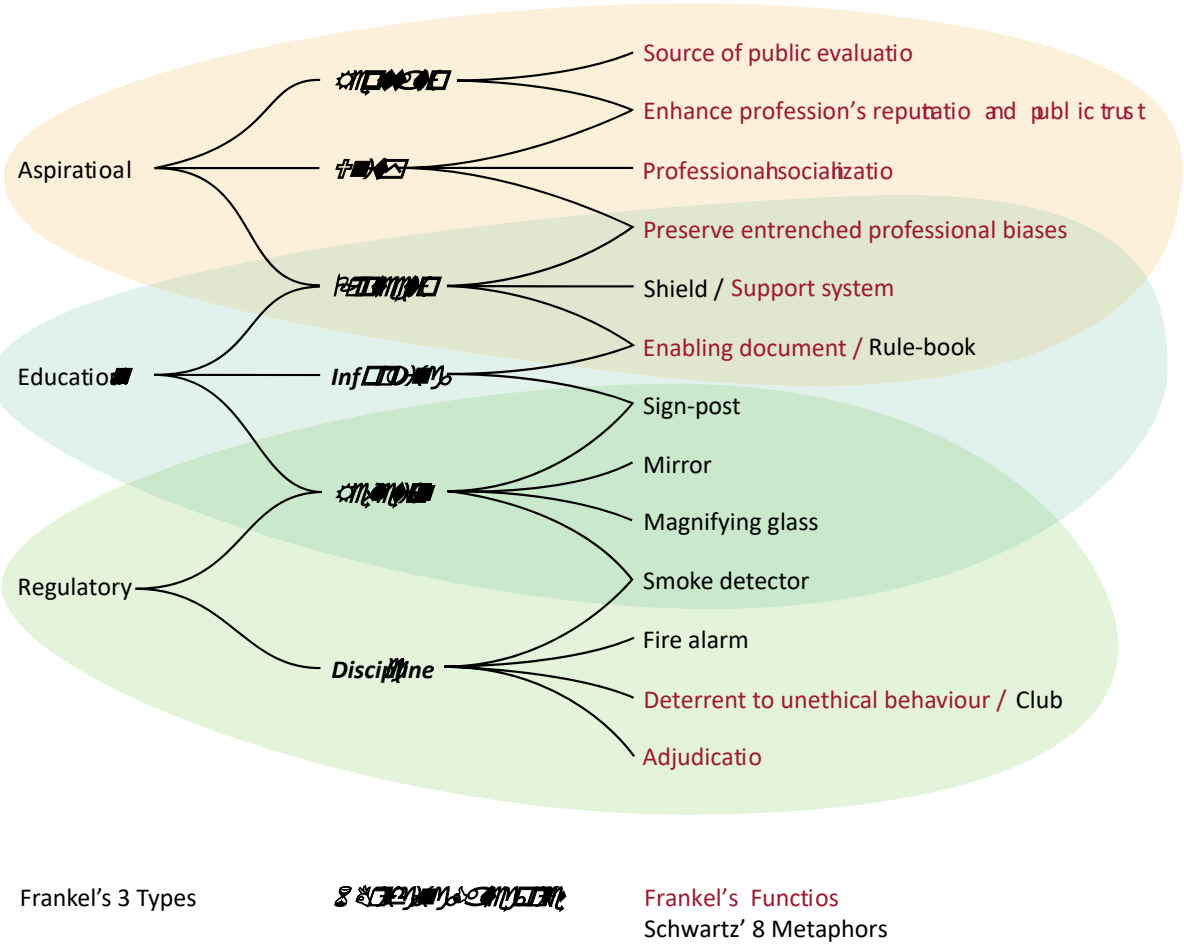


Figure 2: A Framework for the Functions of Professional Codes

4 An Analysis of the Ethical Codes of Fourteen Design Organisations

Considering the multiple dimensions of this framework, it is clear to see that professional codes are multi-faceted documents capable of addressing various motivations, functions and roles. The best way to understand which of these roles, functions, purposes and agendas are at play within design's engagements with professional codes, is to actually look at documents produced in a design context.

Focussing on the organisational rather than personal level, the professional codes of fourteen design organisations were selected for analysis. The sample was limited to organisations publishing their codes in English, but includes codes from six countries across four continents, plus two international bodies. Six of the organisations relate to graphic or visual communication design and one to illustration. Three groups exist for design in general, representing a range of sub-fields. Two are professional bodies for industrial design. One represents interior design and one represents design in a business context. Table 1 shows the organisations making up the sample.

By closely reading the fourteen codes and identifying the individual principles expressed throughout each, then grouping these into common themes emerging between and across the codes, forty-one separate themes recurring in at least two or more codes were identified. These themes are presented in Table 2 where they have been organised according to four categories. These themes are placed here in no particular order and could just as easily be organised according to an alternative scheme of categories or none.

Table 1: Design Organisations Sampled

Field	Acronym	Full Name	Nationality
Graphic/Visual Communication	AGDA	Australian Graphic Design Association Limited	Australia
	AIGA	AIGA, the professional association for design	USA
	GDC	Society of Graphic Designers of Canada	Canada
	ICOGRADA	International Council of Communication Design	International
	RGD	The Association of Registered Graphic Designers	Canada
	wREGA	Graphic Design Association of Malaysia	Malaysia
General Design	CSD	The Chartered Society of Designers	UK
	DIA	The Design Institute of Australia	Australia
	DINZ	The Designers Institute of New Zealand	New Zealand
Industrial Design	WDO	World Design Organisation (Formerly ICSID)	International
	IDSA	The Industrial Designers Society of America	USA
Illustration	AOI	The Association of Illustrators	UK
Interior Design	BIID	The British Institute for Interior Design	UK
Design and Business	DBA	The Design Business Association	UK

Table 3 indicates the presence of each of these forty-one themes within each of the fourteen codes. The table is organised with the themes on the Y axis sorted by order of how many of the fourteen codes they appear in. Along the X axis the fourteen codes are sorted by the number of themes appearing within each. This arrangement in itself reveals nothing particularly meaningful about the content of the codes themselves. It is included here simply as a visual indication of the level of consensus and crossover between the codes on certain issues.

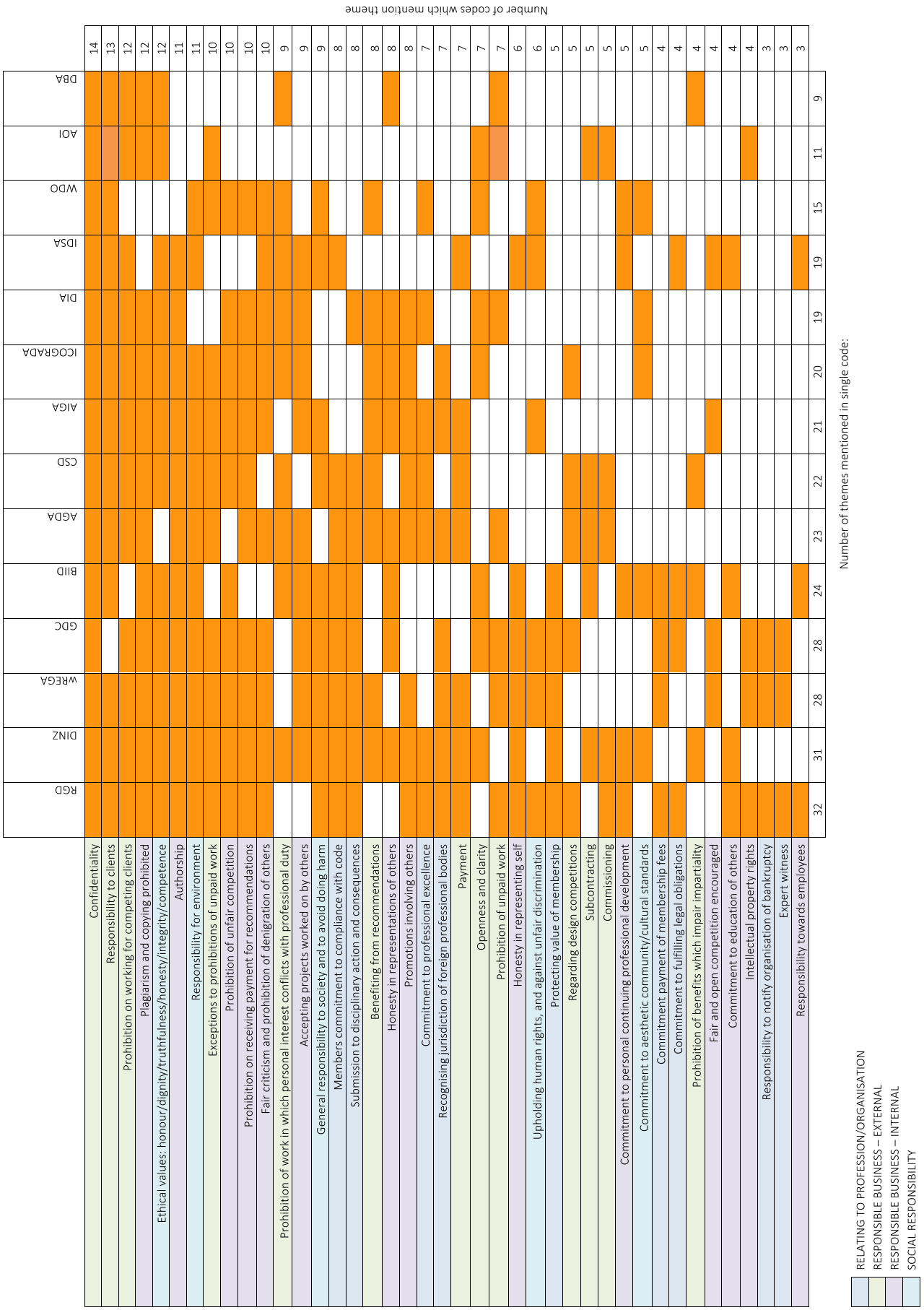
This table only shows which themes occur in which documents. It tells us nothing about the relative importance of those themes which do occur, and nothing about any assumed principles which may have been deemed either too obvious and self-evident to include, or as lying outwith the remit of a document. The themes which occur most frequently across the codes issued by different design organisations are not by any means necessarily the most valued and important ethical principles held by designers in general. Vice versa there may be ethical principles which occur infrequently or not at all in these codes, which are actually held in general by designers to be vitally important if not central to their ethical worldviews.

For example, while we can see that confidentiality is a principle which has widespread consensus, we cannot tell from its prevalence alone whether this principle is valued more highly than the commitment to upholding human rights and condemnation of unfair discrimination which is mentioned by only six out of fourteen documents. It is entirely possible that a significant proportion of designers, if asked to weigh these two themes against each other in terms of importance, might prioritise the fundamental rights of others over professional conventions of client confidentiality. In a situation in which these two principles conflict, either principle may well win out depending on the specifics of the circumstances. The mere presence of themes within a code tells us very little about the relative weighting of these.

Table 2: Grouped Themes

RELATING TO PROFESSION/ ORGANISATION	Commitment to professional excellence
	Members commitment to compliance with code
	Commitment payment of membership fees
	Responsibility to notify organisation of bankruptcy
	Protecting value of membership
	Recognising jurisdiction of foreign professional bodies
	Submission to disciplinary action and consequences
	Commitment to fulfilling legal obligations
	Expert witness
RESPONSIBLE BUSINESS – EXTERNAL	Responsibility to clients
	Confidentiality
	Conflict of Interest 1 Prohibition on working for competing clients
	Conflict of Interest 2 Prohibition of work in which personal interest conflicts with professional duty
	Conflict of Interest 3 Prohibition of benefits which impair impartiality
	Conflict of Interest 4 Benefiting from recommendations
	Fair Remuneration 1 Payment
	Fair Remuneration 2 Prohibition of unpaid work
	Fair Remuneration 3 Exceptions to prohibitions of unpaid work
	Fair Remuneration 4 Regarding design competitions
	Contracts 1 Commissioning
	Contracts 2 Openness and clarity
	Contracts 3 Subcontracting
RESPONSIBLE BUSINESS – INTERNAL	Respect for colleagues 1 Fair and open competition encouraged
	Respect for colleagues 2 Prohibition of unfair competition
	Respect for colleagues 3 Accepting projects worked on by others
	Respect for colleagues 4 Prohibition on receiving payment for recommendations
	Respect for colleagues 5 Fair criticism and prohibition of denigration of others
	Responsibility towards employees
	Education 1 Commitment to education of others
	Education 2 Commitment to personal continuing professional development
	Promotions 1 Honesty in representing self
	Promotions 2 Honesty in representations of others
	Promotions 3 Promotions involving others
	Credit 1 Authorship
	Credit 2 Intellectual property rights
	Credit 3 Plagiarism and copying prohibited
SOCIAL RESPONSIBILITY	General responsibility to society and to avoid doing harm
	Commitment to aesthetic community/cultural standards
	Ethical values: honour/dignity/truthfulness/honesty/integrity/competence
	Upholding human rights, and against unfair discrimination
	Responsibility for environment

Table 3: Distribution of themes



It is equally important to recognise that the absence of a certain principle does not mean that it is not valued by designers. For example, these documents are entirely silent on particular matters such as whether designers should beat their children or hunt elephants for their ivory tusks. These codes neither encourage nor prohibit participation in such activities. The absence of reference to such issues of course does not tell us that designers are entirely indifferent towards child beating and the ecological impacts of the ivory trade, but at best can offer us an indication that such issues have not been considered by those involved in writing the codes to be central to the specific aims and purposes of the document.

It is also worth noting that those codes which contain reference to a greater number of the forty-one themes should not, based on this observation alone, be considered to be in some way 'more ethical' than those which contain relatively fewer items from the list. The volume or nature of the content of these codes, should not be confused with the purposes towards which these codes have been produced, and the matter of whether or not they are in fact capable of fulfilling these purposes.

Considering the forty-one themes identified across the content of the fourteen codes of the professional design organisations examined here, it can be seen that most of these codes are capable of simultaneously touching on almost all of the roles and functions which professional codes are capable of playing as set out in the framework earlier (Figure 3).

Individual articles can fulfil several criteria at once. Take for example the connected principles of the prohibition of unpaid work and suggestions of instances when this general rule might not apply (i.e. pro bono work for charity). These articles serve in an educational sense, informing practitioners of the circumstances under which payment or non-payment for work is seen to be appropriate in the eyes of the profession as a whole. This knowledge can be used by the practitioner as a protective shield against unfair expectations from clients (speculative pitching for example) and as a support system in knowing that other designers also hold this stance. This knowledge that the profession as a whole stands together on this issue also therefore functions as an aspirational source of unity and professional socialisation, helping to build up and inspire a stronger sense of designers as a profession united around common values. In a further sense, these principles can function in a regulatory manner both in terms of allowing practitioners to reflect upon and change their own behaviour, and also through the exertion of peer pressure on fellow practitioners to operate in accordance with the conventions laid out in the codes.

Read in these ways then, the codes which include these two themes can be seen to function in all three of Frankel's aspirational, educational and regulatory senses, and, by merit of fulfilling a variety of the components of Frankel and Schwartz' respective eight part schemes, tick the boxes of at least five out of six of the bridging categories: unity, protection, informing, reflection and discipline. These functions could of course be read differently and in practice may function in ways unexpected and different still. The point remains that even at the level of individual principles, codes are capable of fulfilling multiple roles (Figure 4).

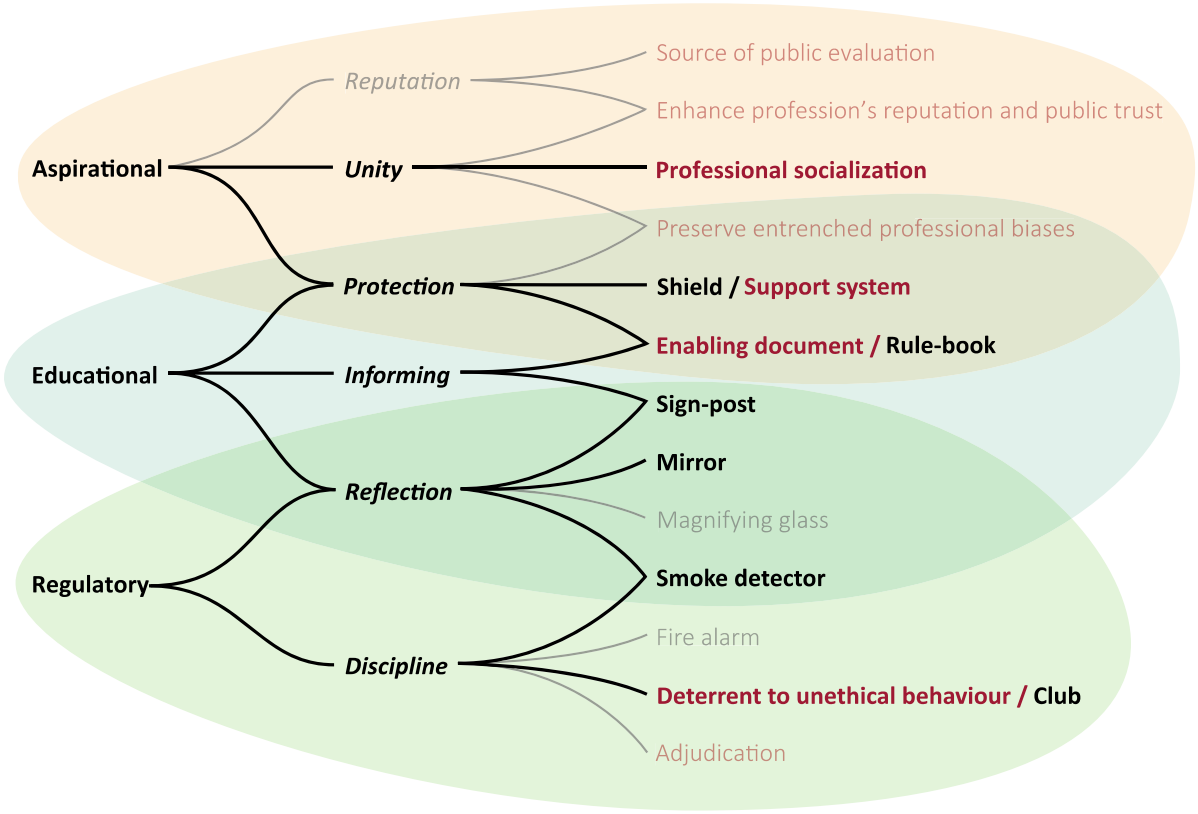


Figure 4: Roles Played by Principles Relating to Unpaid Work

Considering these documents as a set of complete codes it does not appear that any parts of the framework set out here are entirely neglected. We might observe that relatively few articles directly address Frankel's function of adjudication procedures to be carried out in cases of dispute or discipline; however it could be argued that many of the principles contained within the codes provide the basis upon which such adjudication procedures (however they might be organised) might be based. For members who have pledged their commitment to the code, the code itself stands as judge over their activity; it must only be determined whether actions have taken place within or in contravention of the standards set by the code.

According to the framework, design's codes can (at least theoretically) fulfil all of the roles and functions of professional codes. On this basis, it could be argued that design's professional codes are good professional codes, at least in the sense that they conform to the expected structure of such documents. But what bearing does this have on the question of how to make designers good? In considering their potential impacts on the ethicality of design, the final section of the paper will consider some problematic areas and concerns which can be raised around the functioning of professional codes in the design context.

5 Critiques of Professional Codes

In Clive Dilnot's Archeworks Papers, *Ethics? Design?* (2005) – a thorough and thoughtful meditation on what it might mean for design to have its own authentically designerly conception of ethics – he writes:

> *it cannot be a question of there being an ethics that can be simply applied, an ethics that renders a practice morally justifiable but does not otherwise engage of transform it. There is such an ethics of course – but a very poor ethics it is. Such an ethics (of professional practice) is specifically designed not to engage substantive questions but merely to regulate aspects of the designer-or-architect-client relationship. […] This is the*

> *form of ethics which seeks to tie ethical norms to (quasi)-legal prescription. Its effect is to determine that only those aspects of practice so covered need be thought ethically. All other moments, including all those that have to do with substantial questions of practice and design, are thereby licensed to be free of ethical determination. (Dilnot, 2005, p.10)*

Here Dilnot identifies two key critiques which can be raised in regard to the question of the role which professional codes can play in the ethicality of design. The first is that the setting in stone of ethical principles potentially reduces the practitioner's perception of their own need to engage in a process of constantly questioning and revising their ethical reasoning. Rather than having to assess the complexities of individual situations, faith can be placed in the authority of the code, which can then simply be referred to and enacted. This is a perfectly sensible pragmatic strategy to a certain extent. It relieves the burden of having to individually wrestle with complex issues, by offering a conventional standard agreed upon by peers to refer to. Problems arise however when a situation is encountered which is not directly addressed by an article of the code. Principles developed from tried and tested solutions to pre-existing issues are not well suited to coping with unforeseen challenges (for a crushing critique of the inadequacy of predetermined ethical systems in dealing with emergent novel ethical crises, see the work of John D Caputo (1993, 2000)). The practitioner who relies blindly on the code is not accustomed to independent ethical reasoning and may not be adequately equipped to resolve, or even recognise, such a situation. In such a situation the code can become an anaesthetic, offering the aesthetic sensation of ethicality, while in reality operating to decrease sensitivity towards the genuinely ethical (Buwert, 2015).

The consequences of this subconscious delegation of responsibility away from the individual and onto the code, may lead directly to the second hazard highlighted by Dilnot, which is the potential for a code to actually appear to permit any behaviour not explicitly prohibited. A code of ethics which either presents itself as a complete encapsulation of ethics for design, or which is functionally taken as and understood to be such, effectively implies that anything which is not contained within its articles is not an ethical problem. The identification within a code of a specific set of particular issues affecting the field, can create an impression that these issues constitute the totality of ethics within the field. Issues not specifically addressed within the code may not be recognised as ethical at all and therefore may potentially not be addressed in an appropriate manner. Again, this can potentially have a numbing effect on ethical awareness. Obedient code following, can provide an aesthetic sensation of ethicality which numbs the individual to their responsibility to be sensitive towards the potentialities surrounding their activity (Buwert, 2017).

To give this a practical context, consider a contentious professional issue such as the employment of unpaid interns. Many design studios make use of such arrangements, while others decry them as exploitative. If a designer involved in the employment of interns subscribes to a code of ethics which specifically states that a designer should be fairly paid for the work they do, then it would be expected that this designer would be able to apply this principle and enact a policy of paying interns fairly. If, however, the code subscribed to is entirely silent as to issues of fair payment, then the designer may feel able to employ unpaid interns with a clear conscience. As far as they are concerned, because it does not *forbid* such practices, the code effectively *allows* them to employ unpaid interns.

Even where an article is adhered to by a code-follower, this does not guarantee that the underlying ethical principle is being upheld. The extremely tenuous link between the obeying of rules and the fulfilment of principles which motivate the creation of these rules, revealed in the behaviour of toddlers, who often seem to take the greatest pleasure in finding ways to follow instructions while blatantly disregarding and circumventing the underlying principle. I once observed the child of a friend, who upon being warned not to touch the hot oven door, edged closer and closer to within millimetres of the glass, at which point he stuck out his tongue in order to get as much of his body as close as possible to the forbidden fruit without breaking the rule.

Ideally it is imagined that rules perform the function of permitting good behaviour. In practice, it is possible for them to function as they often effectively do for children: as markers which delimit the boundaries of what you can get away with before you get into trouble. In the example of unpaid interns in the design industry it is possible to imagine a scenario in which a studio could potentially subscribe to the principle that designers should be paid fairly for their work, yet still employ unpaid interns by interpreting the principle in such a way that an intern is not yet considered to be a fully-fledged designer and that unpaid internships are simply part and parcel of the reality of the process of *becoming* a designer who is worthy of being paid fairly.

Professional codes are legalistic systems which must be interpreted, and therefore will always remain open to possibilities of being abused in order to justify certain behaviours. In this way it is possible for codes to permit and allow behaviours which are contrary to the values they originally aimed to promote.

Professional codes could be argued to be at least potentially *unethical* in terms of their abilities to suppress or discourage engagement with the key building blocks of authentic ethical experience. The legalistic structures of these documents can subconsciously encourage blind rule following rather than active interpretation of the possibilities available within the unique situations encountered in undertaking design activity.

Further general weaknesses can be identified in the functioning of professional codes in design, at the broad level at which the profession as a whole is committed to the principles contained within the code.

Some functions of codes can operate purely at an individual level. It is relatively easy to see how the educational aspects of a code in terms of informing, protection and reflection can work in this personal way. A designer can sign up to a code, learn principles to apply in his activity, check his activity against these principles and use these principles as a support to justify and defend his actions to others (Figure 5).

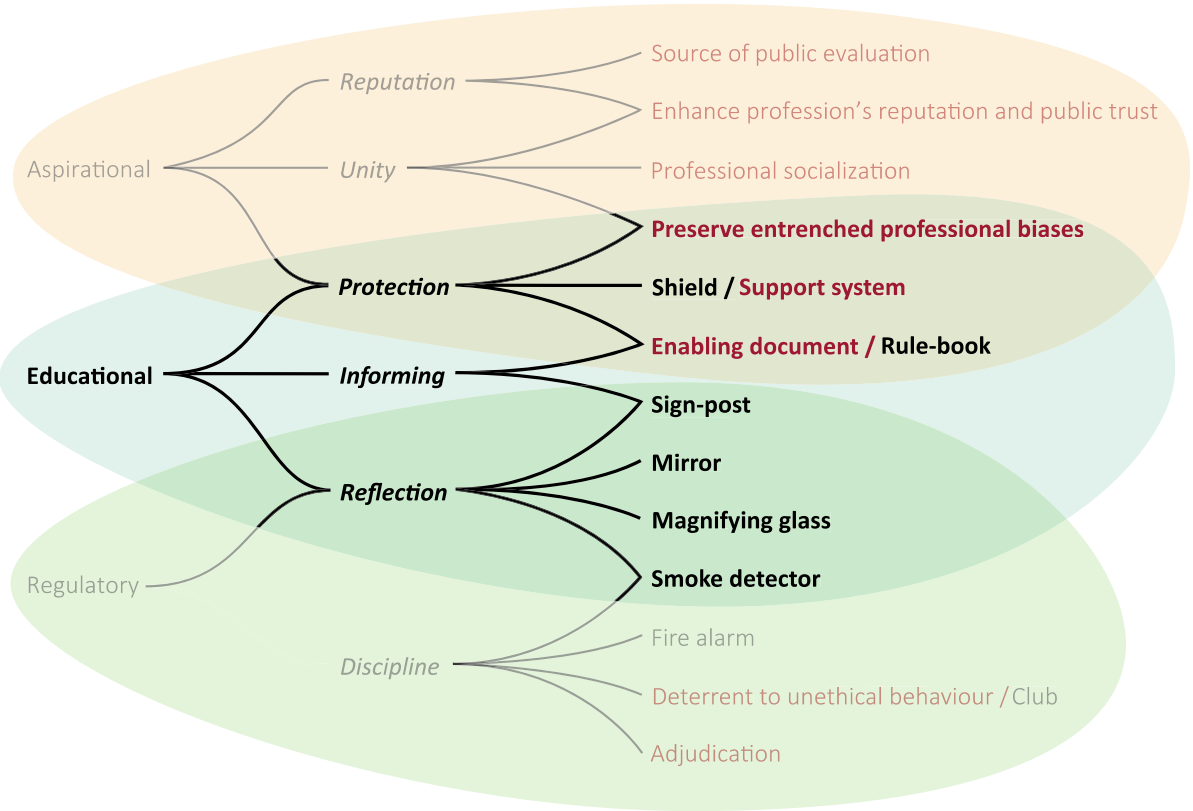


Figure 5: Educational Function of Code at Personal Level

However, the aspirational and regulatory functions of the enhancement of professional reputation, inspiration towards professional unity and the deterring of certain behaviours through threat of discipline, are functions which rely not only on the commitment of individuals to the code, but on the existence of widespread recognition of the professional convention which Davis (2003) talks of. Any meaningful fulfilment of these aspirational and regulatory functions relies upon the reaching of a critical mass of consensus and commitment to the principles expressed with the codes at a profession-wide level. Without this broad consensus, these functions remain weak, partial and unauthoritative: unlikely to be fulfilled.

Do design's professional codes show any evidence of the existence of such a profession-wide consensus? Can we see any indication here that design is ethically united at a profession-wide level? In an authentic professional culture, similarities across professional codes issued by different bodies within the profession should be expected. Looking at the design codes examined in this study, it is clear that there is a great deal of common material shared across the codes. In several cases codes are strongly influenced by or directly based upon earlier precedents. In all of the codes there are instances where the language of certain sections or articles mirrors one or more other codes. This degree of similarity goes some way toward suggesting that the principles listed in these codes are generally held to be true across the broader professional group. This internal consensus may be indicative of the existence of a professional convention.

However, regardless of whether there is a consensus across these bodies as to what the content of an ethical code for design should look like, the ability of design's professional organisations to inspire profession-wide subscription to and compliance with these codes appears generally to be weak, particularly when compared with that of the traditional professions.

This is significant in terms of the aspirational role of enhancing the reputation of the design profession. Neither internal nor external perceptions of the trustworthiness of the design profession will be inspired by designers' collective commitment to a professional code, if a critical mass of designers do not appear to actively subscribe to any code at all.

In terms of the regulatory role of discipline, designers are unlikely to be motivated to regulate their behaviour based on threat of discipline from an organisation which does not represent or command the respect of a significant proportion of designers. When membership of a certain body commands no prestige or respect, the threat of the condemnation of or expulsion from this body will instil no fear.

This is an issue for the design organisations who have produced these codes. Most do not command any significant authority based on a foundation of popular mandate. The case of the Chartered Society of Designers (2017) based in the UK illustrates this. In 2011 the CSD gained the ability to officially award the designation of *Chartered Design*er to its members on authority of Her Majesty the Queen. Technically this is the same level of authority bestowed upon chartered architects in the UK, a distinction which carries great weight and authority. However, simply being able to award an authoritative sounding designation does not mean that the designation automatically carries authority. The title of chartered architect is based on the completion of seven years study in accredited institutions. Without it, one cannot practice as an architect in the UK. The "Chartered Designer" designation on the other hand carries very little authority.

Where such schemes do exist in design carrying genuine authority (such as in Ontario, Canada with the legislatively backed RGD programme (RGD, 2017)) they do seem to provide something of a spine to the regulatory and aspirational aspects of professional codes. If membership of an organisation is respected, valued and backed by authority, there is a greater chance that designers will aspire towards the ethical ideals set out by the organisation, and feel some pressure to act in accordance with the consensus of the group.

It is relatively easy to find evidence of authoritatively enforceable professional codes among the established traditional professions with their national regulatory bodies and accreditation systems.

Designers, however, appear to be less inclined to embrace the restrictive bureaucracy of such systems. The reasons behind this preference, and the pros and cons of legal regulation lie beyond the scope of this paper. What is relevant here is that contemporary design as a general field of activity collectively chooses (whether consciously or not) not to publically demonstrate profession-wide commitment to a professional convention in the traditional way that the established professions do. This is not in itself evidence of the absence of a professional convention. But it does raise the question of whether design organisations which do choose to publish professional codes should simply follow the established traditional formats for such documents.

What must not be forgotten in all of this is that the explicit context of these codes is that of the *profession*. The guidance offered is explicitly targeted and tailored within the boundaries of professional concerns and expectations and in relation to specifically professional contexts. What this effectively means is that these codes have very little to contribute to any conception of design activity which does not conform to profession norms i.e. industrial, commercial norms. As Boehnert (2014) among many others has pointed out, design encompasses much more than its industrial form. Codes might offer practical, pragmatic, useful advice for the professional designer who operates within the dominant conventional client/commission centred conception of the profession. However, for those designers who view themselves as professionals, yet operate in ways which challenge these received conventions of what constitutes professional practice (through trans-disciplinary (Coles, 2012), speculative (Dunne & Raby, 2013), relational (Blauvelt, 2008), participatory (Mazé, 2013) practices etc.), the content of these codes may be felt to be largely irrelevant.

The fact is, there can be radically differing views as to what constitutes the design profession. While professional practice remains conventional, professional codes which reflect the normative conventions of this profession may well be adequate to meet the needs of practitioners. As soon as anything unconventional occurs or is encountered, the practitioner is hung out to dry, left with the choice either to attempt to force the encountered situation to conform to the existing moral framework (which, like hammering a jigsaw piece into the wrong place, is unlikely to lead to an ideal outcome) or to abandon the framework altogether, and in so doing to effectively excommunicate oneself from the profession.

6 Conclusions

In light of these various critiques, should the use of professional codes of ethics in design be entirely rejected and abandoned? Professional codes, as formalised documents, are legalistic and moralistic in nature. What this effectively means is that, while they can serve an aspirational function to a limited extent, their primary core function will always be to offer guidance within the boundaries of the existing moral framework whose values they seek to reflect (the professional convention). A professional convention itself may be fluid and constantly evolving, but professional codes are fixed documents which attempt to serve as reflections of current perceptions of these norms. These passive documents can themselves play no role in the development of fresh ethical reasoning. Where individuals or groups are developing and evolving design practice into new areas, professional codes may quickly come to be seen as redundant.

If professional codes of ethics are to be used within design as part of a strategy towards the development of more authentically ethical design practice, they must be properly recognised as merely reflections of the consensus of a group of designers operating within certain existing conceptions of professional practice. Without this recognition they may be uncritically presumed applicable to all areas of design practice, which may not in fact be the case.

Many situations and encounters fall outside of or in conflict with the existing knowledge and assumptions upon which existing professional codes are founded. In order to recognise and address the ethical implications of these, designers must possess an active ethical awareness and sensitivity (Buwert, 2016). The ability to be actively sensitive, aware and responsive to emergent ethical issues cannot be gained through subscription to the principles found in a written document alone. This

practical ethical wisdom is something which must be cultivated and nurtured. Where this foundation exists, professional codes may play an appropriate and useful role in providing a reflective account of design's perceptions of its professional conventions. As one part of a wider range of conscious engagements with the ethical dimensions of design activity, professional codes can offer a positive contribution to the overall ethical health of design practice.

Many desirable effects can be seen in the use of codes. Subscribing to an ethical code allows an individual to measure their own activity according to the standards of the professional convention which the code claims to reflect. Codes seek to clarify, publicise, preserve, promote and enforce consensually agreed professional conventions as to what constitutes good practice in what might otherwise be an entirely unregulated field. In raising critical questions regarding the effects which ethical codes might potentially have on ethicality in design, it is important to be careful not to throw the baby out with the bathwater. The aim of this paper is to not to condemn use of professional codes, but to open up thoughtful consideration of the roles we see these documents playing within the larger eco-system of ethically motivated activity within the design professions.

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Section 3.

Philosophical Tools in Design Research

DRS 2018 Design Research Society 2018 Catalyst

University of Limerick
25th–28th June 2018

Editorial: Philosophical Tools in Design Research: from empirical turn to practical turn

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Collaboration between Design Research and Philosophy of Technology seems very promising. The reflective, philosophical perspective brings the societal implications of design to the fore and this is an interesting focus for reinforcing research approaches for design. Since the philosophy of technology in the current of the 'empirical turn' aims to study concrete technologies and contexts, contributions from philosophy to design have become all the more feasible. Design Research can use the frameworks of philosophers to theorize the findings from practice, to make sense of the past, and for ethical reflection on the impacts of design and the moral responsibilities of designers. Or, still more practical, philosophical insights in the relationships between humans and technology can contribute to design for usability and design for behaviour change. On the other hand, the practice of designing actual things provides a laboratory for putting philosophical frameworks to the test and to use in the real world.

Following the 'empirical turn' before, the present search for collaboration with design can be termed a 'practical turn' in the philosophy of technology (as will be further elaborated in the first paper, by Eggink and Dorrestijn). Under this notion of a practical turn in the philosophy of technology this track brings together papers which are in one way or another about 'philosophical tools in design research'. All research projects apply insights from philosophy of technology to real world problems and design solutions; or the other way around, they use insights from philosophy of technology to reflect on designs that were actually made.

We will now give an overview of the papers in which we mention the tools and philosophical backgrounds used in each paper. So diverse as the philosophical tools are, so are the design contexts: from service design to infant healthcare, and from the physical to the digital, the emotional and the political. The order of the papers is from the more practical to the more reflective papers, with a more general perspective in the first and the last paper.

The first paper *Philosophy of Technology x Design: The Practical Turn* (Wouter Eggink & Steven Dorrestijn) – apart from elaborating on the theme of the track – reports on applying the approach of technical mediation (Peter-Paul Verbeek, Don Ihde, Bruno Latour) to design projects by way of the Product Impact Tool.

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In *Service Fictions through Actant Switching* Sarah Marie Foley and Dan Lockton present and show the combined use of two tools called Actant Switching and Service Fictions. Foley and Lockton refer to the work by philosopher and anthropologist Bruno Latour on what is known as Actor-Network Theory.

Next follows *The Use of Philosophy of Technology in Design: A Research-Through-Design Case of Treatment Compliance* (about the treatment of infants with clubfoot) by Jonne van Belle, Bob Giesberts and Wouter Eggink. Their main reference in the philosophy of technology is Mediation Theory (Verbeek) and the Product Impact Tool (Dorrestijn).

Turning Philosophy with a Speculative Lathe: Object Oriented Ontology, Carpentry, and Design Fiction by Joseph Lindley, Paul Coulton and Haider Akmal introduces another philosophical strain: Object Oriented Ontology (Graham Harman, Ian Bogost). Their application domain is the Internet of Things.

Then, *Aestheticising Change: Simulations of Progress* by Chad Story and Jocelyn Bailey extends our endeavour to the political domain. With reference to concepts by the philosopher Jacques Rancière they explore how design practice becomes part of the way public sector actors negotiate, envision and catalyse change in relation to public 'problems'.

Also more reflective in nature is *Using the Product Impact Tool for Prospective Thinking* (Thomas Raub, Steven Dorrestijn & Wouter Eggink), which explores the wider application of philosophical tools in prospective studies. The paper shows some of the potential of this direction by a case study on the future of automated driving.

Second-to-last paper *Using Heterotopias to Characterise Interactions in Physical/Digital Spaces* by Haider Ali Akmal and Paul Coulton addresses the complexity of designing interactions in hybrid digital/physical spaces, using the notion of heterotopia as a philosophical lens 'borrowed' from Michel Foucault.

The last paper *DRS Conferences: barometer and mirror of theoretical reflection of design discipline* by Alejandra Poblete provides an overview of theoretical concepts in design research by looking at the DRS conferences over the years. One of the aims that this track wanted to bring to the fore with the collaboration of the two disciplines was not only making philosophy of technology more practical, but also making design research more reflective. Therefore, this contribution nicely suits as a conclusion to the track, not by elaborating yet another philosophical design tool, but by showing the presence of "reflection in design" in a context of design research history.

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Philosophy of Technology x Design: the practical turn

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doi: 10.21606/dma.2018.222

In this paper we explore how the collaboration between Design Research and Philosophy of technology can be profitable for both disciplines. From three case studies where Philosophy of Technology theories and methods were applied in a design context we show how these projects profited from a more reflexive perspective. Then we analyse the three cases again to show how these design projects also lead to a better understanding from a Philosophy of Technology perspective. In putting the in principle rather abstract theories in design practice, the consequences become clearer and designing actual things thus provides a laboratory to test philosophical frameworks in real life. One can say that the Philosophy of Technology, besides thinking and talking, proceeds to action. Not only Philosophy of Technology with the head, but also Philosophy of Technology with the hands. Therefore, in analogy with the empirical turn in Philosophy of Technology before, we present this collaboration with design as the 'Practical Turn in Philosophy of Technology'.

ethics of technology; practical turn; design for behaviour change; mediation theory

1 Introduction

Research in the Philosophy of Technology has led to a variety of theories and reflections about the impacts of technology and innovations on our culture and our daily lives. Bringing such philosophical and critical insights about the impact of technology to the practice of design of technology, where the purpose is to actually change things, holds the promise of developing critical and responsible approaches to the design of our future world and way of living.

This implies that philosophy of technology besides thinking and discussing concepts starts to engage more closely with practical probing. Design thinking in a most literal sense: philosophical thinking about life by way of design, by making and testing products and possible ways of doing. In philosophy of technology there has been an empirical turn, towards the study of concrete technologies in society. Our proposal is to further develop this into a practical turn, with a change from 'study and description' to 'interventions by design', with the redesign of technologies and correlated ways of doing.

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We start this paper with an overview of stadia in the philosophy of technology up to the empirical and practical turn. Next, we present three different design cases where philosophy of technology tools and theories were explicitly applied. From these three cases we will argue how the philosophy of technology perspective can improve design results. After that we will show how these design projects also led to results for philosophy of technology. We conclude with discussions and a positioning of our proposal for a practical turn in the philosophy of technology.

2 Philosophy of Technology Turn by Turn

Technology is becoming an ever more important topic of philosophical reflection. This is however a relatively recent development. There are good reasons to define the human being by the use of tools, from stone tools and the control of fire in the prehistoric beginnings of human history up to today's smart phones and genetically modified crops. Still, the conscious reflection on the technical conditions of our lives long remained a marginal topic in philosophy. During the past centuries a divide has existed between the human sciences and the exact sciences, what C.P. Snow has called the "two cultures". Technology and engineering knowledge belonged to the exact sciences and philosophical contemplation had not so much to contribute there. It is of course basic knowledge in the human sciences that the Scientific and Industrial Revolutions have shaped modern Western culture. Still technology did not receive much attention, because it was only the applied form of science making progress tangible.

2.1 Early, classical, and empirical philosophy of technology

Early philosophy of technology views technology mostly in this utopian spirit of progress that leads human life from a precarious state towards completeness. In this framing technology could easily escape from attention because it appeared itself unproblematic and therefore neutral. The idea of technology as neutral instruments is still widespread in common thought, but philosophical reflection has always explored the deeper significance of technology for society. Ernst Kapp (1877) was the first to use the phrase "philosophy of technology" in the title of a book in which a theory was elaborated of how technologies are projections of capacities of their human inventors. In his view the hammer was a projection of the fist and the saw a projection of the teeth. The telegraph system could be seen as a projection of the neural network. Technology also figured in the theory of a spiritual super-structure which is determined by the material-economic base of a society by Marx and Engels. Their concern was however that most people do not profit from the advancements in production. Technology appears in early philosophy of technology as the means for the completion of human life, while the challenge remained to make everybody share in the advancements.

With the spread of technology during the twentieth century also the dangerous impacts of technology on humans, society and the environment became more manifest. This became a major topic in the work of prominent philosophers, such as Martin Heidegger, Herbert Marcuse, Jacques Ellul, and Lewis Mumford. In this period of "classical philosophy of technology" the tone reversed from utopian to dystopian. What if social inequality was a problem inherent to technology itself? In the twentieth century the Marxist struggle was no longer between classes of people, but between humanity on the one side and all the technology accumulated into a system gone out of control on the other side. The most emblematic event was the explosion of the two nuclear bombs in Japan. An awareness suddenly struck that a humanly construed thing was so dangerous and powerful that it could even annihilate humanity. Classical philosophy of technology analysed the threat of technology dominating humanity and called for limits to the rush of technology.

From the 1970s onwards new approaches were developed with more detailed, differentiated and ambivalent views on technology. This new wave is characterized by a revaluation of the concrete adventures of humans and technology as opposed to the abstract and generalising claims of the classicists. This concreteness was then reflected in the term "empirical turn" (Achterhuis, 2001; Verbeek, 2005). To break out of the framework of technology as a massive and dangerous system philosophers of technology began to incorporate more case studies and collaboration with

historians, sociologists, and anthropologists (in the new field of Science and Technology Studies). Don Ihde (1990, 1993) analysed the variety of relations between humans, technology and world. Bruno Latour (1992) began to describe how technical products give a twist to our way of living, under the general assumption that humans and technology cannot be separated but co-shape each other. Donna Haraway (1991) thought that our merger with technology has long made us cyborgs and that this puts us in need of new ideas about the human being, concerning gender for example. Contemporary philosophy of technology now acknowledges the fusion and interdependency of technology and human life, and concedes that any technology will always have both good and negative consequences.

An advantage of the empirical style of philosophical analysis is the focus on concrete products in everyday life, which appeared refreshing compared to the generalizing and abstract analysis of before. The debunking of abstract and essentialist ideas about technology, meant a kind of liberation from the dystopian fatalistic sentiment in classical philosophy of technology. It also opened the way for Technology Assessment approaches for the government of technology in society.

A disadvantage was that the ethical seriousness of before was largely lost, regretted for example by Langdon Winner (1993). The approaches of empirical description taken by Latour, Ihde, or Haraway were explicitly directed against generalising philosophical and normative claims. However, other proponents of the empirical turn aimed to renew rather than to oppose the classical studies. Albert Borgmann (1984) built upon Heidegger's work, but with more concrete suggestions for meaningful engagement with modern technology. And the critical theory of technology by Andrew Feenberg (2002) explored the possibility of alternative technology and structural change of society, better tuned to social values.

2.2 Beyond the empirical turn

Currently we see a variety of initiatives to explore and develop again the deeper critical and ethical potential of philosophy of technology after the empirical turn. Robert Scharff (2012) questioned if empirical philosophy of technology does not suffer from "too much concreteness" and promotes a reappraisal of the work of Comte and Heidegger (early and classical philosophy of technology). Others plea for a stronger political dimension with a revaluation of resistance and societal change (e.g. Rao et al., 2015). There has been an increase in engineering ethics studies, and recently an appeal for an axiological turn (Kroes & Meijers, 2016). Even Latour who so strongly promoted the empirical orientation has recently been expanding his approach by a profound philosophical framework with a prominent place for the notion of values (Latour, 2013). All in all there is a reconsideration of more critical stances: an "ethical turn" (Brey, 2010; Verbeek, 2010).

At this point we want to bring to the fore a "practical turn", which we see as a different branch for further development of contemporary empirical philosophy of technology. Although the empirical turn led to instant practical success with Technology Assessment and governance of innovation, the collaboration of philosophy and design seems another obvious way to make philosophy of technology practical. This is in line with Peter-Paul Verbeek's (2010) proposal that philosophers "accompany" technology development. Verbeek suggests an approach where philosophers do not act as ethical border guards who say yes or no to new innovations, but where instead they collaborate in the design process, adding philosophical and ethical reflection, and aim to contribute to better designs.

A practical turn suits the contemporary view of ambivalent technology in which there are no predefined and overarching answers to what is good and what is not (utopian and dystopian views). Reflection by ourselves on our own situation and circumstances must lead to a self-defined ethical vision on how to live with technology. In this respect, of determining future ways of living, the design and ethics of technology merge. The reluctance to give a hard yes or no, may be unsatisfactory from the side of the "ethical turn". From a normative ethical viewpoint, the idea of co-evolution of technology and morality, as is assumed in the accompaniment framework, might lead to a sort of

accommodation and justification of shifts of moral values in any direction. From a practical viewpoint however, the advantage of actual influence in the real world contrary to firm but ineffective theoretical moral standpoints is deemed more relevant.

Such considerations about the (ethical) justification in theory of the philosophical accompaniment of technology are important, but what does it actually mean in practice? What are good examples and what are good approaches for bringing philosophy of technology and design together? In the following we will discuss examples of how design may improve by the use of philosophical tools. Afterwards we will also reflect on the question what the philosophy of technology gains by a practical turn.

3 Philosophy of Technology in Design Practice

In the following paragraphs we present three design cases where Philosophy of Technology theories and methods were explicitly used in an attempt to improve the design outcomes. In particular mediation theory by Verbeek (2005, 2015) and the Product Impact Tool by Dorrestijn (2012, 2017; Dorrestijn & Eggink, 2014). Verbeek's mediation theory offers a structured account of human-technology relations in order bring to the fore how technologies mediate human perceptions of the world and actions in the world (figure 1, left). Dorrestijn's Product Impact Tool is a more practical implementation of theories like Verbeek's into a model intended to be helpful in the design process. It offers a repertoire of exemplary types of impact of technology on humans, presented in a model with different sides or levels of affection (figure 1, right).

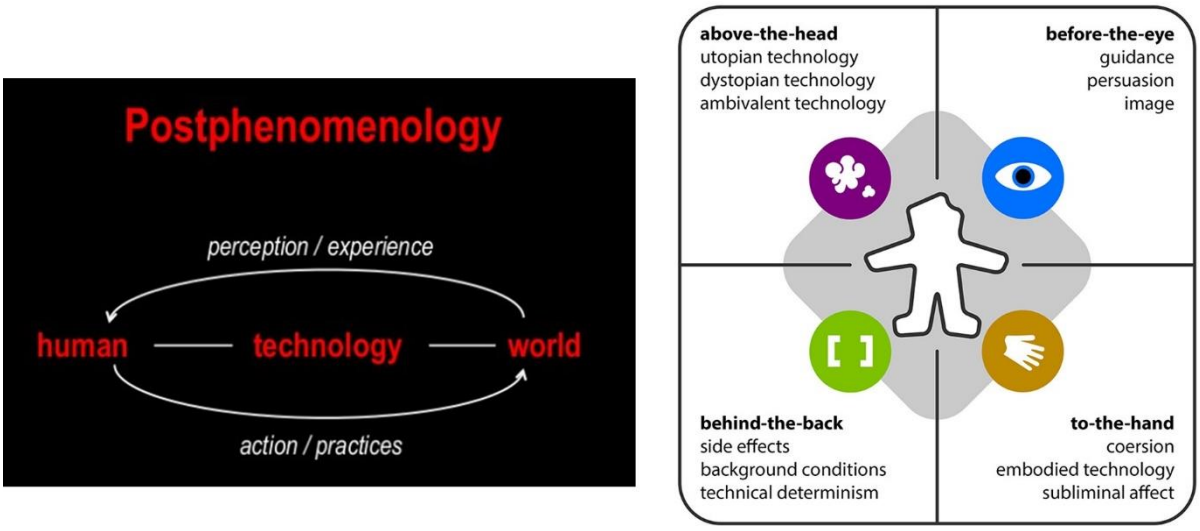

Figure 1 (left) Schematic depiction of Mediation Theory (after Verbeek, 2014) and visual model of the Product Impact Tool (Dorrestijn & Eggink, 2014). See also: http://stevendorrestijn.nl/tool/english.html

3.1 Design Case – eBike interface

In 2008-2009 the Dutch design agency Indes worked on the (re)design of a Dutch bicycle with hybrid traction – as it was at that time called. Specifically it concerned the design of the electrical kit of the bicycle. The electric kit would contain battery, motor and a user interface to control the several functions such as the amount of support of the electric motor. One of us authors collaborated as a researcher in philosophy and technology and usability with the design agency, in fact much like the "accompanying technology" approach, as proposed by Verbeek later (Verbeek, 2010). Because of the focus on usability and interaction design the researcher was assumed to advise on the design of the user interface: the amount, characteristics and functionality of the buttons and display of the user interface. However, analysing the hybrid bicycle from a perspective of mediation theory (and the Product Impact Tool in development), the advice turned out differently (Dorrestijn, 2011).

A display with buttons is particularly an example of a human product relation in the cognitive realm. The user experiences the product through interpretation of the information that is provided to him

or her through the user interface. The user interface thus mediates between the bicycle and the cyclist. However, cycling in itself is exemplary for a direct physical relation. The act of cycling becomes part of our physical routines by practice and is, once learned something one does unconsciously. In this embodiment relation (Verbeek, 2015) the user becomes one with the technology and experiences the world together, so to speak.

The hybrid bicycle concept by Indes stood out with a patented drive train that provided for a fluent adaptation of the electrical support to the movements of the cyclist. The better this works, the better the bicycle will be perceived as a part of the cyclists own body. In the best case the electric motor support would not be noticeable as a device that reacts on the input of the user, but the cyclists would rather have the experience of miraculously extra strength coming out of his or her own legs.

On the basis of these considerations the concept of the "perfectly embodied eBike" was formulated, where the display was completely left out and the interaction with the bicycle stayed purely physical, based on electronically sensing the force of the user. A consequence is that the bike can have less electric functions, however the concept is attractive because of its natural interaction. This could serve ease of use. And while the reduction of functions could harm a high tech image, it could add to an image of pureness and sportive strength and fitness.

3.2 Design Case – Solving a littering problem at a secondary school

A second design project concerned an attempt to influence user behaviour, in particular the waste disposal behaviour of students at a secondary school in Deventer, the Netherlands. Central problem for the school was the large amount of litter that remained every day after lunchtime in the central canteen. The school had already experimented with an installation that should encourage the students to throw away their waste by making it more attractive and playful. The installation that mimicked a basketball ring however lead to an even bigger mess (figure 2, left). Industrial design student Paul de Waard proposed several alternative solutions from which the converted lunch table with a trash bowl directly in the middle was the most successful (figure 2, right).

Figure 2 (left) Playful design of a waste bin didn't work (right) Mock-up of the alternative solution with a waste bowl integrated in the middle of the lunch table (de Waard, 2012).

Although this reduces the effort of throwing away your waste to a minimum, one would say intuitively that having your lunch directly around a waste bin in front of you is not very desirable. A user test however showed that the students had no problem with this solution whatsoever and moreover, it indeed showed that it solved the problem of waste throwing on the ground (figure 3).

On a sidestep it is interesting to mention that a simplified pre-test with waste bowls that were not integrated in the table but just placed on top of it was not so successful. The waste bowls ended up thrown away on the ground themselves (see also figure 3; here the green bowl is visible surrounded by waste on the ground just left of the middle). This shows that it is very important with these kind of intended influence of user behaviour to be precise in testing the designed solutions in context.

Figure 3. Image of the lunch area of the secondary school after one of the tests. The area around the converted table (in the front, with the bowl in the middle full of waste) is free from litter on the ground (de Waard, 2012).

Having seen this big difference in results from just slight differences in design solutions, de Waard chose to analyse the effects of his intervention with the Product Impact Tool. This tool presents the possible effects and affects in the interaction between users and technology, divided in four quadrants. These quadrants represent the physical “to-the-hand”, the cognitive “before-the-eye”, the environment “behind-the-back” and the abstract “above-the-head”.

The analysis showed that the proposed solutions were mainly to be found in the before-the-eye quadrant, with persuasion and suggestion as the most important influencers. The waste bowl seduces the user to dispose waste because it is right in front of his or her eyes. This lead to a whole new strand of possible behaviour influencing measures targeting at changing the attitude of the students towards waste disposal.

Based on the views on technology in the above-the-head quadrant de Waard developed teaching materials for classes in Social Science and Society, and a Facebook Application (figure 4). The teaching materials were in the first place targeted at learning about more sustainable alternatives for the target group, like for instance using a bicycle instead of a scooter. This is based on the view of “utopian technology” from the above-the-head quadrant of the Product Impact Tool, meaning a positive view on the use of technology as the way to better the future. On the other hand, the teaching materials showed the consequences of littering behaviour like in the example of a deformed tortoise due to plastic waste (figure 4, mid). This is related to the idea of “dystopian technology” of the above-the-head quadrant, that reflects on the negative aspects of technology. The Facebook Application was targeted at directly influencing the opinion about littering by promoting likes and dislikes for desirable and undesirable behaviour (figure 4, right).

Figure 4, Examples of alternatives for influencing littering behaviour; Scooter vs. bicycle teaches students about sustainable choices; image of distorted tortoise shows consequences of littering; facebook post influences opinion about littering.

In a questionnaire evaluation, a large proportion of the target group responded that they would change their littering behaviour, influenced by the concepts. Especially more than half of the 100 respondents indicated that they would change their behaviour after having seen the images of the negative consequences. In this way, the teaching materials can strengthen the effect of the before-the-eye based integrated waste-bowl concept.

3.3 Design Case – Digital Camera evolution

The third design case concerns the design of a next generation digital camera. In this project students Sven Deinum and Tom Feij investigated the evolution of the photo camera in order to come to an improved future design concept (Deinum & Feij, 2017). The analysis of the historical development of the photo camera showed that since the introduction of the first commercially successful rangefinder camera, the Leica II from 1932, the appearance of the photo camera hardly changed until the present day. The students then applied a mediation theory analysis to a set of typical cameras derived from the historical analysis, in order to find out more detailed differences and developments. This analysis revealed that the introduction of the digital camera, although not very visible on the outside of the camera design, had a huge impact on the human-product relation with cameras.

Formerly, with the analogue rangefinder camera the user would look through the camera objective onto the subject of the photograph. This is a pure example of an embodiment relation, where the user is not focused on the technology, but perceives the world through the technology. As Verbeek puts it: "In embodiment relations, technologies form a unity with a human being, and this unity is directed at the world: We speak with other people *through* the phone, rather than speaking to the phone itself, and we look through a microscope rather than *at* it." (Verbeek, 2015, p. 29).

With the introduction of the digital compact camera, with a large screen display at the back showing a preview of the photograph to be taken, this completely changed. When busy taking a photograph, the user watches the screen of the camera where one sees a preview of the picture to be taken, rather than the subject out there which one wants to make a picture of. The direct embodiment relation is changed into an indirect alterity relation, where the user interacts with the technology while the real world is a sort of hidden behind the technology in the background. With the attention of the user confined to the camera display, the user is also shut off from the environment, which is in particularly influential when taking pictures in the company of other people, or taking portraits.

Based on this analysis, two major use aspects where included in the requirements for the future camera concept: "If possible, the camera should communicate openness to people around the user", and "While using the camera, the attention of the user should not lie with the camera, but with the subject." (Deinum & Feij, 2017, p. 47). The students solved this by introducing a cleverly redesigned range finder, which serves as a window to the world (figure 5).

Figure 5. Future digital compact camera concept with two possible views through the new rangefinder; an overview when the camera is held close to the eye and a detailed cut-out of the scene when the camera is held far off (Deinum & Feij, 2017)

The rangefinder is a simple glass rectangle on top of the camera through which the user directly looks at the subject of the photograph. The camera would at the same time measure the distance and position of the eye with respect to the camera. When the camera is held close to one's eye the rangefinder shows the whole scene and when held with stretched arms the rectangle encompasses only a tiny detail of the environment (figure 5, right). The photographer in this way uses the glass rectangle to literally *frame* the subject, while at the same time still overseeing the whole scene. In this way the embodiment relation is restored. At the same time, while the user is no longer focussed on the camera, it also enables an openness to the world. This aspect is even stronger than with

conventional analogue cameras, because the open frame of the new rangefinder allows the user to see the whole environment. And from the perspective of the subject, the photographer is also more visible because the camera is held more at a distance (figure 6).

Figure 6. User interface of the future camera concept and a typical use situation holding the camera at a distance (Deinum & Feij, 2017).

4 Better Design by Use of Philosophy of Technology?

In all three design cases the incorporation of Philosophy of Technology theories and tools had informed the design outcomes. It is difficult to decide if these outcomes were better than without the influence of the Philosophy of Technology perspective, but at least one can say that there were new and different ideas.

In the case of the eBike interface the mediation analysis showed that the addition of a traditional cognitive interface would compromise the embodiment relation that is natural to the bicycle. Without this analysis the designers would have simply placed a display and knobs on the bicycle steer. Resulting in a more indirect interface, that could even distract users from their primary task of cycling. Especially in heavy traffic this can be potentially dangerous. The concept of the perfectly embodied eBike means a retrieval of natural interaction with possible gains for usability and safety in traffic and a different positioning qua image. The philosophical reflection enabled the designers to take distance and to rethink what an eBike can be on a conceptual level.

In the case of influencing the littering behavior, the influence is not so much visible in the proposed solution itself. The Product Impact Tool analysis of the converted lunch table provided the designer with more insight in the working of his concept, but it did not change the concept so obviously. The added value of the use of the Product Impact framework in the project lay more in the additional options that were explored to influence the target group. The four quadrants showed the potential to influence in different ways on different levels. In this way the behavior change is potentially strengthened because it impacts the user from multiple sides. And if the user is not so vulnerable for a particular type of influence, he or she can still be affected on another level.

In the case of the camera redesign the mediation theory analysis revealed the ‘problem’ of the interaction with camera and subject-to-be-photographed, even if there did not seem to be a design problem in the first place. The narrow functionalist idea of a taking a picture of a scene is broadened with details about the photographer’s gestures and posture in respective to the camera and the environment or people that make the scene. Moreover, this use of the Philosophy of Technology perspective revealed ways for improvement. Especially when a long product history is limiting innovative solutions because of the image of what a good product should be is influenced by strong archetypes (Eggink & Snippert, 2017).

5 Better Philosophy of Technology by Collaboration with Design?

Is the collaboration with design also beneficial for philosophy of technology? We will now concisely review the three cases again to see which kind of philosophical reflection can be evoked through the philosophical accompaniment of design practice.

In the case of the eBike it appeared that the old phenomenon of embodied technology (e.g. Heidegger 1996 [1927]; Ihde 1990) remains valuable in a high-tech world. In classical philosophy of technology in the wake of the later Heidegger (1977 [1954]) embodied technology is linked to traditional tools and romanticized. Modern machine technology, and contemporary digital and interactive technology would not allow this natural relation of embodiment, and instead cause estrangement of people. The eBike gives practical proof for the claim in empirical philosophy of technology that the estrangement thesis is one-sided, and shows that against a certain trend, embodied technology can be retrieved in an era of smart technology.

The second case, about litter disposal behaviour changing design, brings out how very important actual testing is. The situation of an environment with technical products and people's behaviour is so complex and full of detail that it seems impossible to forecast exactly what people do and experience. The concepts from the Product Impact Tool helped to structure the search for solutions but also raised awareness about the occurrence of unexpected impacts. There is an alternation between conceptual thinking and practical testing which makes this a case of philosophical research with the hands as much as with thought.

The third case, about the rangefinder for digital cameras, shows the persistence of the phenomenon of the embodiment of technology again, much like the first case. What was also present in the first case, but stands out here, is how philosophical reflection helps to take distance for a reconceptualization of how pictures are made. The mediation analysis helped to become aware of the differences between cameras one looks through or looks on for the making of pictures (engagement with the whole actual scene against focus on the preview of the picture on the camera screen). Moreover, it appears that customary values and ways of doing which appeared to be affected by new cameras can still be saved or retrieved by a thoughtful redesign. This is a case for the feasibility of the idea of "alternative technology" (after Marcuse, see Feenberg, 2002) which philosophy could never make so tangible without the practical turn of collaboration with design.

6 The Practical Turn

Philosophy of technology made an empirical turn in recent decades, from abstract theories to more detailed description of concrete technologies, situations and use practices. Today there is a renewed wish to bring back a more critical perspective: an ethical turn. It would be a pity however if this would renew the gap between philosophy and practice. A feasible compromise can be to continue with philosophical reflection on questions about deeper principles and structures while simultaneously continuing with more practical and applied work in collaboration with designers. The two types of work need not be mutually exclusive. Characteristic of our proposal of a practical turn is the application of philosophical insights in actual design. This should not at all mean however that only philosophical work that can directly be put to practice is valuable.

What is then the meaning of the practical turn? The "philosophical accompaniment of technology" is a nice but very general expression for what a practical turn entails. The redesigns and reconceptualization in the three cases we discussed also illustrate Don Ihde's variant of a practical philosophy of technology when he suggested that philosophers of technology can serve in an "R&D role". His proposal is that philosophers contribute to the design process with "deep insight into both technological structure and the history of technologies", and with "a critical take", though "detracted neither by utopian nor dystopian aims" (Ihde, 2002, p. 112).

Such ideas must however be made one step more concrete and operative. There is a need for more translation of work in the philosophy of technology into philosophical tools for design research. The

Product Impact Tool is our version of such a translation. We think our proposal compares to approaches such as Critical Design, Social Design and also Persuasive Design.

Persuasive Technology (Fogg, 2003) and Social Design theories, like Tromp et al. (2011) deal with the same kind of 'user-influencing-for-the-greater good', but they are also limited to this specific focus and come with a smaller, less versatile repertoire than our approach. The classification of Tromp et al. (2011) of the intended user influence, based on the dimensions of force and salience is more or less limited to the physical and cognitive quadrants of the Product Impact Tool that encompass coercion, suggestion and persuasion. Characteristic of the Product Impact Tool is the inclusion of the environment and reflection via the quadrants "behind-the-back" and "above-the-head". Philosophical reflection is also a characteristic of Critical Design (Malpass, 2010). However Critical Design is merely limited to criticizing the status quo by stimulating critical thinking and user reflection (Markussen, 2013), therefore with limited results for everyday practice. In comparison our approach is more practical and focussed on functional and usable results. So, our approach to philosophically accompanied design compares to Critical Design, Social Design and also Persuasive Design, but characteristic and distinctive is the simultaneous orientation towards practical use and critical reflection.

7 Conclusion

In three cases presented above concepts and tools from the philosophy of technology were applied in design. This proved to have results in the sense of new, surprising, and perhaps better designs. The other way around philosophy of technology also gained from the collaboration with designers. The effects of technology are ambivalent. Estrangement and domination as may be a threat, but more desirable alternative directions are possible. These are philosophical claims, which however cannot find their ultimate form nor decisive proof in philosophical argumentation, but only in practice. In that sense philosophy of technology has to become practical if it wants to fulfil the task of answering its own questions.

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Service Fictions Through Actant Switching

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Actor-Network Theory (ANT) and speculative design inspired the creation of Actant Switching and Service Fictions. ANT states that each action is a system made up of human and nonhuman actors. All actors play their set role for the system to move forward. By mapping out the system, ANT can enable exploration of relationships within a context. Actant Switching is a method for speculative scenario creation that interchanges human and nonhuman actors to create counterfactual scenarios exposing tension with the context and technology. Service Fictions is a method for engaging participants in a co-created speculative design around the created Actant Switching scenarios. A case study on sleep practices demonstrates these techniques. Both methods enable insights from allowing participants to confront their relationship with a system, to make explicit the implicit roles in the system and therefore their relationship with technology. These methods are a useful addition to designers' toolboxes, at the intersections of service design, speculative design, and participatory design. Both techniques provide a practical way to apply ANT.

speculative design; participatory design; actant switching; service fictions

1 Introduction

This paper introduces two related generative methods which enable design researchers to explore questions of people's relationships with a system and the technology internal to that system. Both methods bring to focus the questions around delegations of agency to technology in everyday life. Actant Switching (AS) is a method for speculative scenario creation, based on Actor-Network Theory (Latour, 1992; Verbeek, 2005), which involves switching nonhuman actors to human actors in order to create slightly counterfactual (speculative) scenarios. Service Fictions (SF), evolving from AS, is a method for engaging participants in co-created speculative design based on a slightly counterfactual scenario generated through AS. Both methods enable insights for design, from allowing participants in a user research or design process to confront their relationship with a system, and from defining the implicit relationships between actors in the system or network. AS provokes *designers* to make explicit their relationship to the system; SF enables *participants* to make explicit their own

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relationship to the system, based on a designer's prompts. Both methods use speculative design and Actor-Network Theory (ANT) to explore and understand a context.
These methods grew out of wanting to explore the boundaries of a context; speculative design was chosen as a way to push the boundaries of a context and ANT was chosen as a way to generate slightly counterfactual speculations based on existing systems. Initially, when these speculations were shown to participants, they tended to only react, rather than engage. SF are a way of having participants engage more fully with the generated AS speculations, by having the participants co-create a scenario that makes sense for their lives, based on their preferences and values. The speculative nature of both methods allows researchers to examine their own values, and to open up conversations with participants regarding their values, preferences and ways of thinking, otherwise harder to attain in a first encounter.

1.1 Background: Speculation and Probes

Speculative design can be used to elicit reactions through thought-provoking materializations of counterfactual concepts, its intent can be to initiate reflection and discussion (Dunne & Raby 2001). However, if the scenarios presented are too uncomfortable, too difficult, or too devoid of context, participants may potentially only *react* to the scenario—amplifying gut reasoning—without exploring the reasons why such a reaction is provoked. There is a trend of using speculative design to provoke debate in public discourse through gallery exhibition or promotion. This 'showroom model' (Koskinen et al, 2011) keeps the participant at a distance, where they are perhaps unable to engage fully with the scenario.
One way of rooting this more closely with 'one foot in the present' is to use speculative design methods. This exaggerates elements of what is already present in a familiar situation—making it easier for people to connect the speculation to current reality, so long as they are open to engaging with the prompt. The closer the speculation is to reality, the more the speculation perhaps 'disturbs' the customary conceptions that participants have of a context (Dunne, 2007: 10). There is an effort to remove the 'showroom' model and have participants engage more directly with the speculation. Chris Elsden et al's 'Speculative Enactment' (2017) uses scripted bodystorming to allow participants to experience speculative scenarios in situation. Other methods that attempt to use speculative design in a participatory way to initiate conversation to inform the design process include speculative design probes (Wallace et al, 2013), *provotypes* (Boer & Donovan, 2012), *probotypes* (Fuez, 2015) and other similar approaches, at various levels of resolution. These methods have been used to explore and gain an understanding of research participants' values, context, and ways of thinking, through collecting responses to a provocation in the form of a "part-made object[...] explicitly awaiting closure" (Wallace et al, 2013), or a presented scenario for "what might be" (Gaver, 2012: 940) which explicitly invites, and makes use of, participants' responses. For example, the evolving approach taken by Bill Gaver and colleagues (the Interaction Research Studio at Goldsmiths) involves giving prototypes of new products and artifacts to participants, to live with over time (e.g. Gaver et al, 2015). These prototypes are used as research probes, where conversations have often started with the designed object but opened up to "encompass the broader and more particular issues, practices and controversies with which our volunteers were living" (Gaver et al, 2015). This use of speculative design as a form of research employs the object as a prompt for rich conversation around, as opposed to simply evaluation of it as a product—similarly to Dunne and Raby's *Placebo project* (2001), examining people's experiences of electromagnetic fields in the home through a series of prototype objects. "We are not interested in whether these stories are true or scientific, but we are interested in [the] narratives people develop to explain and relate to electronic technologies, especially the invisible" (Dunne and Raby, 2001, 75).
Our intention with creating AS and SF were similar; the counterfactual AS scenarios work as research probes meant to spur 'rich conversation' around the context. The aim of co-creating speculative service scenarios is to open up a deeper conversation around participants' reasoning for their decisions—enabling different insights to emerge from the process. SF aim to help pull out the

reasoning behind participants' preferences. With the designer co-creating this scenario with the participant, the context can be explored thoroughly.
Since speculative design is meant to spur conversation, the benefit of SF is capturing engagement through progressive disclosure and recording how participants relate to the scenario that they create. In co-creating the scenario, participants can engage with the scenario in a way that makes sense for them and thus illuminate the reasoning behind their choices. Conversation also allows for slow 'buy-in' allowing participants to explore and engage more with the provocations rather than the encounter ending with the initial reaction (Dorst, 2015).

1.2 Background: Actor-Network Theory

ANT describes an approach to the description of situations, arising from work in science and technology studies (STS), which centres on interactions and relationships between humans and non-human actors—together making up networks which perform actions. In ANT, objects, environments—indeed all entities—are considered to be actors just as humans are. As such, ANT holds some interest for designers, as a sociological approach which recognizes the performative role of designed artefacts in social systems. It has particular relevance in service design, in terms of its focus on relationships and changing interactions between actors, which influence how we as humans and our nonhuman counterparts work together to act, or achieve a goal (Uden & Francis, 2010). In working together, each actor's role can be seen to move the action forward to the next actor that plays its part until the desired action is complete. An action depends on the actor before them for the system to move forward; each actor in the system is as important as the next. These networked systems are flat continuous networks that make up everyday life.
Latour saw systems in need of both technological nonhuman and human actors to allow the system to function and work seamlessly. Systems are not 'either or', but made up of both types of actors, as a system of only nonhuman actors could not exist without a human actor. Each actor's role can be delegated to either a human actor or a nonhuman actor. For example, Latour uses the example of a door being opened and closed: the actor that closes the door can be either a human or nonhuman (mechanical) actor; it does not matter as long as the action is done.
The reason for considering how both humans and artifacts make up a system is that they are dependent on, and co-construct each other. As Yaneva (2009: 284) puts it, "a thing or a design project can modify all the elements that try to contextualize it, triggering contextual mutations. In this sense, a design project or a disputed design resembles more a complex ecology than it does a static object." An artifact is usually designed with the intention that a human interacts with it in a certain way. The actions of the human are designed. Nevertheless, an artifact is nothing if a human does not use it; and use it the way it was designed to be used. Artifacts shape individuals' day-to-day actions. Likewise, much technology is only realized when a human actor uses it. For example, if a human actor picks up a phone to call someone the human is allowing the phone to be a phone, the phone is then allowing the human to talk to someone, thus completing original desire for the action. Both are reliant on each other for the action to work. The way the phone interacts with the human, and the way the human interacts with the phone is predetermined.
ANT does not recognize free will: there is only one interaction a human can have with a nonhuman and vice versa. If a human deviates, there is a notion of an *anti-program*. Anti-programs are designed into nonhuman actors that are meant to reinforce the intended interaction if a human were to stray from their role. In Latour's example of the seatbelt, if the human actor chooses to not buckle up, the car will beep incessantly until the human actor puts on the seatbelt. If a human strays too far, Latour states that 'the technical shifting-out forces the reader to choose between frames of reference'(Latour 1992: 169). This means when anti-programs are not strong enough, one needs to make a choice to abandon the system 'as is' and make a new system by introducing a technology switch. Each time a technology switch occurs and technology is added or subtracted a 'price is paid' (Latour 1992: 174). The system will normalize through an additional need, i.e. the 'price'—precisely the place the designer can examine, and make explicit, otherwise implicit relationships. This offers

an opportunity for designers to explore: playing with these relationships to provoke discussion and reflection.

1.3 About/ Background for Actant Switching

AS was born as a way to explore a context through using ANT—specifically, exploring the differences between delegating a role to human and to non-human actors, and the effect this has on the actions of others. If one starts playing with whether an actor is human or nonhuman, the role the actor follows stays the same, but its connotations may change. Switching actants provides an imbalance that allows one to examine the roles and meaning placed upon nonhuman or human actors. In the following case study, the role an object or technology once played became intrusive and awkward when a human did the same action. Participants were more aware of the actions humans performed, rather than an object providing the same action. This highlights questions about the types of relationships we have with our objects and the amount of control we actually hand over to technology (Figure 1).

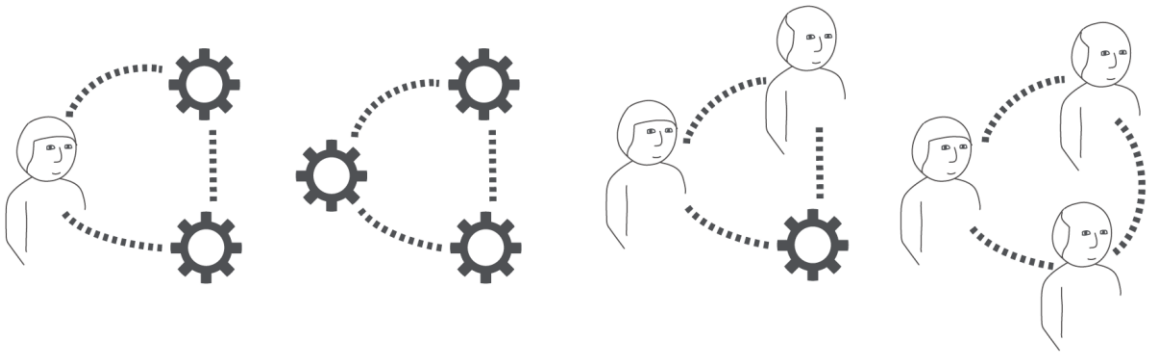

Figure 1. ANT, interchanging actors in a system.

In changing one actor for another, the action stays the same, the role stay the same, but the makeup of the system, and connotations change. This creates a slightly counterfactual scenario that could in fact exist, but doesn't. Different sets of actors lead to different actions, ('the price to pay'(Latour, 1992), allowing for emergent qualities. In changing the connotation, the scenario itself needs to change to rebalance the imbalance that switching actors created. This imbalance creates tension, this tension delineates that this is the boundary of a context. The act of understanding these tensions and attempting to rebalance the system so the scenario becomes plausible, if not preferable, uncovers implicit relationships, underlying contingencies and one's relationship to both the context and its technologies.

This tension allows us to examine our viewpoint and our interpretation of the inherent roles actors hold in a system. AS spurs ideas through the cascading changes in roles and interactions that result from changing a single actor in a system in an effort to find the boundary of what was comfortable for a specific context.

1.4 About/ Background for Service Fictions

SF attempt to minimize the 'reaction' to the speculation, by engaging participants in the scenario generated through the AS method. Initially, participants' reaction to the AS scenarios were because they didn't know where to start… SF were created as a way to slowly take them through the scenario by co-creating a scenario that could fit into the participant's life.

SF in the end, are co-created speculative scenarios (the captured SF Scenario, see Figures 6-11) that are reactions to speculative prompts based on scenarios generated from AS. SF attempt to situate the speculative scenario which is centered around an activity or practice, into a participant's life, in a way that makes sense for them based on their values and preferences. It is the participant attempting to rebalance the imbalance AS created. The rebalancing is an act that forces participants

to reflect on their relationship to the system, and thus provides an entry point to talk about the participants values and preferences (or reveal their values to themselves).
This engagement is less about the reaction to, but an exploration of the speculative prompt. In stepping through the speculation, participants are eased into engagement. Starting with reflection of the now, then stepping slowly towards creation of their own scenario with prompts based on their rituals. By stepping through the thought process taken in creating the AS scenario, the resistance to engage in the scenario is less than it was when the scenario was just shown to the participant.
The purpose of these scenarios is for the participant to explore a scenario that is slightly outside of their comfort zone. Service Fictions provided steps for the participant to think through how a speculative scenario fits into their lives. In stepping through a speculative scenario, it becomes fiction and it is no longer about the participant or their life, it is about this world that they are building. Since it is no longer about them or their life, participants feel more free to open up. Their stories, even if based in fiction, are still tied to their lives. The insights are in the participant's comparison between the two, and the why.

2 Methods

2.1 Actant Switching Methodology

AS is meant for the designer to understand their relationship to the context. It is used best in a purely generative way to uncover the possibilities of the new configurations of a network or to explore and understand a network. This allows the designer to understand the system they are designing within, it helps explore the dependencies and assumptions internal to systems.
AS works well in a context where technology has created a need that has not previously been occupied by humans. AS also lends itself well to contexts that are sensitive in nature. The goal of the designer is to find a scenario that sits on the edge of what is acceptable. Slightly sensitive contexts have varying mental models and any slight variation may be normal to one person or be at the boundary for another.
Procedure:

1. Choose a system/context.
2. Map actors and their roles in the system.
3. Using the same role, switch out one non-human actor for a human actor.
4. Design the scenario so that it makes sense. (Rebalance the imbalance)
5. (Optional) When returning to the original actors, how has this changed viewing the system?

Some useful questions to ask when using AS:

1. When roles/relationships are made explicit, how does the nature of the relationship change between actors?
2. How would making relationships explicit change the world around them?
3. How does having 'x' change the way one interacts with the world around them?
4. Re-balancing the system allows one to ask 'what would fit into my life?'
5. When switching back to the original actor, how does that change the original context?
6. What was displaced before this technology came into being?

2.2 Service Fictions Methodology

SF should be done at the end of the exploratory phase, at the beginning of the generative phase.

To generate the SF, participants were prompted with situations that are slight shifts to conventional practices, and presented speculative service scenarios as provocations. These slightly counterfactual scenarios were the basis for the SF. Instead of presenting the scenario at face value, the interview mirrored the designer's thought process when creating the service scenario. From there, the participants are asked to co-create scenarios to the initial prompts. Making part of the interview a co-creation session allows for the participants to closely relate to the material. Participants are able to talk through and reflect on what the speculative service would look like in order to fit into their individual lives, values around a topic, and rituals.

It was important to lead the participant through the thought process taken to generate the speculative scenario before engaging in co-creation of a script. 'Priming the Participant' was necessary for them to 'arrive at the same frame idea themselves' therefore '[bypassing] the adoption problem' (Dorst, 2015, 65). The participants are asked to think through their rituals around the context first, then with the prompt in mind, how would their rituals for this context change? The co-creation development of the script allowed individuals to react to the prompt, but then situate the service scenario in their own life while remaining emotionally separated. Counterfactual probes allow participants to think about circumstances that are close to reality but are still based in fiction. This gives participants permission to explore the topic in a way they might not normally have considered. SF allow participants to play with a certain idea without having to actually live through it in reality. The participants' insights given in storytelling nevertheless still reflect their individual values and thoughts towards certain issues.

Possible Procedure:

1. Development of speculative scenario (AS).
    a. Since this method was interchanging actors as a way of highlighting tensions in the dependencies of actors, it is important to develop the scenario separately beforehand for the development of the interview.
    b. Designers should capture their thought processes taken to get to the scenario, break down the core concept and devise steps on how to get the participant to the desired result.
2. Interview/Step users through thought process:
    a. Breakdown thought process to:
        i. What happens now, what do you wish was easier, what is challenging?
        ii. Shifts in convention, and how that would change things.
        iii. Engagement with scenario prompts.
3. Co-create the scenario.
4. Post-interview:
    a. Each created scenario was illustrated in storyboard format, using the same character and environment for each scenario.
    b. Capture script.
    c. Anonymizes scenarios by having same actors.

3 Case Study

SleepGivers

Sleep is a slightly sensitive and private subject. While everyone sleeps they don't generally talk about it, unless things go wrong. People do not talk about their practices or rituals because it is something that is shared with only a select few, and to talk about nightime routines is slightly intrusive to some, but not others. Everyone has different mental models of and around sleep, it means something different to everyone even though there is an assumption that these mental models are all the same or similar.

This inconsistency provided a starting point to probe to discover what was acceptable around sleep (thus the boundaries) and to make more transparent the differing mental models and relationships to sleep as a system. AS proved useful in creating scenarios that were not abnormal but were uncomfortable.

Taking the system of going to bed, there is a person and non-human actants that allow for that person to go to bed. If one inserts or switches humans to take over the role of the non-human actants, the system changes as seen in Figure 3.

If a designer contextualizes this system and a human actor takes over for that of an app a human actor uses when going to sleep, a scenario starts to emerge (Figure 4).

Using this context, the following speculative scenario (Figure 5) was generated focusing on switching a sleep app that helps one sleep for a person who helps one sleep.

The scenario was not out of the realm of the possible. Elders often have night nurses, ICU's have a service that aims to help people sleep better, and hotels mimic this to a degree with a turndown service with a mint on one's pillow. Attempting to normalize the scenario revealed that individuals were more comfortable when the scenario was medicalized and this person acted as a medical professional who had medical knowledge of how to make one sleep better.

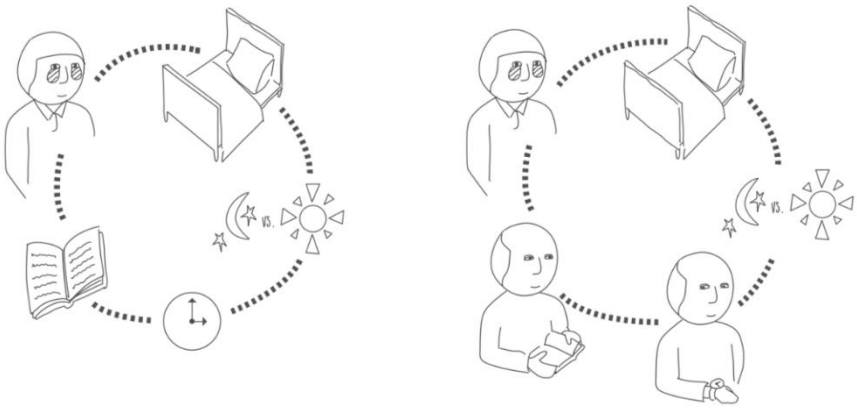

Figure 3. AS Scenario

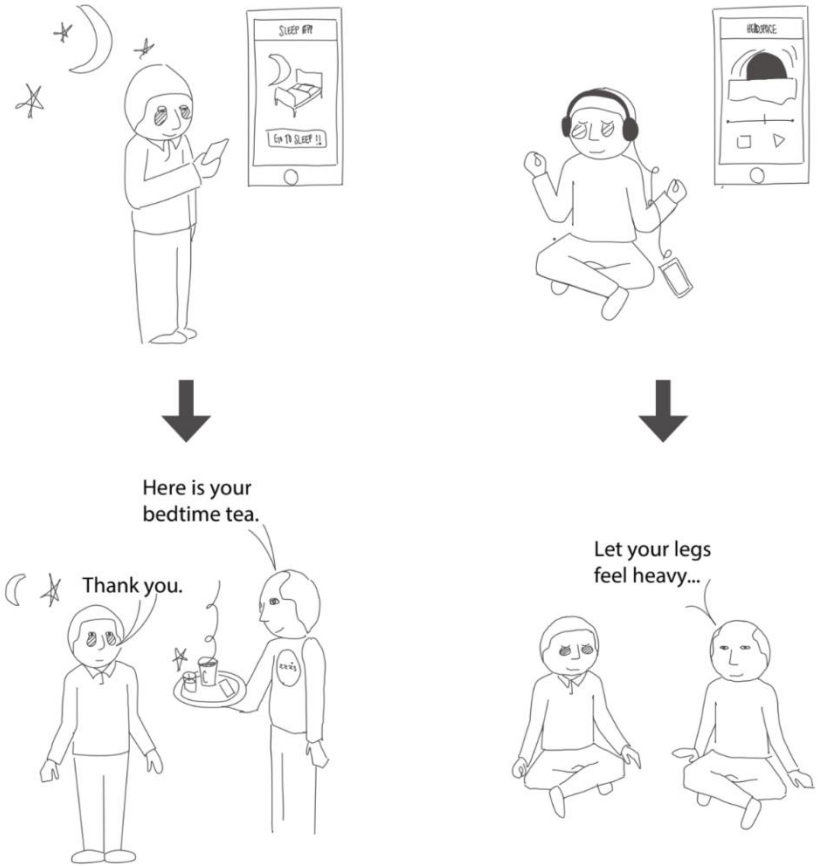

Figure 4. AS Scenario

Figure 5. AS Scenario

An informal call asked for individuals with insomnia who expressed the interest to 'be able to sleep more'. Of the 40 who responded, 12 SF were created illustrating the participant's boundaries around what they were comfortable with related to sleep.

The questions asked in the interviews:

1. What are your rituals around sleep.
2. If there was technology associated with an action, what would it be like if someone was facilitating that same action for them?
3. Then we co-created a script for a person who comes in to help the participant sleep.
    a. When would they come?
    b. What would your conversation be like?
    c. What would they do?
    d. When would they leave?

Below are some of the resulting scenarios from these SF sessions.

Select Generated scenarios: (Figures 6-11)

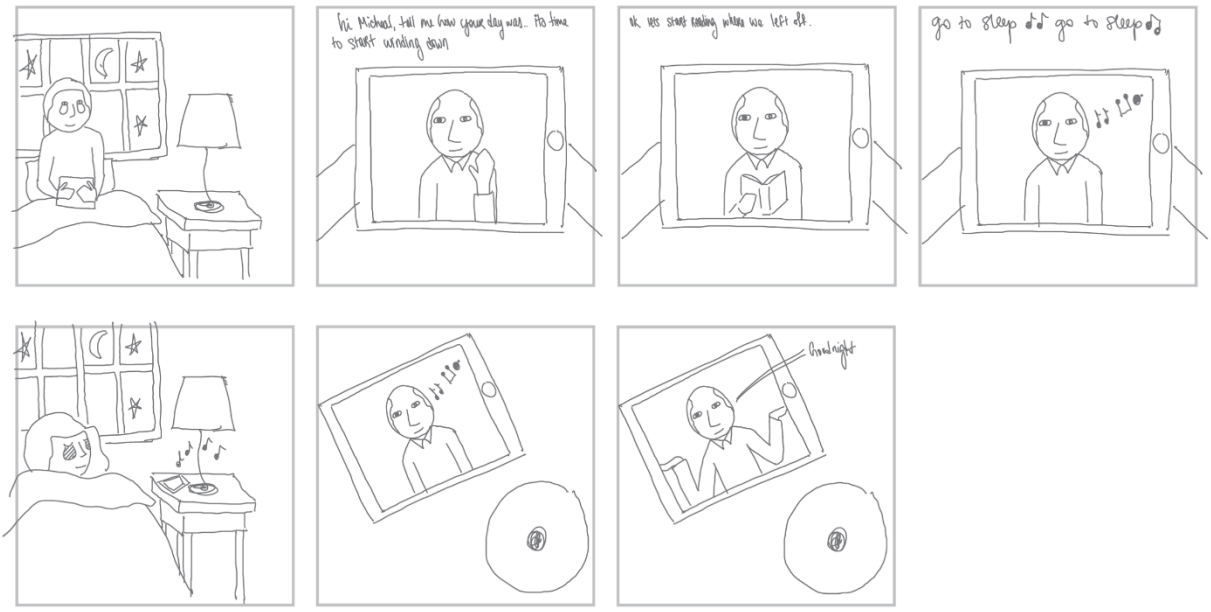

Figure 6. SF where the SleepGiver Sings the participant to sleep remotely.

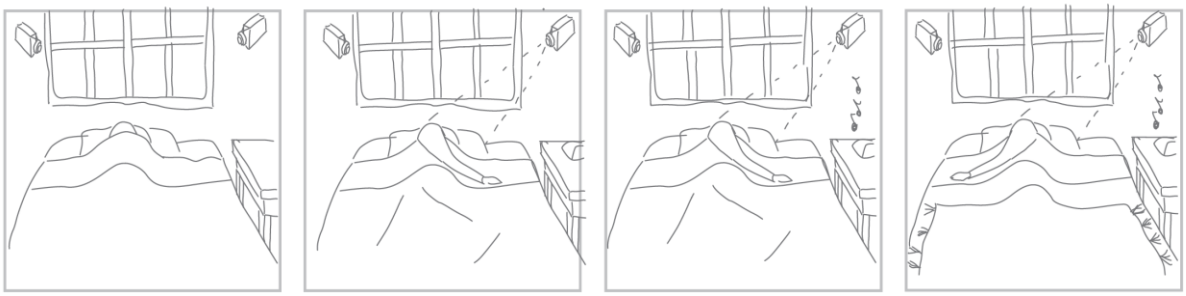

Figure 7. SF where the SleepGiver watches Participant sleep remotely, so that they could give participants tips on how to sleep better.

Figure 8. SF where the SleepGiver helps with chores, then blow dries Participants hair dry and rubs feet until they fall asleep.

Figure 9. SF where the SleepGiver hangs out and reads a book, does not interact with Participant. The SleepGiver brings dog, dog falls asleep on bed.

Figure 10. SF where SleepGiver watches Participant sleep, puts eye drops in their eyes so they won't wake, and if they do they walk them to the bathroom and back.

Figure 11. SF where the SleepGiver acts like a hotel Concierge and brings tea so the Participant can fall asleep.

Participants had varying degrees of comfort when creating the SF and normalized the scenario in completely different ways. Some made their scenario far-fetched as a way to bypass the privacy issue, but their reasoning behind their choices gave insight into what sleep meant to them. One participant wanted a person in a rocking chair reading but did not want that person to acknowledge them or speak to them (See Figure 3d). Having a person setting the mood of sleep, the participant felt that sleep would then become much more contagious. Other individuals wanted a person to help them make the dinner and help with chores, but wanted them to hide in a closet when the rest of the family sat down to eat.

Themes that emerged from this method were about when it was appropriate to use humans or technology in the design of services and preconceptions one has of each. For example in some cases, the 'SleepGiver' was stripped of their human qualities and used as a proxy for technology that did not exist. Or a reason people were hesitant about this 'SleepGiver' was that they didn't know their intentions, and it was not a closed but variable feedback loop, as opposed to technology where you 'know' what you are getting. Other themes that came up were the varying degrees of control, privacy and trust.

4 Results

AS is the method utilized in creation of slightly counterfactual speculative scenarios to be used in the creation of SF. If systems are made up of both human and non-human actors, shifting one non-human actor in this system to a human, the balance and relationships in that system changes. The system becomes a service. It creates service scenarios that could exist, but yet are not wanted. This allows one to examine their relationship to the previous non-human actor (technology). These Service scenarios exist at the boundaries of a chosen context. It allows the designer to explore their

individual boundaries, and understand the roles internal to the system making explicit the implicit relationships.
SF are co-created speculative scenarios evolved from AS. AS is the designer exploring their relationship to a system/context through speculative scenarios. In SF, it is the participant exploring the boundaries and understanding their relationship to the prompts and thus the system.
These speculative scenarios are meant to allow participants to adapt speculative prompts as related to their life. The end result is a SF, or a co-created scenario that takes place through a semi-structured interview/session. The participant uses the prompts created from AS and creates a service scenario of their own based on their preferences in how they see the prompts fitting into their own life. The purpose is to understand the 'why' behind the reasoning for these choices. These co-created scenarios allow for insight into a participant's preferences, values, and imaginaries while allowing them to define, reflect and explore their relation to specific actors internal to a specific context. SF allow participants to reflect upon and converse about their values and underlying assumptions specific to a context in a non-confrontational manner.

4.1 Validation of Methods

A workshop at Carnegie Mellon University was held to see if these two methods could be applied to a financial health context in a way that gathered rich insights, and if designers could use these methods without too much guidance.
The workshop took place with second year Master of Design students. The workshop was four parts, the introduction of the topic, AS, Interview script, and SF. The last three parts were done in teams of three, and activities were slightly modified in order to make it group work.
Students worked around a system of withdrawing money from the ATM (Figure 12). Initial concepts resulting from Actant Switching were switching out either currency, the ATM or the receipt.
Students noted that to normalize the scenario, more than one actor needed switching. Normalizing was less about fitting the scenario into their current lives, but about making the scenario make sense in a fictional world.
The participants then voted on one scenario, where the money had been exchanged for a human substitute. The groups then broke the scenario down to a script, and generated SF based on the speculative prompts.

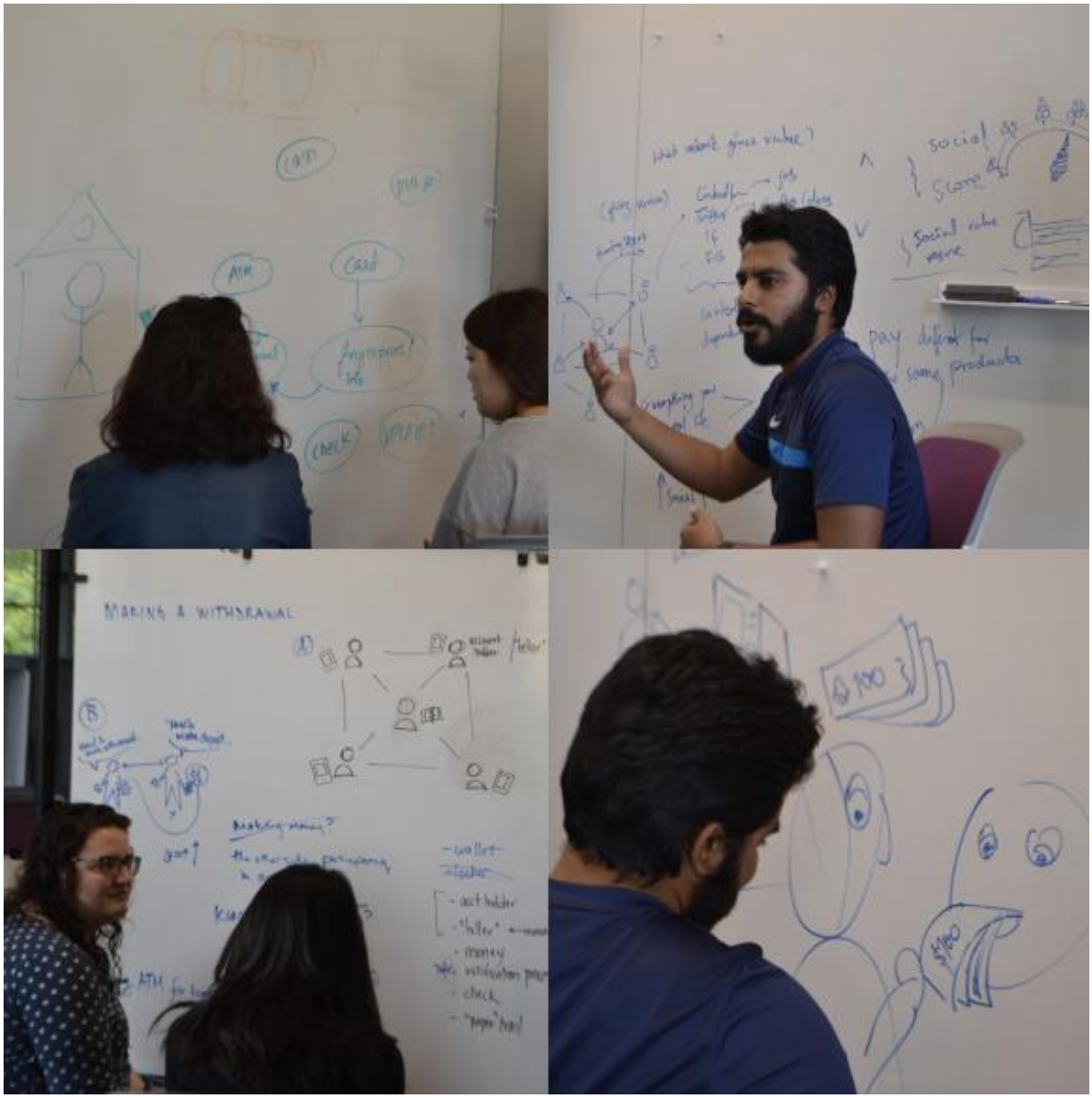

Figure 12. Validation workshop on Financial Health

Conversation that was spurred centered around the script that humans delegated to money and what humans displaced when delegating the script to money. We also noted that most scenarios treated social relations as capital, and if AS also looked at social relations.
The workshop participants found that AS was useful in changing the way one thought about a system, specifically what would happen when that system was switched back.

5 Discussion

5.1 The Benefit of Actant Switching

AS is a useful way of reframing problems/exploring problems as different relations or properties may emerge in its creation process. ANT in this iteration of AS and SF has proved useful when trying to understand social conditioning and constructs as related to one's possessions and the type of care one deems to be acceptable.
Tensions and imbalances resulting from AS allow one to examine their relationship to the context. When one attempts to rebalance the scenario, one is forced to make explicit the implicit relationship between actors. Thus, forcing one to confront what it is that they like or don't like or care about in

relation to particular actors in their life. Since AS focuses on switching non-human actors with human actors, this un-automation primes the conversation to one's relationship with technology.

5.2 The Benefit of Service Fictions

In showing participants a speculative design that sits on the boundaries of a context, participants can relate this slightly counterfactual scenario to their own life, without it being part of their own life. This allows individuals to safely engage in fictional world building that is relative to them. The fact that this created world isn't real and is fictional allows participants to feel that they can engage. How they relate this world to their life is where insights can be and are gained about the context and boundaries. These thoughts towards a provocation can be extrapolated to be one's relationship to provocation itself, and thus their relation to the original context.

SF work well with sensitive contexts and expose insights from participants and stakeholders without broaching the topic head on. Generally, sensitive topics are difficult to ascertain what the participants truly feel about the topic. This may be due to the participants not knowing how they feel and needing to figure out their thoughts towards a prompt. Exploration of this in real time can capture and lead to powerful insights. Alternatively, sensitive topics may be considered private and considered not up for discussion. Speculative scenarios are fictional, are not based in this current world, and thus provide an analogous storytelling element where participants feel that they can engage because it is fictional and thus not about them or their situation.

Captured Engagement

SF are an attempt to allow individuals to engage and react with speculative scenarios in a way that can be captured. Slowly stepping through a scenario, allowed the participants to experience and engage with the SF rather than just reacting to it. By stepping through it, participants could digest smaller bits of information, and acclimate slowly to the scenario prompt. Also giving the participant not the script itself but the prompts to generate the script allowed them to respond to the reasoning behind the scenario, not the scenario itself. This lead to the point that the scenarios generated reflected the participants' own personal values and boundaries.

Analogous storytelling

Participants may be reluctant to voice their experiences to a complete stranger. Since the prompt is fictional, it is not about them or their experience, however since it is the participant who is telling the story, aspects and reasoning are not separated. It is about what is acceptable to the participant, and their boundaries. Analogous story lines allow the interviewer to dig deeper without being intrusive to the sensitive aspects of the participant's day to day.

Defines boundaries on social norms

In some slightly sensitive contexts, individuals hold vastly different mental models towards a chosen context. Yet, people are not aware of these differences, and assume their mental models are the same until they are made explicit. This method breached slight social norms, to see where the norms were for different people.

Decisions on level of engagement

Participants accepted creating scenarios, but as soon as they were asked to act it out, they felt as if it was an intrusion to their privacy, or they felt weird, or they felt that was asking too much. This reflected the level which the participant is free to explore the scenario. If it is just talk, it is still fictional, when they are asked to act it out, it becomes more or less real.

5.3 The Limitations of Service Fictions

It is well known that there is a difference in what people say that they want, versus what they do, and therefore what they actually want (Bertrand, Mullainathan, 2001). When participants build their own scenario based on the designers prompts, it is not about what they want but their rationale behind that leads to insights.

Some people were initially reluctant to explore creation of the script because it was still out of their comfort zone. It was only when the designer said "I understand it is weird and I understand you may

not want this, but what would happen if this were the only way you could go to sleep". This was the allowance needed for people to engage in the SF. SF seemed to be the right amount of abstraction for people to engage.
Some participants still found it hard to engage due to the semi-private context and only answered what was specifically asked. This made it more difficult to spur conversations or to go off script, so some scenarios were short and not very detailed. The benefit of the semi-structured-ness of the script creation was to allow people to wander and reflect in the moment. This is still valuable however, because one is able to see and reflect about where their boundary was. In retrospect, it was hard to ask 'why' at the end of the creation of each SF. Instead 'whys' were asked during the conversation or when the participant felt the need to explain.
This method is used to gather insights, it does not attempt to analyse insights. Analysis is a separate event and has been used successfully with clustering.

5.4 Applications to Service Design

AS interchanges a nonhuman actor with to a human actor. This switching turns a system into a service.
Service design is concerned with designing people's actions within the system that they operate. ANT says that each actor in a system is interchangeable (whether it is a human or technology), so in designing a service- the designed service designs human actions the same way one would design a product. Each actor has a purpose and plays their role.
There is value in using these two methods to make relationships explicit, or understand where the boundaries are particularly when researching sensitive topics. Defining relationships, one starts to see how actors and roles are delegated to each other. In any service or service ecosystem, modelling things in terms of actors allows one to see what part of the system relationship or goals are delegated to human actors and which ones are delegated to nonhumans, and how they delegate to each other.

6 Conclusion

This article describes and details the development of AS and SF. Both help to uncover an individual's relationship in a context/system/or network by making explicit the implicit relationship in a system or network. Both techniques enable design researchers to explore questions of people's relationships with, and delegations of agency to, technology in everyday life.
AS provides an imbalance that through rebalancing allows the designer to reflect on their relationship to a context and the technology within that system. This imbalance allows the designer to look for the boundaries of the context through generation of different scenarios, and by doing so examine what roles are delegated to what actors, and what those roles mean when given to a human actor. Reflection of these delegations perhaps change how one perceives technology in the given context.
SF allow designers to engage participants in rebalancing the imbalance created with AS, and enable capturing the participant's reflection in real time. This opens up pathways of conversation not available in the typical interview session. Understanding how speculations would manifest in the participant's life and their reasoning for their decisions, allows the researcher to see values, boundaries, and beliefs that would otherwise be harder to obtain. In making relationships explicit, participants are provided an entry point to talk about their preferences if not reveal their values to themselves. SF are a useful way to gain access to participants' ways of thinking, and to build the variation of mental models towards a context.
Both techniques rely on the imbalance that switching actants provides. This allows one to examine the roles and meaning placed upon nonhuman or human actors. In the case study, the role an object or technology played became intrusive and awkward when a human performed the same action. As a result some participants attempted to dehumanize them and turn their role back into technology. Participants were more aware of the actions humans performed, rather than an object providing the same action. The act of understanding these tensions and attempting to rebalance the system so the

scenario becomes plausible if not preferable, uncovers implicit roles and its underlying contingencies and one's relationship to both the context and its technologies. The use of AS and SF can give powerful insights for discovering the intricacies of the implicit interdependencies internal to a system and our relationship to them.

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The Use of Philosophical Theories in Design: A Research-Through-Design Case of Treatment Compliance

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Design has a key role in shaping humans. In the design process, an understanding of the complex human and its often conflicting relations could be fruitful to improve the design. Ideas from Philosophy of Technology could offer a different perspective on product design. In this paper it will be explored how a philosophical perspective can support the design process in case of a conflict of interest using the 'research-through-design' method with a case study of clubfeet treatment compliance. The comfort and usability of the treatment could be improved using a brace instead of a cast. However, this change raises two conflicts of interest between and within parents, child and medical experts. Two philosophical theories were used, the Mediation Theory and the Product Impact Tool, to analyse the problem and design solutions. The results are, finally, discussed in light of the general design process. This philosophical perspective in the design process enabled the designer to reveal the core problem and design solutions that go beyond a technical fix.

philosophy of technology; product impact tool; design methodology; treatment compliance

1 Introduction

The question of what design entails is one that is difficult to answer. Design has a broad scheme of fields and styles, from graphical to technological to service design. The overarching characteristic in all these directions is, however, that design is always about humans (Buchanan, 1995). Similarly, the design of products and technologies is also about humans because it contributes to the material environments in which humans live and are shaped (Dorrestijn, 2012; Verbeek, 2005). A merely engineering approach to the design of new products seems, therefore, not sufficient to create products that are compatible with the life of people. Humans are complex beings: the interests and requirements for a product are often conflicting between different stakeholders, between individuals and society and even within individuals themselves. Understanding humans and the relation they have to each other and their technical environment in the design of products needs an

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approach that goes beyond the technical. Philosophy of Technology is a rising field of study that has potential to be fruitful in the process of designing products and technologies for humans (Dorrestijn, 2012; Verbeek, 2005), especially when there is a conflict of interest of any kind. Philosophy has a long tradition of trying to understand and find the deeper problems concerning humans. Could this tradition be useful in the process of design, a practice that is also deeply intertwined with humans? In this paper the question will be explored how a philosophical perspective can support the design process in case of a conflict of interest.

2 Research approach

The added value of using philosophy in a design problem was explored during a case study about clubfeet treatment (van Belle, 2017). In this 'research-through-design' approach (Findeli, 2010; Frayling, 1993), two different tools derived from philosophy of technology were used to analyse and conceptualise a dynamic brace to treat clubfeet in which multiple conflicts of interest occur. The case study offers an active approach to find the practical uses of the philosophical perspective. First, the case study of clubfeet treatment is presented. Second, two philosophical tools are explained. Then it will be shown how these tools were used for the analysis and design of the case. Finally, the end results are discussed against the background of the general use of philosophy in design problems with a conflict of interest between and within different users and stakeholders.

3 Case Study: Clubfeet treatment

A clubfoot is a congenital deformation of the foot that can be diagnosed at birth. Typically, the clubfoot is corrected using the Ponseti method, which entails a casting period of five to six weeks. During the casting period, the foot and leg of the baby are fixated with a plaster cast reaching up to the diaper (Pletch, Morcuende, Barriga, Segura & Salas, 2015; Scheurs, 2007). Even though the method is effective in treating clubfoot, the casting period offers multiple usability problems for the parents of the child. These problems range from practical to health to emotional problems. On the practical side, (1) it is hard to find clothing that fits, (2) it is difficult to bathe the child, (3) change the diaper and (4) clean the cast. Besides, (5) the cast feels wet and cold, which is an unpleasant feeling to both parents and child. The treatment also causes common health problems like (6) skin problems and (7) increases the risk of bladder infections. Additionally,(8) the cast itself is heavy on the legs of the child and immobilizes them, possibly affecting the development of the knee. Emotionally, (9) it is harder for parents to hug their child, (10) they get bad reactions from others and (11) are sometimes insecure on how the cast might look to strangers. Also, (12) parents reported that for example bathing is an important activity for bonding with their child, which is now practically impossible (Nogueira et al., 2013; van Doorn, 2016).

The Biomedical Engineering Department of the University of Twente is, therefore, developing a dynamic brace to replace the casting period. The brace would offer a more comfortable, hygienic and more efficient alternative, because it can be taken off by the parents when taking care of the baby. However, during the development of prototypes and feedback sessions with parents the department came across new problems regarding the usability and treatment compliance of the dynamic brace. The use of a brace instead of a cast means that the parents are now becoming an important part of the treatment. Where they first had to undergo the treatment together with the baby and deal with the consequences as they were, they will now be responsible for putting the brace on as often as possible. Since the possibility is there, the parents might impede treatment by taking the brace off for any small reason. The parents are now active attributers that need to comply with the treatment for it to be effective on the long run (Dobbs et al., 2004). The first conflict of interest is, therefore, the conflict between usability and responsibility, which changes the relationship between child, parents and medical experts.

The Biomedical Engineering Department is struggling with this problem, because there doesn't seem to be an easy technical fix. They want to improve the treatment in terms of comfort and usability,

but don't want the parents to obstruct the treatment. The dynamic brace places the parents in a difficult position in which there is an internal conflict between the short term intuition of preventing discomfort and the long term treatment and health of the baby. The second conflict of interest is, therefore, within the parents themselves in regard to the taking care of their child.

To analyse the problems regarding the non-compliance of the dynamic brace and create solutions, two different theories derived from philosophy of technology were used: the Mediation Theory of Peter-Paul Verbeek (2005) and the Product Impact Tool of Steven Dorrestijn (2012). First, these two theories were used to ideate on different solutions for the clubfeet compliance problem of the dynamic brace. Second, three ideas were elaborated into design proposals. The proposals are mainly focused on the interaction between the parents and the clubfoot brace. They consists of a visualisation of this interaction and the argumentation why it is likely to improve the treatment compliance of the brace treatment for clubfoot. Finally, the three proposals were evaluated using the two philosophical theories again and recommendations for the further development were proposed.

4 Philosophical theories

To gain a better understanding of the problems concerning the case of clubfeet treatment compliance, the two philosophical tools were used to analyse the problem at hand. Questions were asked, following the theories, on how the stakeholders related to each other and the previous and new treatments. The philosophical perspective was then used to reframe the problem, so that different solutions can be found.

4.1 Mediation Theory

The Mediation Theory is an answer to the question how the role of technologies in our lives can be understood. The approach stems from the idea of the mutual constitution of subject and object, that is, of human and world. Following the ideas of Post-phenomenology as laid out by Don Ihde (1990), it is understood that humans and their world are always interrelated. According to Verbeek (2005), technologies are mediators of the relationship between humans and their world: humans and technologies are intertwined instead of two opposing entities. Artefacts are not neutral intermediaries, but actively co-shape people's being in the world by mediating the way reality can be present for people and the way people are present in the world. By using technologies, humans change their perceptions of the world, like glasses change how we see the world. However, technologies also influence how people act and exist in the world. The mobile phone, for example, has changed how we interact with our friends and family. Designers could, according to Verbeek, anticipate the mediating role of products during the design process to ensure a better interaction and impact of their designs. This anticipation should not only look at the functionality and meaning of artefacts, but especially at the materiality. Mediation occurs, namely, because products are being handled and perceived by humans, and not only liked or used functionally (Verbeek, 2005).

Following the Mediation Theory, it can be found that the dynamic brace changes the parents' perceptions of, and actions, in the world. Where parents perceive themselves as a receiver of treatment with the cast, with the brace they perceive themselves as a giver of treatment. This raises insecurities and considerations on how to take good care of the child, because parents are not educated as medical practitioners. These insecurities are reinforced by the fact that a removable brace gives an image that it is sufficient to not follow treatment from time to time, because parents have by design the ability and authority to do so. Compliance with the treatment becomes a problem, because parents are not forced to comply anymore, but have to be motivated. This is a problem, because motivation is less predictable and needs to eliminate forgetfulness, laziness and a lack of knowledge. All in all, the underlying factor in compliance is the ability of parents to deal with new responsibilities in the treatment. The original cast treatment asks for a lot of engagement to keep the child healthy and clean during treatment, where the dynamic brace solution asks for a lot of engagement of the parents to make sure the clubfoot will be treated well on the long term.

Therefore, the role of the parents in the relationship towards the child has changed and given the parents more responsibilities (van Belle, 2017).

4.2 Product Impact Tool

In contrast to Verbeek's philosophical theory, Dorrestijn (2012) has created a more practical method for analysing technologies philosophically. He combined the overlapping interests of both philosophy and design research concerning the mutual adaptation of technologies and humans. With the Product Impact Tool, Dorrestijn brought together the knowledge of design theory, psychology and philosophy on the impact of products on human and society. The tool consists of a model (figure 1) containing four quadrants. Each quadrant represents a different way an influence reaches the human: via the conscious decision-making process (before-the-eye), physically (before-the-hand), via the environment (behind-the-back) and by changing ideas and thought-structures (above-the-head). In each of the quadrants there are three different concepts explained that elaborate how products impact people more specifically. In the 'to-the-hand' quadrant, for example, the concept of coercion explains how products and technologies can physically force users into a certain kind of behaviour. An example is the speed bump that makes sure that car drivers have to slow down in order to not break their neck or car (Dorrestijn, 2012).

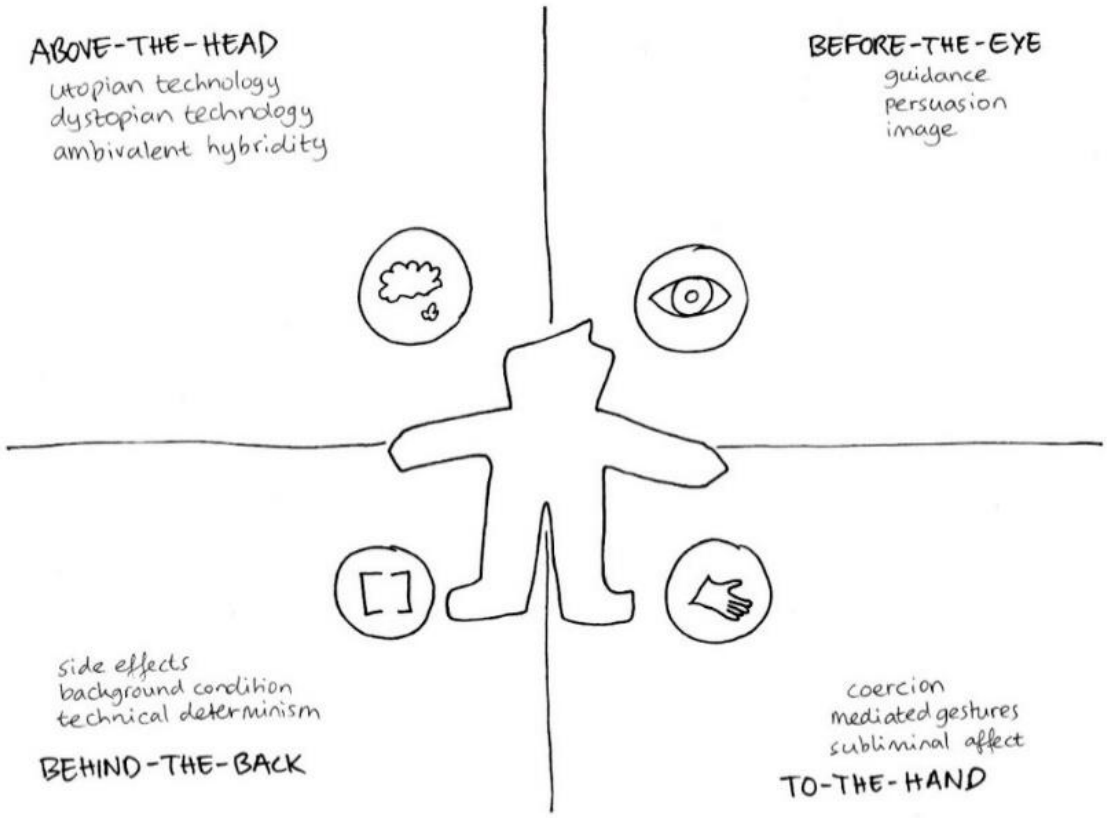

Figure 1: the Product Impact Tool (adapted from: http://stevendorrestijn.nl/tool/)

Different quadrants of the Product Impact Tool can be used to both analyse existing products for their impact and create new design solutions. Designers can use the tool in brainstorm-like sessions to take a step back from the design process and look at their product concept from a new perspective. The tool can also be used to create solutions for specific social and environmental problems of a product (Dorrestijn & Eggink, 2014; van Belle, 2016).

Using the Product Impact Tool, it can be analysed that the dynamic brace is a somewhat utopian solution. The brace tries to solve the usability problems of the cast by eliminating the coercing effect and giving the parents more freedom and responsibility. However, giving the parents more freedom

and responsibility turns out to have its own problems in the compliance of the treatment. Important values that are in play are the care and health of the child, but also the appearance towards others and the acceptance of the situation. In addition, the brace has a different image and association than the cast: it looks less serious and, therefore, less pitiful, but also less effective as a treatment than the casting treatment. There is also a shift in side-effects, from the usability issues to the compliance issues (van Belle, 2017).

5 Design proposals

The results of the analysis were used to create different design solutions during an ideation phase. Since the ideation phase offered a wide range of creative solutions, important points in choosing the best ones were the feasibility and amount of coercion in the design of the brace. To meet these requirements, it was decided to opt for the design ideas that can be taken off completely and were as simple as possible (no electronics and complex systems). Based on these ideas three design proposals were set-up and elaborated on their interaction, use and effectiveness: proposal “parent-participation”, proposal “baby-toy” and proposal “keep-it-close”.

5.1 Parent-participation

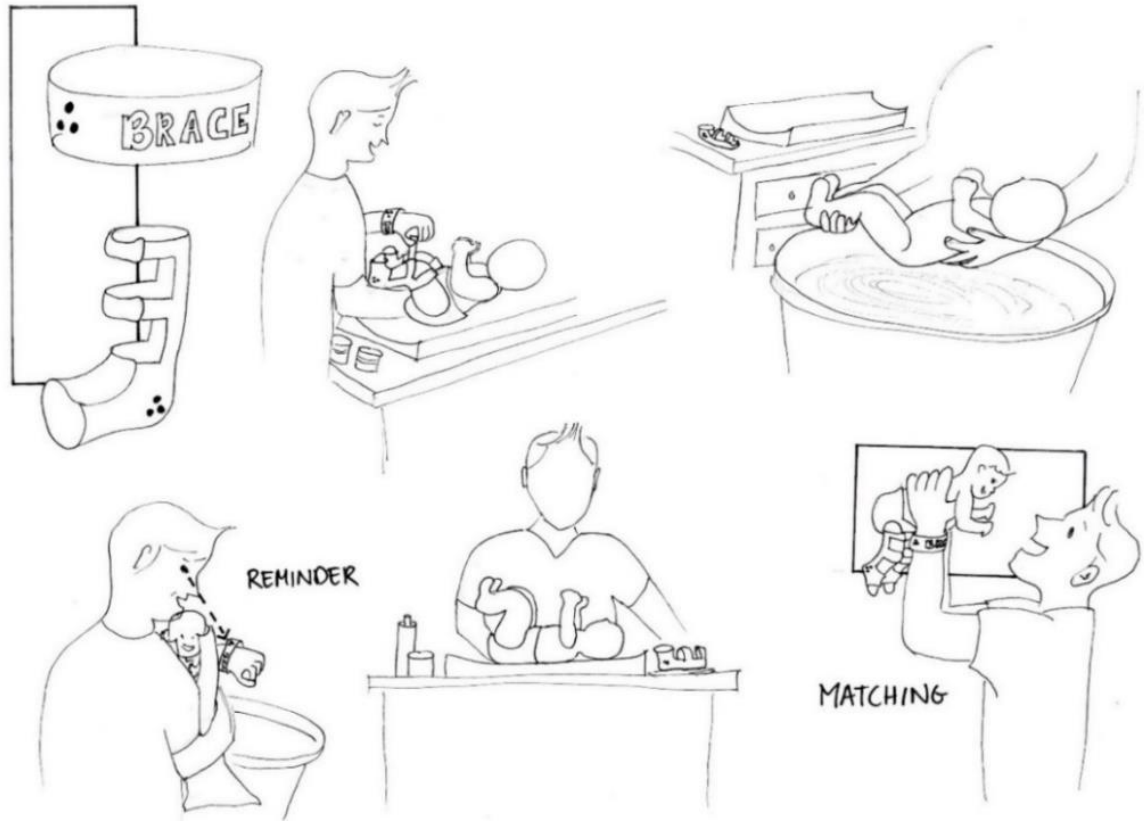

Figure 2: description of the parent-participation design proposal

With the parent-participation proposal (figure 2), the focus is on giving the parents the idea that they are partly undergoing treatment together with their child and giving them less opportunity to forget to put the brace back on by providing a little reminder. In this concept the parent is wearing a bracelet that matches the colours and patterns of the brace for the child. On the bracelet is an empowering quote (for example ‘Beat Clubfeet!’) to deal with clubfeet. This might improve treatment compliance for several reasons. First, the parents are more connected with the brace, because their bracelet is matching. It stimulates an idea that the parent and the child are together in this treatment, which could raise the motivation to comply with the treatment. Second, the bracelet works as a reminder to put the brace back on, making it less likely for the parents to forget. Finally,

the bracelet has a motivational quote which might raise the motivation to comply with the clubfoot treatment.

5.2 Baby-toy

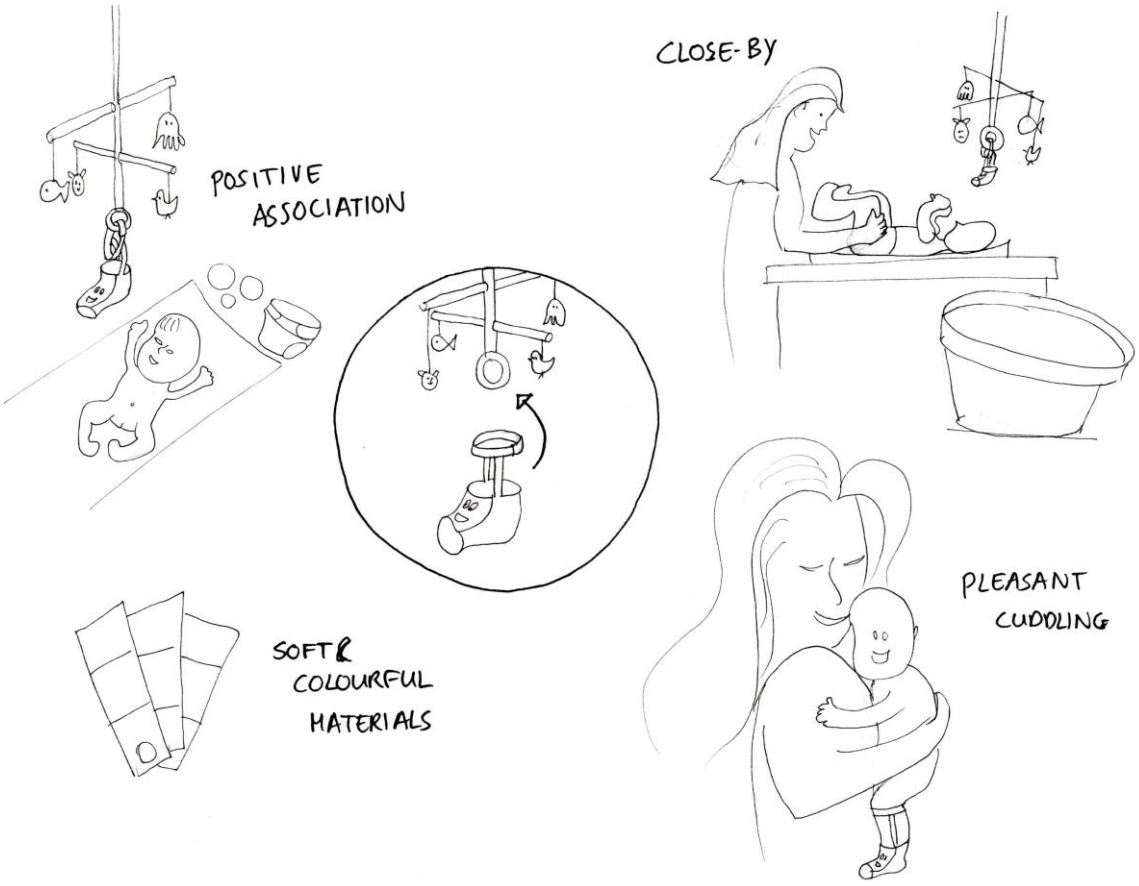

Figure 3: description of the baby-toy design proposal

The focus with the second proposal (figure 3) is on giving the brace a friendlier and more cuddly image, that is more comfortable to the senses of both the baby and the parents. The idea of this concept is that the brace has soft materials and can be used as a baby-toy when it is off. Babies of a couple months old can differentiate different colours (Bornstein, Kessen & Weiskopf, 1976) and a variety of objects that can be grabbed or reached in its environment stimulates the child positively (Yarrow, Rubenstein, Pedersen & Jankowski, 1972). In this proposal, when the brace is off, it can be hanged in a part of a matching mobile above the diaper changing station. This is an improvement in comparison with just a plain brace for a couple of reasons. First, the brace is actively associated with positive aspects, like fun, diverting and decoration. Besides, it has soft materials, making it more pleasant to touch and less of an annoyance in cuddling and bonding with the baby. Third, if the baby enjoys the brace, it creates a more positive association about the treatment for the parent, making them more motivated to comply with treatment. Lastly, the brace is always kept close by the baby when it is off, making it harder to forget about it.

5.3 Keep-it-close

The idea of the last proposal (figure 4) is that parents are less likely to forget the brace if it stays close to them. Next to that, it stimulates the idea that parent and child are undergoing treatment together by providing a way in which the brace is always either on the feet of the child or around the neck of the parent. The brace in this concept has to be taken off with help of a key on a cord that hangs around the neck of the parents. As long as the brace is not on the feet of the baby, the key holds on to the brace, ensuring that the brace is always either on the feet or on the key cord. This

will improve treatment compliance, because the brace is always kept close (around the neck), so it is less likely for the parents to forget it. In addition, the parents are more connected with the treatment, because they are also “wearing” the brace for certain amounts of time.

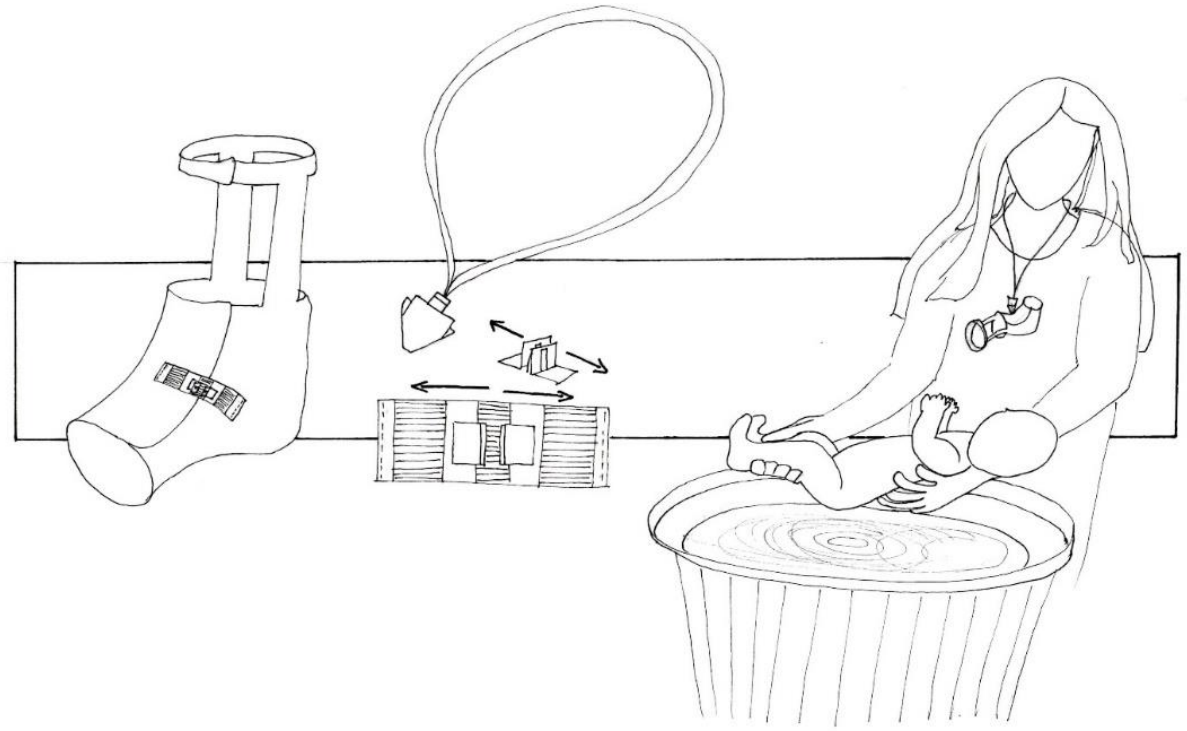

Figure 4: description of the keep-it-close design proposal

6 Evaluation of the proposals

The three design proposals were then again evaluated using the philosophical theories. This ensured the designer to take a step back and look at the bigger picture of the different relations between stakeholders and treatment.

Broadly seen, the parent-participation proposal is mainly based on the before-the-eye quadrant of the Product Impact Tool and makes use of conscious persuasion, guidance and a reminder to help the parent build a routine to comply with the treatment. In this concept the brace is accompanied by a matching bracelet for the parents, which creates an image of solidarity. Besides, the bracelet acts as a stimulus and a reminder from the doctor which can be perceived as supporting the responsibilities of the parents regarding the treatment. In addition, the motivational quote helps to perceive the disability as something that can be changed.

The baby-toy proposal takes another route by mostly focussing on changing the unconscious associations of the parents with the brace by use of physical properties and is therefore more fitting into the to-the-hand quadrant of the Product Impact Tool. In the before-the-eye quadrant, on the other hand, the soft feeling and friendly look of the brace gives a positive association and makes it more positively perceived as belonging to a baby, instead of a device for treatment that is imposed on the baby. In terms of the Mediation Theory, the attention and engagement of the parents is now also on the brace itself and not only on the treatment it embodies.

The third proposal is based on distance: by coercing the parent to keep the brace close it tries to lightly force treatment compliance, but creates at the same time a distance between the baby and the parent. To explain this further, it can be understood as the decreasing of the physical distance between brace and key, since the key is embodied in the parent. The brace can only be opened by them together. To use the terms of the to-the-hand quadrant of the Product Impact Tool, it coerces

the use of the key. On the other hand, the mental distance between parent and child is increased, because the using of a key to open the brace distances the action from the baby. Instead of taking off a brace, it might even feel like opening a device. This can possibly create an association with an unpleasant device from which the baby needs to be freed.

Based on the philosophical analysis and evaluation, the most important ideas to keep in mind when developing the brace are to be aware of the image and associations the brace gives to the parents and others involved; how it feels to the senses and the mind in handling the brace, and lastly, what the role is of the parent in the treatment. The parent shouldn't feel the pressure of a lot of responsibilities in the effectiveness of the treatment. To minimize their insecurities, it should be clear to the parent what their role is in the treatment. Even though they will always be responsible for taking the brace off and putting it back on, the design intent of the brace can be of help in making sure the parents feel not as responsible as they actually are, since having a new-born baby is already hard enough to deal with. The design of the brace should, therefore, help them by guiding, reminding and informing as much as possible.

In the end, treatment compliance is a human subject that needs an approach which takes the actual users into account. Proceeding with the design of the brace, it is of importance to involve the users themselves in the design process with questionnaires and user testing. Even better would be to specifically ask the input of the parents in the design of the brace itself by using co-design sessions. The Product Impact Tool can also be used in this case, because it has proven to be a great tool to use in a brainstorm session with users (van Belle, 2016). The different quadrants give a clear structure to such a session and can offer a new perspective on what it means to deal with the brace for the parents which can fuel their design inspiration.

7 Results

The use of the two philosophical theories in the case study of clubfoot treatment led to three design proposals that are technically simple, but have potential to address the problem of treatment compliance effectively. The use of the theories, however, asked for a bit more theoretical philosophical study than a designer could be used to in the common design process, especially in the case of the Mediation Theory. There was some introduction into Philosophy of Technology required to understand the different concepts used. The Product Impact Tool offered an approach and terminology that fits the practice of design better. Despite this small obstacle, the use of the two theories provided an interesting and extensive way to not only identify the conflict of interest, but also find the assumptions, beliefs and images that lie beneath the conflict. The philosophical perspective enabled the designer to reframe the problem, so that different solutions could be found. An interesting insight was, for example, the fact that a brace gives a completely different image of treatment effectiveness than a cast, which could explain why in a previous study (van Doorn, 2016) the parents leaned towards a brace/cast-combination treatment instead of a complete brace. The use of philosophical tools could, therefore, additionally be of help in critically analysing the user input derived from questionnaires and user testing.

For the analysis part, the Mediation Theory proved to be more useful than the Product Impact Tool, which could have been for two reasons. First, the Mediation Theory is more focused on analysis, whereas the Product Impact Tool is more focused on design. Second, the use of the Mediation Theory before the Product Impact Tool might have influenced the amount of new insights found in the Product Impact Tool analysis, creating a bias that the Mediation Theory was more useful. However, based on the first argument, the use of both Mediation Theory and Product Impact Tool in the design process is a fruitful combination.

8 Discussion

The deeper understanding of the underlying assumptions resulted in solutions that worked on a different level and were not just a technical compensation of the negative side effects. As a result,

the solutions were rather simple and intuitive, but well substantiated and potentially effective. The baby-toy proposal addressed the image of the brace not only visually, but also tactile and associative. A similar solution had previously already been discussed in the department, but the philosophical theories offered a stronger argumentation to go into this direction than 'it just feels good'. The parent-participation proposal offered, for example, a solution to the separation of parent and child in the treatment by recreating a mutuality in the treatment. The keeping-it-close proposal also offered a solution to the separation problem using the embodiment of the brace as a type of mutual identification between parent and child.

In general, the use of the Mediation Theory and Product Impact Tool in this case study achieved positive results. The philosophical ideas and analyses might be unfamiliar to designers, but can give an insight in how the design is perceived and how it influences actions and behaviour. It, therefore, contributes to the core of design by helping to create new solutions for human problems. This paper offered of course only one case study and wasn't able to make a comparison with the results without using philosophy, because it is practically impossible to control the conditions of such research, but it was able to show the potential philosophy of technology has in the process of design in case of one or multiple conflicts of interest.

9 Conclusion

In conclusion, the case study of clubfeet treatment showed how the design of a product that needs to address a complex conflict of interest can be supported by the use of ideas from philosophy of technology. Especially the Mediation Theory proved to be useful for the analysis of the problem, whereas the Product Impact Tool showed fruitful in the ideation of new solutions. A philosophical perspective and understanding in the design process enabled the designer to reveal the core problem and design solutions that go beyond a technical compensation of side-effects. In addition, the two philosophical theories used offered a framework to argue why the created solutions were a good answer to the analysed problem. The use of philosophy of technology was, therefore, able to bring designers the tools to better understand and design for the complexity of the human being.

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Turning Philosophy with a Speculative Lathe: object-oriented ontology, carpentry, and design fiction

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Arising from the complex relationship between their physical affordances, digital shadows, and interconnections, the things which make up the 'Internet of Things' (the IoT) present designers, users, and society at large, with a range of unique and as-yet-unfamiliar forms of network-contingent agency. These new design spaces engender new forms network anxiety, that in turn can result in a range of ill effects including overstimulation, information overload, and paranoia. Contemporary philosophies of technology provide a theoretical base with which designers can temper these emergent techno-anxieties with a sort of scholarly comfort blanket, however, closing the loop between such theories and design practice so that one explicitly informs the other remains a rarely-tackled and elusive challenge within design research. To help explore how designers may underpin their practice with philosophical foundations, in this paper we recount our own experience of conducting an IoT-based Speculative Design project. This research attempts to encode, enact, and express ideas derived from a contemporary philosophical movement—Object Oriented Ontology (OOO)—and 'Carpenter' those ideas into designed artefacts using the Design Fiction as World Building approach to Speculative Design. To 'turn' a physical material—wood, metal or plastic—means reshaping the material with a lathe to afford it a tangible elegance and grace. Metaphorically speaking, in this paper, OOO is our material and Design Fiction is our lathe, we reflect on the process of sculpting and carving theory, lending shape and poise to OOO through Design Fiction enabled Carpentry.

internet of things; object-oriented ontology; speculative design; design fiction

1 Introduction

Design and technology shape and change both us and our world. Designers, the things they design, and the people who interact with those things, are instruments of rhetoric (Buchanan, 1985) and are mutually influential, together shaping the world (Silverstone, 2006; Stam & Eggink, 2014a). This holds true across many domains and contexts, with examples including industrial design (Lockton,

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Harrison, & Stanton, 2010), design of services or platforms (Stam & Eggink, 2014b), and even areas such as video game design (Coulton, Burnett, & Gradinar, 2016). By attempting to understand the nature of this reciprocity between designers, users and things, the social construction of technology—which can be cast in various lights such as domestication (Silverstone, 2006), mediation (Verbeek, 2015), or emerging lenses like 'open script' (Stam & Eggink, 2014a, 2014b)—is a key driver of the Philosophy of Technology's so-called 'empirical turn' (Brey, 2010). Theories contributing to this empirical turn reject pessimistic-by-default and dogmatically-deterministic perspectives, and rather than referring to capital-T 'Technology' as a universal phenomenon refocus their interests on *specific* technologies and/or use contexts. Given the pervasion of technology through society during the late 20th century it was perhaps inevitable that pragmatic and empirically reinforced theories, equipped to differentiate between disparate technologies and contexts, also emerged in this period. During the 21st century technologies and the profundity of their impact on society have become even more ubiquitous. This ubiquity of effect brings with it, as Brey points out, the need for supplemental theories which help us make sense of a landscape that changes ever-quicker:

> *"To better understand human-technology relations, we need theories of the interaction between technological artifacts and practices on the one hand, and human perception, cognition, action, experience, identity, body image, moral development, moral deliberation, human nature, basic beliefs and values, and so forth. Without such theories, either developed within philosophy or borrowed from the social sciences, we can make little progress in understanding and evaluating human-technology relations."* (Brey, 2010)

The merits and necessity of this empirical turn notwithstanding, bridging the space between theory-derived insights and the messy tangibility of design practice—to take a so-called *practical turn*—is not straightforward. To explore aspects of this *practical turn*, within the context of the empirical turn, is the principle aim of this paper. We achieve this by using Speculative Design to enact and give form to Object Oriented Ontology (OOO)—a new materialist branch of metaphysics (which is, perhaps, in an *ironic* ascendency, given the Philosophy of Technology's relatively recent conveyance towards empiricism). Irony aside, within the domain that the design practice this research has emerged from (the IoT) OOO's rejection of 'correlationism' (Gratton & Ennis, 2014) and proposed 'flat ontology' (Bryant, 2011) seem to be useful means to theoretically present the IoT's network-and-data contingent 'constellations' of agency and meaning (Lindley, Coulton, & Cooper, 2017). We build on the OOO thesis and mediate the challenge of the practice-theory gap by experimenting with 'Carpentry'— a kind of "philosophical lab equipment" (2012). Put simply, Carpentry is "making things that explain how things make their world" (ibid). The process we describe in this paper, then, is about making 'Speculative IoT things' whose purpose is to explain how 'IoT things' make the 'IoT world'. While the work is based on insights gleaned from an IoT research project, the main contribution of this paper is *not* about the IoT itself, but rather the intention is to provide generally applicable insights about how to give shape, form and poise to theory—in this case OOO—by using Speculative Design.

The paper is organised as follows. First, we provide additional background with an introduction to OOO and Speculative Design. Then, we explore the design space of our case study, describing the IoT and then discussing contemporary IoT design issues. Next, we provide a reflexive account of how we brought these constructs together in a design process, detailing the designs themselves. Finally, we reflect on what we have learned about enacting and shaping OOO by using Speculative Design to inform future design practice.

2 Object Oriented Ontology

As we are not philosophers we willingly defer the task of arguing OOO's validity and/or critiquing its merits to those more qualified than ourselves. However, what follows aims to articulate an

accessible summary of our interpretation of OOO and to contextualise the subsequent account of the interplay between our design practice and our engagement with theory.
In his seminal work *Being and Time*, Heidegger presents his view of ontology. By providing the foundations for OOO this highly influential 20th century philosophical text has taken on a new life in the 21st century (Harman, 2002). The traditional Heideggerian view argues that things—*objects*—are all but impossible to understand in their own phenomenological terms, and therefore, we should make sense of them in relation to human use. Heidegger coined neologisms to communicate his argument, and famously uses a hammer as an example. When a hammer (or other object) is in its normal context of use it is 'ready-to-hand' and if that context is disturbed (for example if the head of the hammer falls off) then it is described as 'present-at-hand'. The metaphysics of this distinction are complex and must be negotiated outside of this paper, but the important point to note is that the hammer only comes into being via a human use (or perhaps non-use, in the case of the broken hammer). Central to the Heideggerian position is the notion that existence is a "correlate between [the human] mind and world" (Bogost, 2012). That these two constructs are inseparably linked is what Meillassoux refers to as 'correlationism' (Gratton & Ennis, 2014). OOO *rejects* this notion of correlationism and instead entertains the idea that objects have their *own* realities which are distinct from human use. From this post-correlationist position, anything—literally *any thing,* from a fibre optic cable, to a blade of grass, to a quantum computer, to a gooseberry fool—may be cast in the limelight of its own ontological resolve. If we consider the amalgamated glow that emanates from the bazillions of tiny *lights-of-non-correlationism* then the resulting luminescence is what illuminates the tundra of OOO's so-called "flat ontology" (Bryant, 2011). Having departed from familiar and intuitive human-centric ontologies, the vantage point one must adopt when considering the nature of OOO's flat ontology is a strange and conflicted place to stand:

> *"In short, all things equally exist, yet they do not exist equally […] This maxim may seem like a tautology—or just a gag. It's certainly not the sort of qualified, reasoned, hand-wrung ontological position that's customary in philosophy. But such an extreme take is required for the curious garden of things to flow. Consider it a thought experiment, as all speculation must be: what if we shed all criteria whatsoever and simply hold that everything exits, even things that don't? […] none's existence fundamentally different from another, none more primary nor more original."* (Bogost, 2012, p. 11)

This open-endedness is necessary because in OOO the scope of the term 'object' is not limited to *material* things, but extends to include *any* given idea or construct. Such a categorisation requires special appreciation, and a theory which allows for multiple types of 'Being' to meaningfully coexist. Exemplifying this Bogost uses the famously ill-fated video game *E.T. the Extra-Terrestrial* as an example. He muses that E.T.s object, is in fact simultaneously many different things:

- 8 kilobytes of opcodes
- a compilation of source into assembly code
- a flow of radio frequency into a television
- a plastic cartridge
- memory etched on wafer
- a consumer good
- a set of rules and game mechanics
- intellectual property
- 'the worst game ever made'
- a constituent of 728,000 Atari games buried in New Mexico[1]
- all of the above

[1] cf. https://en.wikipedia.org/wiki/E.T._the_Extra-Terrestrial_(video_game)

There is no elementary unit which comprises the video game, it is never a *single* one of the objects above, nor is it their conglomerate. Bogost tells us Latour refers to this as 'irreduction'—or the idea that no single thing can be truncated to another. Irreduction's consequence is that, in most cases, inter-object relations are devoid of intimacy or mutual-knowing. *Being* for different objects is usually uniquely distinct and thus "objects only unlock each other's realities to a certain extent" (Harman, 2002). Although this notion is challenging even when considering the objects we are most familiar with—those known as homo sapiens—this view of ontology is evocative, powerful, and represents an enticing philosophical renaissance; "the epistemological tide ebbed, revealing the iridescent shells of realism they had so long occluded" (Bogost, 2012).

2.1 Carpentry

Beyond a shared rejection of correlationism there is much disagreement between OOO's scholars. Our interpretation aligns with that Bogost presents in *Alien Phenomenology* (2012). Of particular influence is the notion of *Carpentry*; the practice of creating "machines" that attempt to reveal clues about the phenomenology of objects. While it's accepted that objects' experiences can never be fully or intimately understood, the machines of Carpentry act as proxies for the unknowable. They proffer a "rendering satisfactory enough to allow the artifact's operator to gain some insights into an alien thing's perspective" (Bogost, 2012, p. 100). A range of examples are cited some of which are created as deliberate acts of Carpentry whilst others simply demonstrate the properties of Carpentry serendipitously. One of Bogost's examples is software to visualise how a 90s games console stores and constructs sprites and palettes using the finite memory available, the result is a unique view on the connection between the 'raw' versions of the image—perhaps closer to how the computer and software might see things—and the game as we see it on the screen (ibid). Another example, the *Latour Litanizer*[2], is a carpentered machine which queries Wikipedia, calls upon the random article feature, extracts the article title, repeats, and then presents a number of these randomly extracted titles as a list. While its instrumental purpose is to quickly and easily generate Latour-like litanies, it also provides a portal of sorts into the interior reality of Wikipedia's content: "Not only does the diversity and detachment of being intensify with each fresh litany, but those very qualities also invite further discussion of the object in question at Wikipedia" (2012, p. 96).

Whether achieved by leveraging computer code or some other craft "through the making of things we do philosophy" (Wakkary et al., 2017)—*that* is the essence of Carpentry. Wakkary et al. do their Carpentry through material speculations (ibid), and while Bogost sees himself as a philosopher-*programmer*, he notes that philosopher-chefs, philosopher-astronomers, and philosopher-mechanics are all uniquely equipped as Carpenters in their own right. In our case, we are exploring the practicalities of being, and the possibilities for, philosopher-*designers*. Couching OOO in some kind of applied practice is, in fact, the process by which it is lent a concrete legitimacy that other branches of metaphysics often evade. Hence, *material* engagements with OOO are what make the theory compelling, and Carpentry is the process by which that engagement happens:

> *"If a physician is someone who practices medicine, perhaps a metaphysician ought be someone who practices ontology. Just as one would likely not trust a doctor who had only read and written journal articles about medicine to explain the particular curiosities of one's body, so one ought not trust a metaphysician who had only read and written books about the nature of the universe."* (Bogost, 2012, p. 91)

Having realised that computers have, by virtue of the programming languages we've created to tame them, relatively accessible inner worlds, Bogost uses computing as a compelling context to practice Carpentry. There is some shared ground between Bogost's computer-centric approach to OOO and the way which we used Design Fiction in this work. We might say that computer programmers, emboldened by the ultimate control code has over the computer, allows them to 'play God' (within the realm of the computer or system they happen to be programming). This

[2] http://bogost.com/writing/blog/latour_litanizer/

demiurgic gift affords the philosopher-programmer a great deal of freedom to explore the objects of the computer realm (including the computer itself). As we discuss below, a similar quality is afforded when designers unshackle themselves from the preconceptions of contemporaneous truths of reality, and, with this freedom practice Speculative Design.

3 Speculative Design and Design Fiction

Design usually seeks to answer questions, and thus to *create* futures. Speculative design, in contrast, uses design to asks questions about *possible* futures[3]. Hence the family of approaches which we collectively refer to as Speculative Design do not aim to create a products for sale, or that necessarily solve a problem, rather they are design processes intended to elicit thought and provoke deeper understandings about whatever design space they address (Auger, 2013; Dunne, 2006; Dunne & Raby, 2013). There are many nuanced views on the Speculative Design landscape which are beyond the scope of what we can address in this paper [4] however the specific method of speculation we employ is *Design Fiction*.

There are a number of concurrent yet incongruent perspectives on what Design Fiction is; these disagreements with discussions about the most productive ways to create and use the practice. The school of thought referred to as *Design Fiction as World Building* (Coulton, Lindley, Sturdee, & Stead, 2017) most exactly describes the approach we adopt in this work. The World Building approach argues that Design Fiction is the creation of multiple artefacts that, when viewed together, describe the coordinates of, or 'entry points' into, a fictional world (ibid). As well as providing points of entry, these artefacts tend to depict aspects of that world at different scales. So, a given constituent artefact of a Design Fiction may either represent a large area of the world (providing a 'zoomed out' summary view), or a smaller area (providing a 'zoomed in' detail view).

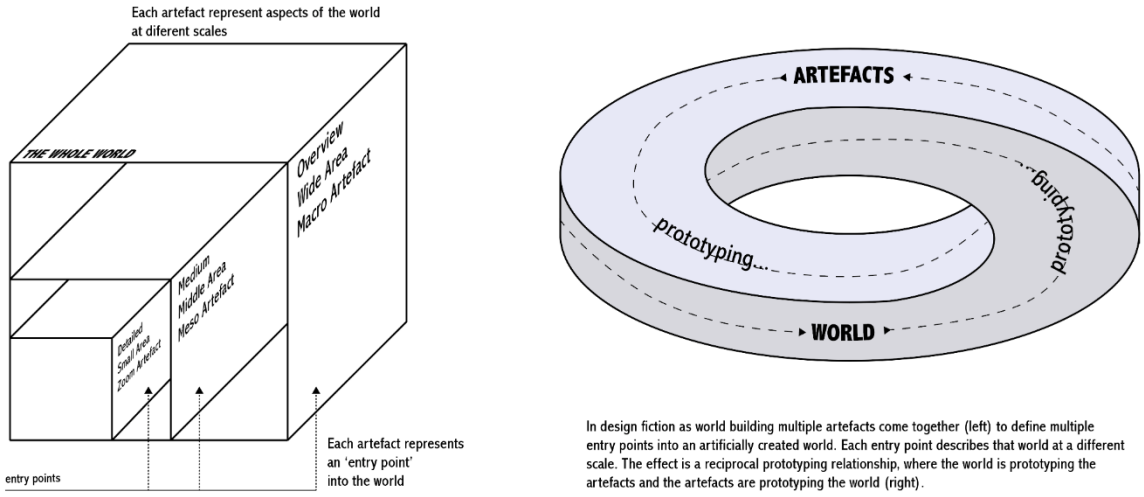

Figure 1. Visualising how multiple artefacts construct a fictional world and how this fosters a reciprocal prototyping relationship with the artefacts.

By creating multi-scaled worlds like this, Design Fictions produce a reciprocal prototyping relationship. The artefacts define the contours of the fictional world and simultaneously prototype the nature *of* that world; *meanwhile*, the world that emerges from the artefacts reciprocates and prototypes the contextualised properties of those artefacts (ibid). We also suggest that both the individual artefacts, and the whole Design Fiction world, may be seen in terms of Bogostian

[3] Although more couched in the related practice of critical design, this asking/answering contrast is summed up nicely in "A/B" (Raby & Dunne, 2009)

[4] For an overview, disambiguation, and exposition of Speculative Design's internal we recommend reading Dunne & Raby (2013) and Tonkinwise's review of the same text (2014).

Carpentry. Returning briefly to the notion of a programmer-philosopher playing God by manipulating computer code, the same logic plays out with Design Fiction but rather than the subroutines, APIs and procedure calls that the programmer-philosopher might utilise, a Design Fiction-philosopher has the texture and contours of the artificial world—and the design of the artefacts that *define* those attributes—at their creative disposal.

4 The Internet of Things

The term 'IoT' probably emerged from a presentation given by Kevin Ashton[5] in the late 1990s. Ashton was a pioneer of RFID and saw it as one of the technologies that would facilitate the realisation of a future akin to Mark Weiser's 'ubiquitous computing' vision (1999). Reflecting on his coining of the term Ashton notes "If we had computers that knew everything there was to know about things—using data they gathered without any help from us—we would be able to track and count everything, and greatly reduce waste, loss and cost" (2009). Today 'the' IoT is in fact many related concepts and is defined variously depending on the interests and motivations of the person making the definition. Popular tropes include technologically driven explanations like Ashton's original RFID-centric vision) and application-domain driven visions (e.g. IoT for healthcare, transport, or manufacturing). Ultimately, reductionist attempts to define the IoT are somewhat futile as it is the *implications* of IoT adoption that carries with it challenges, opportunities and risks (cf. Lindley, Coulton, & Sturdee, 2017). Notwithstanding the gamut of possible meanings for the term IoT, this research is part of an IoT-centric research project specifically interested in consumer-grade, domestic and home-based IoT devices and/or services.

Connected IoT products in our homes have a brief but chequered history. In recent years product manufacturers, spurred on by new market opportunities and the increasing accessibility and affordability of the hardware necessary to connect devices to the internet, have brought to market vast arrays of familiar-looking devices, but with somewhat unfamiliar IoT-enabled attributes. From toothbrushes to hair brushes; televisions to lightbulbs; washing machines to ovens; cameras to consoles; juicers to socks; kettles to t-shirts; health trackers to sex toys—the diversity of domestic IoT products is already extensive and continues to grow.

Amidst this variety of products there are many examples of innovative and novel designs—sometimes with distinguishable benefits over their unconnected counterparts—however issues with domestic IoT products have also come to the fore. For example, the television manufacturer *Vizio* was reprimanded for producing televisions that, without appropriate permissions or consent, gathered data pertaining to customers television watching habits[6] which the manufacturer then went on to sell for marketing purposes (Barrett, 2012). Other issues result from the fact that many IoT products rely on cloud services to function. This has potential unintended consequence that if the devices have been designed to be *dependent* on the cloud, and if these services go offline for some reason, it leaves customers with semi-functioning or worse, useless, hardware such as occurred in recent years with *Nest's Revolv* hub and *Pebble* smartwatches. Perhaps the most pertinent issue around the IoT, is security. In a 2016 attack an array of IoT devices from various manufacturers were breached, then updated to run malware, before being utilised in a distributed denial of service (or DDOS) attack which caused web services including Netflix, Twitter and Airbnb to become temporarily unavailable. Although high profile because of its visibility and scale, this is but one of many similar attacks which are made possible by the most basic of security oversights, particularly prevalent in emerging IoT contexts. Exemplifying a great many issues in a single product/service, the toy doll *My Friend Cayla* was ultimately banned in Germany due to meeting the legal criteria of a digital surveillance device (Oltermann, 2017). Contributing to this legal classification are a litany of design flaws: its lack of security could expose child users' to malevolent hackers; the privacy policy seems to provision for the *possibility* that recordings of child voices being

[5] https://en.wikipedia.org/wiki/Kevin_Ashton

[6] These practices are, in fact, commonplace in modern televisions. Vizio received disproportionate coverage because details of their data collection were omitted from the user agreement.

utilised for unknown purposes by unknown third parties; the doll relies on an already-unsupported cloud system, and hence despite *still* being on sale from various retailers may be 'broken out of the box' (Moye, 2015).

As we begin to share our homes with the IoT, and transpose open aspects of our private space to the far flung reaches of the Internet, personal, societal and commercial impacts abound. Pierce and DiSalvo explore some aspects of the IoT's advance into our homes with visual metaphors, and ultimately reflect on the "anxiety, exhaustion, overstimulation, overload, paranoia, unease, distrust, fear, and creepiness"—or what they collectively refer to as *network anxiety* (2017)—that has so far come hand-in-hand with the IoT. Emerging design research stances—from *Animism's* objects-with-souls (Van Allen, McVeigh-Schultz, Brown, Kim, & Lara, 2013) to *thing ethnography* (Giaccardi, Cila, Speed, & Caldwell, 2016)—are unified by an awareness of this anxiety, and respond with varying theoretical foundations. Arguably the advent of OOO, as one of these new materialist perspectives, is also driven by the desire to facilitate our understanding of the new ways of Being that emerge as we adopt technologies like the IoT. Of course, these responses are not confined to academia, philosophy, or design. For example, the EU's General Data Protection Regulations[7] (GDPR) is reflective of a Europe-wide realisation that IoT devices and the data they generate have the ability to impact upon citizens in terms of their most basic of rights.

GDPR is the specific design space around which the project we recount here was centred. The work aimed to take into account the unique properties of networked services and devices in the IoT, whilst responding to the yet-to-be-tested GDPR, and the fundamental ethical and rights-based contentions which underpin it. We do this, specifically, by invoking Bogostian Carpentry, which, in turn, is achieved by utilising Design Fiction as World Building.

5 Designing the IoT Around Meaningful Consent (or, 'By Reading This Title You Agree to Positively Review This Paper')

In the following we describe our journey through the design process. In order to better explain the context of our design space, however, first we review some of the GDPR's protections and make comparisons to established practices in the design of digital systems. Although legal interpretations are so far untested in courts the articles of the GDPR theoretically protect the right:

- To be aware what personal data is held about an individual;
- To access any personal data that is held;
- To rectify inaccurate personal data that is held;
- To data portability (i.e. to extract data in a readable form to be taken elsewhere);
- To refuse permission for processing or profiling of personal data;
- That any consent obtained relating to personal data must be verifiable, specific, unambiguous and freely given.

The apparatus of consent (i.e. how information is presented to users, and how that consent is recorded) is the problem area that became of particular interest to us. Although some progress has been made recently, for example *pre*-ticked checkboxes and non-consensual cookie usage were both outlawed in Europe in 2011[8], inappropriate apparatus for users to indicate they have, understood, and agree to conditions of use—for example a long body of text followed by an 'I agree' tick box—are still the norm. There are fundamental problems with this approach, the most obvious being that while pre-GDPR laws assume a tick in a box as legal consent, in practice it is very rare that users *actually* have read the terms, and even less so that they have understood them. Crudely but vividly demonstrating how such mechanisms are not an effective way to gain meaningful consent, a 2016 study found that of people who agreed to terms, only 25% of participants looked at the agreement at all, and only 2% could demonstrate reasonable comprehension (Obar & Oeldorf-Hirsch, 2016).

[7] http://www.eugdpr.org/article-summaries.html

[8] http://www.bbc.co.uk/news/world-europe-15260748

One-size-fits-all approaches, whereby user agreements are written in such a way as to obtain *all* the permission the device or system could *ever* need, structurally remove the ability for users to be selective about which features of a system they actually want to use, and thus denies them the GDPR protection for 'specific unambiguous' consent. These systems also tend to fail to account for temporality meaningfully; once consent has been given it is often difficult, and sometimes impossible, to revoke all or part of it at a later date.

5.1 Carpentering a Design Fiction World

Prior to directly considering how we might approach Carpentry we began the process by determining and shaping the entry points to our Design Fiction world. We elected to make this a product-led Design Fiction; focusing on a single product—an IoT door lock—which would act as a fulcrum, around which other aspects of the Design Fiction coalesce. Inspired by IoT locks that already exist on the market[9] the fictional lock has the following features:

- Keyless opening using NFC;
- Geofencing (automatically lock/unlock depending on user's location);
- Providing guests temporary access via smartphone;
- Voice activation (via a voice agent such as Amazon Echo);
- Interfacing with other services (via integrative platforms such as IFTTT).

In terms of the design problem, each of the lock system's features requires a subtly different relationship with collected data, where data is stored, and how it is processed. Keyless opening using NFC operation only requires that data be stored within the user's own network; geofencing requires that data be processed by the lock company; and voice activation or services such as IFTTT could lead to data being shared with any number of 3rd parties. Given that the Design Fiction's primary concern was GDPR, we opted to give technical implementation only cursory consideration and working around the assumption the lock is activated, via a hub, by an IoT radio standard such as ZigBee and that suitable APIs facilitate integration with external services such as IFTTT.

[9] cf. http://uk.pcmag.com/surveillance-cameras/77460/guide/the-best-smart-locks-of-2017

Figure 2. Still from supporting video showing the simple lock design. The electronics are housed in this plate which would replace one side of the standard lock plate with the remainder of the lock mechanism remaining the same.

With the basis of the Design Fiction established the task was consider how we might 'do' Carpentry. Extrapolating backwards from central issue we were concerned with (ethical and rights-based concerns related to personal data in the domestic IoT) and attempting to consider what 'unit operations' should act as basecamp for our expedition into OOO[10]. Immediately it is obvious that whilst human object and the device object are, of course, relevant, it is the *data* object(s) that appear central to the issues here; they are the *containers* and *carriers* for the information to which we attach ethical and moral significance. With this in mind our experiments with Carpentry began by trying to understand what it is to 'Be' among the data. While it is generated from the material world we live in, once captured by sensors and processed by silicon chips the data is no longer of our world. We began by appropriating network analysis software Wireshark[11] for use as a Carpenter's tool, to explore the otherworldly nature of the network and data.

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0000  01 00 5e 7f ff fa 94 10  3e 3e 66 e9 08 00 45 00   ..^..... >>f...E.
0010  00 91 00 00 40 00 04 11  2b 0e c0 a8 9a ab ef ff   ....@... +.......
0020  ff fa 0c 03 07 6c 00 7d  ee 3b 4d 2d 53 45 41 52   .....l.} .;M-SEAR
0030  43 48 20 2a 20 48 54 54  50 2f 31 2e 31 0d 0a 48   CH * HTT P/1.1..H
0040  4f 53 54 3a 20 32 33 39  2e 32 35 35 2e 32 35 35   OST: 239 .255.255
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0060  22 73 73 64 70 3a 64 69  73 63 6f 76 65 72 22 0d   "ssdp:di scover".
0070  0a 4d 58 3a 20 32 0d 0a  53 54 3a 20 75 72 6e 3a   .MX: 2.. ST: urn:
0080  42 65 6c 6b 69 6e 3a 73  65 72 76 69 63 65 3a 62   Belkin:s ervice:b
0090  61 73 69 63 65 76 65 6e  74 3a 31 0d 0a 0d 0a      asiceven t:1....
```

Figure 3. This is a 'packet' of data that an IoT device broadcasts on whatever network it is attached to, essentially saying "hello" to the network so that it can be discovered by any devices it needs to talk to.

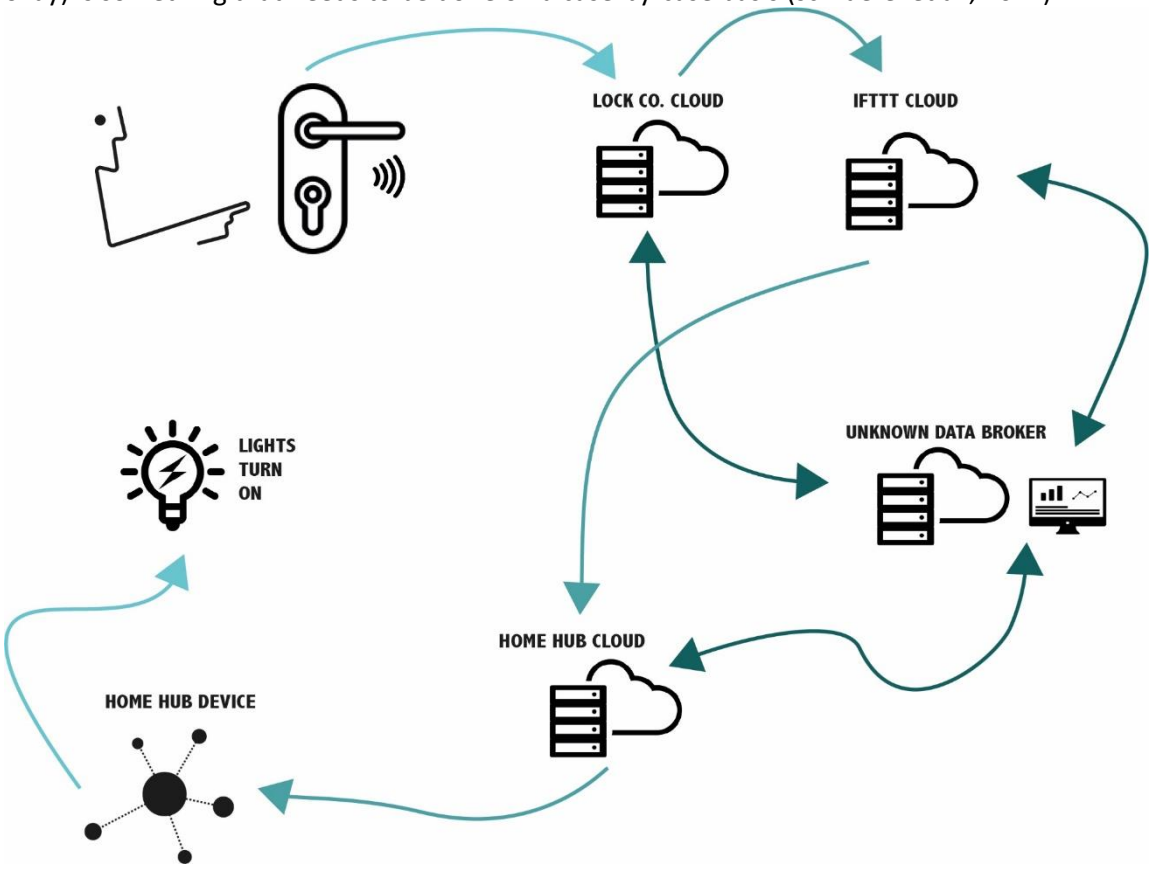
Wireshark is a network protocol analyser, allowing an unadulterated view of data as it is moved around computer networks. We applied Wireshark to a private network with various IoT devices attached to it. Beyond the volume of network traffic (over 3000 individual packets of data going to/from a single computer on a network with only a handful of devices in under 15 seconds) one of the most striking things we noted when looking at data packets as OOO unit operators was the similarity between them. Packets are dissected into hexadecimal code and metadata, and hence trying to imagine the network hardware's phenomenology, it may be rather like a postman's; although packets are clearly packets, and the metadata is visible (i.e. address), a *qualitative* assessment of its *contents* simply isn't possible within the system's architecture. The same is true on the Internet, and while it may seem obvious, this very simple application of the Carpenter's mind-set hints that there is likely no purely technological solution to the problem of GDPR-compliant personal data and privacy, because, vis-à-vis the network's own tiny ontology, *there is no problem*: there are only data to identify, process, and ultimately deliver to the right recipient. Ideas like data protection and GDPR are human concerns. They have no gravity to the computer, network, or data objects.
If we move away from the digital space, traverse the flat ontology, and adopt the more familiar human lens, we might ask "How would I decide whether this system's data policy is private enough to be acceptable to *me*?". Whilst Human-Centred Design techniques such as ethnography, activity analysis, focus groups or co-design (cf. Giacomin, 2014) could be used to *try* and elicit generalizable insights about human attitudes to data, humanity's penchant for context may confound attempts to find a happy medium representing the 'right' way to interpret GDPR (schraefel, Gomer, Alan, Gerding, & Maple, 2017). This problem of ultimately particular context dovetails directly with our

[10] 'Units' and 'unit operations' are Bogost's terms for individual objects within what Levi Bryant calls 'mereology' and Latour cites as 'irreduction'—that any given object is simultaneously its own thing and inevitably part of another object too, e.g. an IoT lock is part of the door object, the house object, and the network object, and the lock object itself (Bogost, 2012, p. 22)
[11] https://www.wireshark.org/

OOO-derived perspective in that we wouldn't expect multiple examples of human objects to necessarily have shared values.

Having noted these two extremes (context-driven value judgements on the human side, and the arbitrary delivery of data packets on the computation side) our consideration of how to connect the two led us to develop a map metaphor. If we take the Lake District National Park[12] as an object, whilst it is possible for a human object to understand its phenomenology in some small way by, for example, visiting the park, the Lake District's reality can *also* be accessed by reading a map of the area. The map can be seen as a form of Carpentry, it mediates a relationship between objects that otherwise have very little in common (i.e. the National Park and a human being reading the map) even if they are physically in different places and have never encountered each other. Similarly, mapping-as-Carpentry like this could mediate between humans and ecosystems where data a native inhabitant.

Initial attempts to construct maps for this purpose were fraught with difficulties arising from how complex potential data-relationships are, even in relatively straightforward IoT systems. Figure 4 illustrates a data scenario around an IoT door lock which has been configured to trigger smart lighting to turn on when the user unlocks the door. While the cause and effect are straightforward and visible to the user (opening the door results in the lights coming on), there are in fact at least three cloud services behind the scenes making the hardware work, and as shown in this example there may be unknown 3rd parties also using the data. To translate this into a static map that absolutely and concretely details where data goes and when, in an accessible manner, is not practical. Confounding the already difficult task, our human appreciation of context makes the challenge *even harder*. To cartographically represent, or respond, to each human object's understanding of context-specific 'acceptability' (i.e. when it is okay to share data and when it is *not* okay) is something that needs to be done on a case-by-case basis (schraefel et al., 2017).



[12] https://en.wikipedia.org/wiki/Lake_District

Figure 4. Triggered by the user unlocking a door data flows across and is processed on different networks and does not necessarily have a specific end point.

To resolve our mapping-misgivings we needed to make two compromises, and although this changes the nature of the design space it does not hamper our enquiry's overall aim to explore practice and philosophy. First, we reduced the scope of our interest from a very general notion around 'GDPR compliance' to the specificity of 'personal identifiability' (based on data). Second, we had to reject the wholly deterministic view that our exploration of data packets brought, and instead build a map with the ability to communicate aspects of context, risk, and probability. Hence, it turned out that the path our exploration with OOO took, was wholly different to what we had initially expected. We anticipated that exploring the tiny ontologies of the IoT lock itself, the data it produces, and its users, would lead us toward Carpentry applicable to one of *those* objects, what *actually* happened is that we arrived at an artefact of Carpentry around an entirely new object—one that communicates the *likelihood of identifiability*—and whose own tiny ontology, offers a new way to view any specific assemblage of devices, services, data, and people. By communicating the chance that a person could be identifiable based on the data associated with device use, and presenting that in terms of whether the data is held on devices owned by a user, servers owned by companies the user knows, or servers owned by 'anyone else', we aimed to have defined a construct that could represent both sides of the human/computer dichotomy that OOO helped us comprehend.
The most basic forms of the identifiability maps which reflect notions of risk and probability, are shown in figure 5. Due to some metaphorical and visual similarity to the Bohr model of the hydrogen atom[13] we have referred to these as 'Orbits', or Identifiability Orbits. These maps represent data that is generated, stored and processed as part of an IoT system, and specifically *where* that data is held. A circular band represents each 'level' of data and our key privacy construct of identifiability is communicated by how sharp or blurry the edge of that level is. Hence, if the circle is the middle is has a clearly defined edge, it is almost definite that the user could be identified by the data at that level. The blurrier the edge of any level is, the less likely it is that a user could be identified.

Data held locally, with known providers, and with unknown 3rd parties is represented by the three circles. The lower the chance of identifiability at any given level, the less blurry the edge will be shown. In the example on the right the user is definitely identifiable with the local data whereas in the example on the left the user is almost certainly not idenifiable with the data held by unknown 3rd parties.

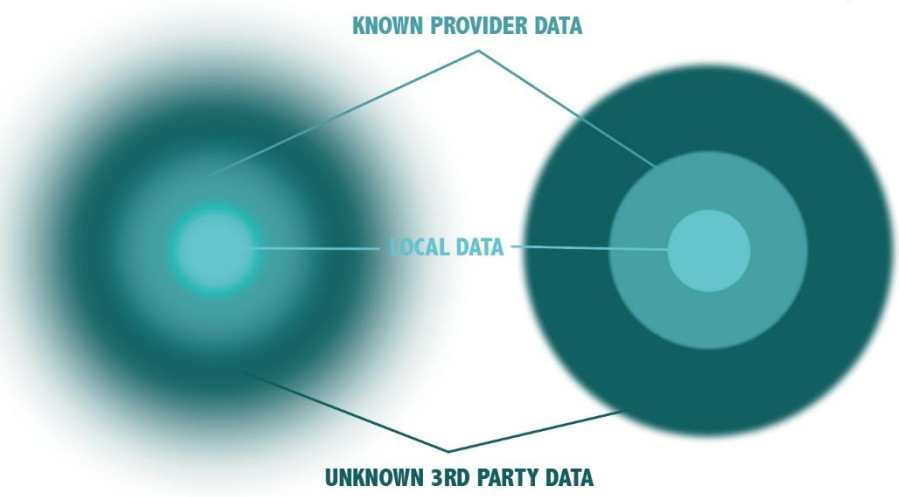


Figure 5. Early prototype design for identifiability Orbits.

Exploring how the design might be implemented in software, and how a user might interact with it, we implanted the Identifiability Orbits into our Design Fiction world by creating a film that depicts a user adding a lock to their smart home. The interaction in our film is triggered by instructing a voice agent to detect new devices; once the lock is detected the home's, the voice agent instructs the user to use the supporting 'Orbit Privacy App' on the user's phone so they can configure their privacy settings. By using a slider, the various functions of the lock can be enabled or disabled, and the data implications of those choices visualised using an Identifiability orbit.

[13] https://en.wikipedia.org/wiki/Bohr_model

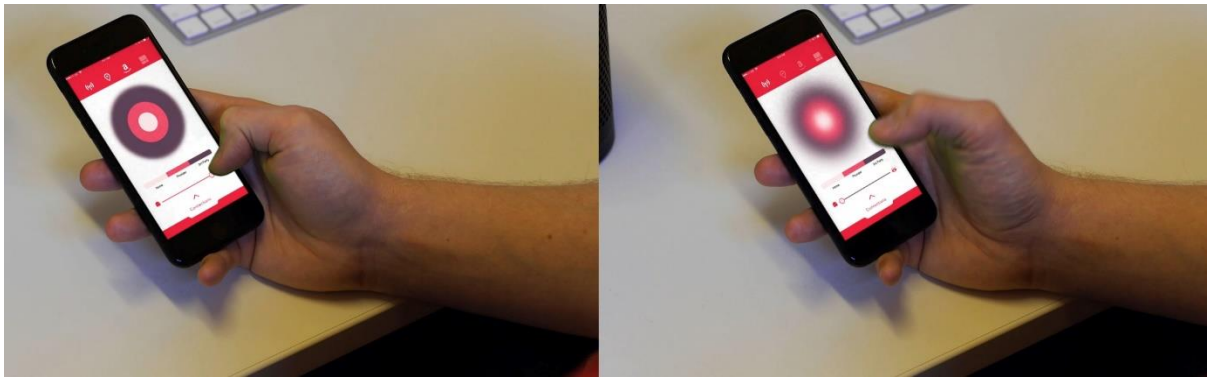


Figure 6. Stills from the Design Fiction film. A user uses the Orbit-based privacy app to configure which functions their IoT lock will have permission to use. On the left they have enabled maximum functionality, Orbit updates to show that the user will most likely be identifiable at all levels, although that is not certain with third parties. The inverse is shown on the right.

With the basic interaction demonstrated the film proceeds to demonstrate how a user may use such an app to dynamically modify their choices (figure 6). In our scenario, the user originally configured their lock for maximum privacy. The scenario extends to show that, if notified by a delivery company who require access to the house, the Orbit app communicates to the user identifiability implications of the data flow associated with provisioning temporary access to the delivery company, before revoking it again once delivery is completed. Although this work was completed before it was announced this is a data flow very reminiscent of what is being proposed to support Amazon Key[14].

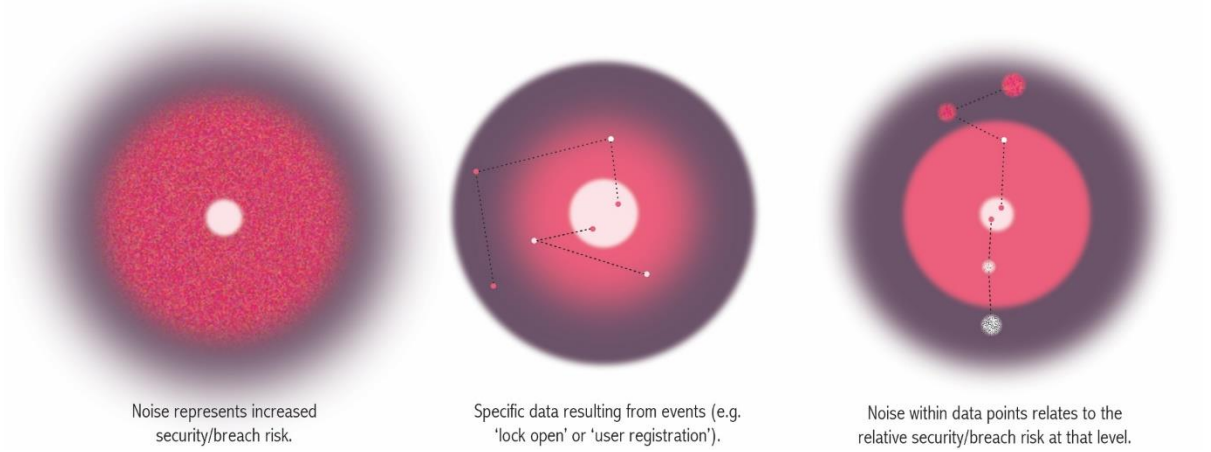


Figure 7. Prototype designs extending the core Orbit concept to communication richer information.

While this project explores how Design Fiction Carpentry is viable means to attempt to *do* OOO, it's worth noting the Orbit maps have some merit as a design proposal in their own right. If such a system were to be implemented specific areas that we identified for development include moving beyond the identifiability compromise and understanding how to augment the maps to include richer information (see figure 7), and on an operational level, understanding what background research would be necessary to create meaningfully-populated Orbits in the first place. However, these questions of implementation go beyond the scope of the academic enquiry we present here.

6 Concluding Reflections

Responding to the emerging network anxieties associated with our increasingly connected world, in this research we unpack and apply OOO in order to shed light on design's intersection with

[14] https://www.theverge.com/2017/10/25/16538834/amazon-key-in-home-delivery-unlock-door-prime-cloud-cam-smart-lock

philosophy. The case we draw is focused on the IoT's physical presence in our homes combined with its mostly-unseen data shadow, and the risks arising from how data flows, is processed, and has agency. Legislative responses such as GDPR are intended to protect citizens from these risks, and whilst contemporary scholarship has sought theories to conceptually contain these new complexities with a range of theories, including OOO, this research explores the practicalities of injecting this theory into design practice.

We are not philosophers and thus we acknowledge that this paper is built from *our interpretation* of OOO—heavily reliant on Bogost's Alien Phenomenology (2012), which itself is but a single scholar's take on a theory that is the subject of disagreement even among its proponents—and it is therefore likely other scholars' perspectives may be subtly or considerably contrast with ours! Whilst we do not argue that designers *must* incorporate theory into practice, our belief is that we've demonstrated that by recognising a synergy between the qualities *this particular theory* and the challenges we sought to address, OOO was demonstrably a generative and analytical tool to help understand the design context, and as such played a central role in both deconstructing the problem but also in assembling possible solutions.

To adeptly respond to the rafts of previously unknown technologically-driven challenges we collectively face, design's methods and metaphors need to be reimagined, invigorated and bootstrapped. Exemplified by the Orbit prototypes, this thesis is intended to be taken as an indicative example of how design researchers may dissect similar challenges, ultimately in pursuit of contemporarily-apt approaches. While the Orbits appear to be viable early design concepts, our main contribution with this work is to demonstrate how to *turn* OOO's metaphysics—to make OOO tangible through Design Fiction. Reflecting on this process it seems that OOO, performed in this way, has the potential to change the nature of the design space to which it is applied in the first place; in our case by arriving, unexpectedly, at a place where the Orbit concept emerged as a means to communicate aspects of data policies in a meaningful and potentially GDPR-compliant manner. Although extending from a relatively tightly scoped study, we suggest that to develop design methods apt for the modern world, design researchers may viably use Design Fiction as World Building to practically engage philosophies such as OOO, in the process helping to progress understanding of how design intersects with theory, as well as arriving at rewarding and useful design outcomes.

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Aestheticising Change: simulations of progress

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If, following Rancière, politics revolves around who has power to articulate 'the sensible', then designers, as aesthetic practitioners, must be caught up in questions of politics. This is particularly so when design practice becomes part of the way public sector actors negotiate, envision and catalyse change in relation to public 'problems'. However, this is also typically a form of design practice that eschews any talk of aesthetics — presenting as de-skilled, democratic and 'de-aestheticised', in a sense. By analysing and re-describing such design practice in aesthetic terms here — illustrated with an example from practice — we provide an alternative characterisation to the more instrumental account of design as a reliable route to innovation for public sector managers. This opens up a different perspective on what such practices function to achieve, and what is at stake: an effacing of the political nature of design decisions, and an obscuring of the real work of change by the seductive techniques of simulation.

design; public sector; aesthetics; politics

1 Introduction

It appears, at least according to mainstream media reports, that we are in an epic period of change. But what does all this change look like? How do we know when it is happening — and who benefits? To believe that one is experiencing change, or at the very least that change is possible, requires material evidence — to feel, see, touch and hear it. And so there is an aesthetic and material quality to change. We use the term 'aesthetic' here in its most general sense, to refer not simply to qualities of art or style (as aesthetic might often be interpreted when discussed in relation to design), but to those aspects of experience that manifest themselves to the senses, or as Rancière (2006) argues, "what presents itself to sense experience" (p.13).

Materializing change by embodying potential in artifactual form, and manipulating aesthetic experience, are defining features of design practice. Prototypes, for instance, have been called "figures of suspension and expectation" functioning as "'traps' for the emergence of compossibility" (Jiménez, 2013, p.381). They serve as provisional markers of change by way of their precarious and

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often rudimentary character. These artifacts draw upon broader narratives of change inherited by the design profession; a historicity wherein the design professional has been heralded as the creative genius from which innovation, progress and, by extension, change is realized (Sparke, 1983; Kimbell, 2011; Suchman, 2011). It is from this privileged position — designer as catalyst — that the "aesthetics of change" are monitored, curated and produced to make change knowable. These aesthetics, as we argue, have less to do with appearance and style, but instead the manner in which controversial issues are rendered sensible (knowable) for public consideration.

Our focus here is specifically on the public sector, where design is increasingly proposed and mobilised as a catalyst for change (Mager, 2011; Julier, 2017). On a global scale, there are emerging fields of design that are bound up in the shaping of government policies, strategies, services, innovation, and change. This intensification of design activity has led to new practices derived from design being gradually absorbed and normalised by non-designers within government, often under the guise of public sector innovation (Windrum and Koch, 2008), policy design (Junginger, 2017), and service design (Buchanan, Junginger and Terrey, 2017). This is evidenced in the uptake of internal design labs in public sector contexts (cf. FutureGov, 2017; Public Policy Forum, 2013), a growing field of public discourse and debate principally managed, curated and facilitated by the design industry (Julier, 2017), research into public sector design best practices (Bason, 2014), and the proliferation of consultancies that specialize in design related services for government, such as Livework in the United Kingdom and Doblin in Canada.

Theorisations of these trends, situated within broader discourses of innovation, public sector renewal, and democratic participation, follow a distinct pattern: design is positioned as a problem-solving faculty, coming to the aid of the public sector at a time of crisis. This positioning of design as a means of introducing "new ways of working" in an effort to combat "complex problems" is strengthened by actors in academia and industry who actively make the case for design intervention. The notion of a new kind of design practice thus flows through an international discursive community of designers, researchers, civil servants and others. Our project here is to question this narrative by looking at these practices from a different — aesthetic — perspective, one which exposes the political dimensions of the work, and opens up a more nuanced discussion.

We examine the field through the lens of each author's localised engagement with it — both as practitioners and researchers — in Canada and the United Kingdom. We use an example from a local government change project to shed light on a wider field of practice, and demonstrate how the design profession carefully curates narratives of change in the public sector through the aesthetic choices made in the planning, enactment, and documentation of participatory design projects. We unpack the particular aesthetic modalities of what we have seen — design presenting as de-skilled, democratised, and in some ways 'de-aestheticised' — and discuss the function this might be serving: purporting to empower the bureaucrat while enrolling them as willing participants in change programmes, and presenting design practice as rational and logical in order to avoid the risks and complications of political entanglement. Drawing upon Jacques Rancière's (2006) concept of 'distribution of the sensible', we argue that an aesthetic of 'public sector change via design' has emerged that obscures the practicalities of political change — messy, relational and often affective work — in favour of what *appears as* change: a simulation of what design purports to deliver. full paper submissions for DRS2018 will be selected through a double-blind review process conducted by an international review panel.

2 Standpoint and Methodology

We have drawn out some distinct aesthetic modalities through a socio-material reading of practice. More specifically, this analysis examines how "materials (objects, tools and infrastructures)", "competencies (knowledge and embodied skills)", and "meanings (cultural conventions, expectations, and socially shared meanings)" (Shove, Pantzar, & Watson, 2012, p. 23) are configured in specific design encounters, such as co-design workshops, to form 'proto-practices', or new ways of

working and doing in situated contexts. Design objects, interactions, and dialogue between participants become texts that can be read and interpreted discursively. Our analysis focuses on meta discourses that arise in these encounters in order to understand how they contribute to, are predicated on, and respond to discourses of public sector design and innovation.

While this analysis is illustrated with one concrete example of public sector design, it is informed by our ongoing PhD research that examines the importation of design methods, tools, and approaches to work into public and democratic contexts, drawing upon a range of case examples, interviews, participant observation, and auto-ethnographic accounts in Canada and the United Kingdom. More specifically, we examine the political implications of public sector design — the production of subjects and subjectivities — and situate this analysis within a genealogy of design: namely a practice that is born out of, contingent upon, and at times, functions in opposition to industry.

3 Aesthetics and Design

Design is an aesthetic practice: both in terms of the decisions that are made through the process of giving form to objects and images, but also in terms of the kinds of experiences that design objects afford. And yet aesthetics in the context of design has historically been confined to discussions of beauty and taste, and more specifically, how objects are crafted to appeal to the eye. These accounts rely upon a philosophical and phenomenological tradition that enquires into the essential qualities of beauty that are manifest in art and literature, or as the work of Immanuel Kant explores judgements of taste. Design objects are difficult to assess according to this aesthetic approach because unlike art, they are also concerned with questions of function; design 'objects' (as in, the productions of design) must address practical human needs if they are to be deemed useful. Thus, the aesthetic quality of design objects is as much about capacity to fulfil a particular need as it is about appearance to the eye.

Perceptions of usefulness cannot be separated from appearance, as these qualities form part of the sensuous character of a designed object. Take for instance the term 'affordance' which is used in design to describe how the performative qualities of an object are rendered sensible to end users. During the process of design, the designer attempts to identify the wishes, aims, behaviours and skills of users. These things are instantiated in material form; the resulting artifacts are inscribed with actions, protocols and instructions for future use (Akrich, 1992). A chair, for instance, with its scooped bottom and straight back suggests by its aesthetic form that it is perfectly suited to accommodate a human body while in a seated position. The aesthetic of the chair, the manner in which it presents itself as sensible to the user, "mediates and conditions experience and our basic access to experience" (Folkmann, 2013, p. 26). The demonstrable aesthetic of the object "frames" the user's experience (i.e. calling out its presence as a chair) and affording particular courses of action (i.e. to sit). Aesthetic practices, therefore, delimit our experience of the world inasmuch as our very sense of what is knowable is made possible only through ongoing material attachments. Put simply, the world may become knowable when rendered sensible through material action.

4 (Re)Distributing of the Sensible

Jacques Rancière's concept 'distribution of the sensible' is a useful starting point to consider the interplay between politics and aesthetics. As he puts it, "politics revolves around what is seen and what can be said about it, around who has the ability to see and the talent to speak, around the properties of space and the possibilities of time" (2006, p.13). If phenomena remain unknowable, that is they are not rendered in some sense-able way, then they cannot be spoken of, thought about or acted upon. Rancière argues that social order itself is established through the distribution of the sensible, which polices common sense and what becomes unquestionable within society.

Distribution of the sensible is a useful concept for examining how privileged narratives of change are articulated and circulated because it draws attention to those who have the authority to legitimize narratives. Rancière's theory of aesthetics points to the political role designers play in managing a

design process: selecting what and whom to include, or who can 'speak' within the process, deciding how the problem ought to be framed, and which issues ought to be made sensible – predominantly through form-giving. As consummate form-givers, designers, working with project stakeholders, render images of the future-in-the-present (cf. Yelavich and Caccavale, 2014), and as such, have a political stake in delimiting the terms of how change is understood, discussed and realized in the public sphere. This work is made possible by way of aesthetic practice, such as prototyping, storyboarding and role playing, that becomes material evidence of the kind of public sector change envisioned by design.

The aesthetic practices of participatory design within this setting in particular demand scrutiny: at first sight they may seem more inclusive and accessible than dominant bureaucratic aesthetic modalities, and this is ostensibly why they are employed. In which case, the question of what is included and what is left out becomes even more acute.

5 Applying the Aesthetic Lens

Gagliardi (2006) makes the case for an aesthetic reading of organisations, arguing that all organisations have an aesthetic, meaning a set of ways the organisation manifests itself to the senses. This is reflected in architecture, branding, communications materials, and other physical, sensible things that are the carriers of organisational culture more than ephemeral actions, thoughts or speeches:

> *Artifacts… are themselves ... primary cultural phenomena which influence corporate life from two distinct points of view: (a) artifacts make materially possible, help, hinder, or even prescribe organisational action; (b) more generally, artifacts influence our perception of reality, to the point of subtly shaping beliefs, norms and cultural values. (p. 706)*

This being so, the introduction and use of design practices into public sector organisations — which in general serve to introduce new and different artifacts — can be seen as an intervention in organisational culture and politics via a kind of aesthetic interference.

It seems, however, dominant design research and practice cultures are far from recognising this aspect of their own operations. Tonkinwise (2011) documents a concerted effort in "Design Thinking" to downplay the role of aesthetic judgment. He attributes this resistance to the perceived subjectivity of aesthetics: the managerial class considers aesthetics as "inherently subjective and/or cultural" and thus "foreground interpersonal politics" (p.536). Read historically, these actions sit within a broader history of consultant design which has tended toward a modernist ethic that eschews decoration and style for form and function: positioning design as a repeatable (rational) process for problem-solving, 'design as science' as opposed to 'design as art'. This derives from a widespread reliance on Herbert Simon's treatise as a means of legitimising both design research and practice, but this is not unproblematic, as Huppatz (2015) points out, "Much contemporary design research, in its pursuit of academic respectability, remains aligned to Simon's broader project, particularly in its definition of design as "scientific" problem solving" (p.29).

As Tonkinwise concludes, "this risks concealing the way in which designing is the designing in, with and of styles; styles that make possible existing and new forms of social practices" (p. 543). The emphasis on rational process (rather than subjective form-giving) has produced a distinctive visual language, intended to emphasize neoliberal value creation, creative know-how, and entrepreneurial optimism (Julier, 2017, p145). Journey maps, process diagrams, sticky notes: each of these artifacts, through their associations and affordances, dispel the notion of design as an expert practice of object-styling. Insistence that design thinking reject style, a kind of anti-aestheticisation, is predicated on a series of aesthetic judgments intended to improve the allure of design, not as subjective cultural product, but as change process, equally applicable in a variety of contexts,

including the public sector. This is not an absence of aesthetics, it is a new and pervasive aesthetic idiom that requires critique.

6 Designing Approaches to Homelessness Prevention in the UK

To illustrate our analysis, we have selected an example of design practice deployed as public-sector change process — a project for the housing department of a UK local authority — which exhibits some of the typical aesthetic modalities in operation, and illustrates how design practice serves to render political issues sensible, or not, through careful aesthetic choices.

6.1 The Brief

The local authority in question commissioned a design consultancy (for whom one author was working) to help develop a homelessness prevention programme. This was to include early detection of those likely to be at risk of homelessness, early intervention and prevention strategies, and a culture change programme to support staff to transition to new ways of working. The brief was open-ended; the agency was simply asked to help the local authority work up a general strategy to be delivered over the following two years.

6.2 The Design Response

Working closely with managers in the housing service, and holding weekly workshops and conversations with the wider housing staff, the design team planned a three-month period of intense design work, following the double diamond process model (British Design Council, 2015). In *discovery*, a homelessness prevention map and a set of personas was created with housing staff and using housing data, which sketched out a typology of people in different risk categories — 'not at risk', 'at risk', and 'in crisis' — and the 'triggers' and 'resilience factors' that might tip people one way or the other.

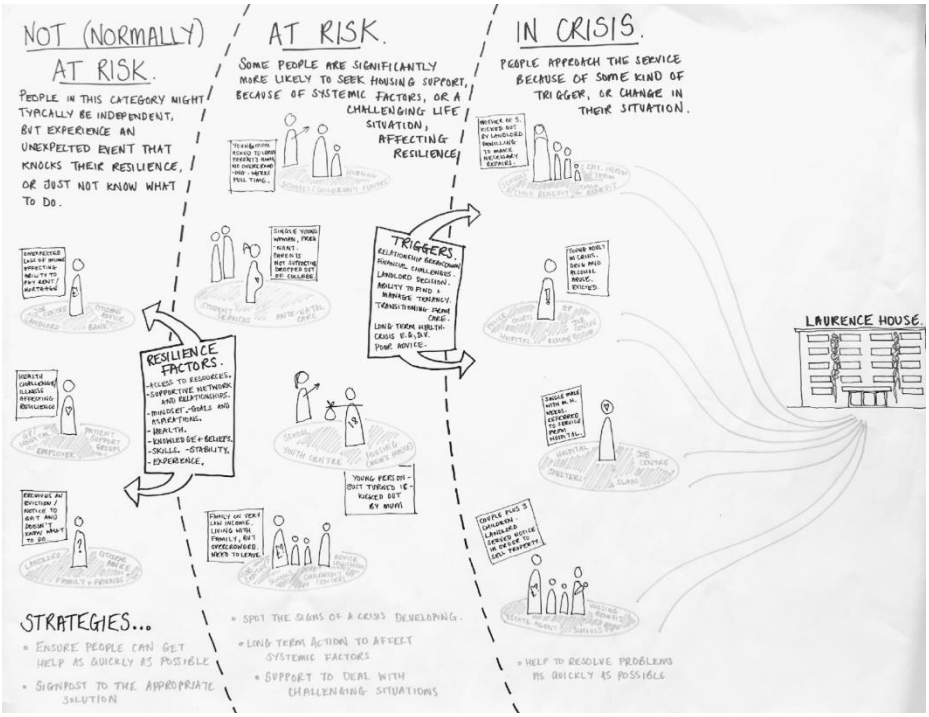

Figure 1: mapping people at risk of homelessness

In *define*, the project board (a mixture of team leaders across different parts of the housing service) used the persona stories to identify opportunities to intervene earlier in the journey towards homelessness — in some cases much earlier, for example in childhood. These were then regrouped into an 'opportunities matrix'.

Long term strategies	Medium term strategies	At the front door strategies
Affecting the supply of affordable housing		
Managing difficult situations		
Shifting perceptions and expectations		
Equipping people to be independent		
	Identifying problems before they become a crisis	
	Making it easier for people to solve their own problems	
		Quick resolutions in a crisis

Figure 2: the prevention opportunities matrix (high level)

In *develop*, housing staff attended an ideas workshop, in which they were guided through collaborative creative activities and brainstormed new ways of responding to some of the opportunities.

Figure 3: the ideas workshop with council staff

In *deliver*, some prevention ideas were selected, developed, visualised, and in one case actively prototyped: housing staff role played, and then live-tested, a new way of having more 'empathic and collaborative' conversations with clients. The agency then produced a report summarising the overall strategy, identifying key changes that would support the organisational shift to prevention, and making recommendations around culture change.

7 Analysis

This example serves as a helpful reference point to discuss the aesthetic modalities at play in this design-led approach to envisioning change, where design is emphasised as process (the double diamond) and method (workshops and design activities) as much as outcome. Beyond the general observation that this kind of practice marks a distinct break or departure in aesthetic terms from 'normal' civil service practice — a symbolic aesthetic disruption — we have identified some recurring aesthetic features of the idiom, which set it apart from other design idioms, and which we have articulated as 'temporality', 'playfulness', and 'provisionality'.

7.1 Temporality

Time is a pronounced feature of public sector design practice: both in terms of the pace and structuring of work, and as part of the material of design.

Speed seems to be essential to the narrative around how to do this kind of design. It is reflected in the nomenclature — 'rapid' prototyping, lateral thinking 'sprints', hackdays and 'jams' — and infused into practice — starting, stopping and developing ideas quickly in workshops; producing design 'things' and project outputs within short spaces of time; doing rather than debating. This is perhaps the colonising influence of Silicon Valley-style working practices: 'lean', 'agile', etc. (Avle, Lindtner and Williams, 2017), where pace has come to be synonymous with creativity, but it also plays into a sense of urgency in the (currently austerity-riven UK) public sector about delivering innovation and ultimately savings. In contrast to the supposed inertia of the bureaucratic machine, design proposes itself as a light-footed and entrepreneurial catalyst of change. The aesthetic communicates the value of trying things out and 'failing fast', and demonstrates that moving at pace is possible.

Time is also the material we are working with, brought into view as a dimension of reality through (for example) constructing an individual's life history and projecting forward, developing service propositions as narratives that unfold over time, stripping away the messy non-linear complexity of life to highlight certain 'key' moments or issues in a trajectory. As a practice it introduces speculation as a valid form of data-gathering, thus proposing to make the future sense-able, knowable — and therefore manageable. It serves to bring subjects and their (past, present or future) capacities into range, manipulable as the material of public sector change.

7.2 Playfulness

Play is implied through both activities and materials. Light-hearted 'warm-ups' begin the process of aesthetic disruption through physically mixing people, or inviting different modes of expression. Idea generation activities are deliberately far-fetched, asking people to imagine 'what would happen if …?', and to push beyond the bounds of normality. Workshops loosely follow the structure of a game or competition — there are rules and guidelines, permitted and non-permitted behaviours, silliness and laughter. The materials of the craft invite play in various ways: some are deliberately reminiscent of childhood (pipe cleaners, coloured card, balloons, Play-Doh, etc.); some suggest neutrality and universality — post-it notes, sharpies, newsprint — and downplay the need for draughtsmanship or skill; others suggest disposability and impermanence.

All of this playfulness performs multiple functions: it invites participation and lowers the barriers to action, symbolises a break from business as usual, permits creative thinking, engenders collaboration, and (hopefully) elicits goodwill from participants.

7.3 Provisionality

Provisionality is inherent to design process, and is perhaps the biggest point of difference when contrasted to 'normal' civil service practices as we have observed it through our ongoing research in this area. Provisionality is communicated both explicitly as part of the method: building iteration into the project plan, or holding a 'prototyping' phase. It is infused into micro-practices: the nature and quality of materials as noted above; constant representation and re-representation, making ideas

sensible for dialogic purposes; leaving things on the walls and building up layers of work; working interactively, visibly taking and incorporating feedback. It is also produced and communicated through the performance of (co-)design practices: symbolically breaking away from traditional meeting formats, literally changing the layout of tables and chairs, sticking things to the walls, and creating a sense of creative clutter. All of this affords the possibility to re-distribute the sensible, or at the very least to temporarily rescript these environments as venues to intervene and disrupt how one *ought* to behave when in a public sector organisation.

Provisionality serves multiple ends. This work privileges material practice as a mode of expression that gives provisional ideas a form other than words, spreadsheets, and powerpoint slides; in other words, it makes change sensible in different ways. Provisionality is dialogic: it allows ideas to emerge and evolve. And it is persuasive. Unfinished design objects can hold great rhetorical power. In the homelessness example, acts of representation — perhaps because of their clarity of communication — gave confidence and certainty to the client. What the design team experienced as subjective, sometimes arbitrary, and often simply expedient decisions, took on a life and rationale of their own: as one option is made sensible, all other past potential options fade from view.

8 Discussion

Design practice cannot escape its aesthetic modalities, and an aesthetic reading of practice, such as we have attempted here, serves to demonstrate what is made knowable, what can be discussed and what can be acted upon within the scope of the design process; and also, we argue, what design, performatively, is functioning to do. Design activities *police* the nature and quality of action that is directed towards "changing existing situations into preferred ones" (Simon, 1996, p.111); they determine how, who and by what means change is to be realized.

We have proposed three dominant aesthetic modalities to this new design idiom, and noted some common aesthetic markers. What is clear here is a kind of de-emphasizing of style and expertise. The sheen, degree of polish and state of completion of the objects is replaced with another aesthetic that implies creativity and inclusivity. In what follows we speculate on the function this might be serving.

8.1 (dis)Empowering Bureaucracy

These practices are symbolically different to 'business as usual' — a way of performing the work of change that differs in pace, tone, detail, etc., and also functions as a visible marker of inclusivity and organisational willingness to innovate. They promise to empower the apolitical bureaucrat with a neutral and logical set of tools for innovation, with foresight, and insight into the subjective selves of citizens. Creativity is democratised — evident in the particular kind of naive design language (the opposite of, for example, an architect's drawing) that plays down the idea of expertise. The aesthetic suggests that anyone can (and should) do it. Or can they? In the homelessness example, despite performances of collective creativity, the ensuing ideas were not wildly different from the existing range of services, and had to be covertly supplemented by the design team. There's a sort of skill-less design going on, where the ideas of the non-designers are overtly privileged, as though the appearance of a collaborative process, the democratisation of creativity, is more valuable than the actual ideas.

This begs the question of whether it is empowerment or distraction, innovation or anti-invention, grappling with politics or effacing them. In a time of political dysfunctionality, do we need more or less investment in the refinement of expertises of bureaucracy? As Di Salvo (2010) notes, "diverting attention away from the political by a focus on politics, i.e., a focus on the improving the mechanisms of governance, can endanger the practice of democracy because it draws us away from engaging in the contestation necessary for democracy" (p. 3).

8.2 Consensus, Dissensus and Issue-Framing

Provisionality and playfulness grants permission — to have unfinished ideas, to explore concepts that can be discarded, to 'try things out' — and thereby signifies the opening up of a space of potential contestation and agonism. However, in practice, there are limits drawn around the allowable forms of dissensus. These design practices "overwhelmingly gather at that end of the spectrum governed by the principle of consensus" (Di Salvo, 2010, p.1): they do not have forms for dealing with disagreement, dissent, and polemic. Issues that sit outside the problem framing are 'parked' rather than wrangled with. In keeping with 'managerial' styles of government that seek to achieve consensus through promotional rather than political tactics, these aesthetic modes tend to neutralise resistance (Fairclough 2000).

In the homelessness example, often throughout the project, but particularly acutely within the ideas workshop, certain problems were raised that were deemed 'out of scope'. In particular, the housing staff were quite united in their view that the causes of homelessness were political and structural, and therefore far beyond their remit to effect change: "It's not a local government problem — it's central government". There was always some discussion about this fundamental contradiction at the heart of the project (in their view) — sometimes this coalesced into unsanctioned discussion outside of the main agenda, and sometimes it came out through the more imaginative and playful activities that encouraged them to express their wildest hopes and ideas for change. But in later stages these ideas were easily weeded out as impractical, and thus remained, ultimately, unrepresented. In determinedly solution-seeking within the local authority remit, solutions have predictably been found, and they operate either on the machinery of local government, or the psychology and behavior of individuals. Ideas that address national politics, macro-economic conditions, and wider social norms, are absent. But the tactics and forms of design as deployed here have helped enroll staff as willing participants in this approved programme of change.

8.3 Simulation and Change

Simulation can be a useful and compelling step on the path to change. In our example, the act of role playing the new conversation held enough rhetorical power to spark action. A trial period of holding conversations with clients differently is underway, staff by their own admission have started seeing homelessness as one among many issues they might help with, and are experimenting with how they perform their roles and work.

The design objects (prototypes) produced here were simulacra of new situations, rather than the change itself. This is not a criticism of design — it is what design does. But there is a risk of misrepresentation — or misperception — of how much is actually being achieved in the design process. The sense of potential change afforded is powerful and attractive in the context of contemporary bureaucracy where public servants are frustrated and keen to find ways to empower themselves to create change. It is also attractive in the context of difficult public issues because it radically simplifies — reducing the challenge to a cluster of post-it notes or a tantalisingly clear service journey. People leave workshops with a sense of satisfaction. Something has been made. An idea has been realised; but only in the temporary reality of the workshop. There is a kind of virtualism to it: a prototype seems closer to a new situation than, for example, a white paper, even though it is not — and in some cases it might even hold less authority in legal terms.

Unlike other design fields, there is no clear account here of the journey from design to delivery — from prototype to real change. In this way, this aesthetic of change risks obscuring the practicalities of the messy, relational and often affective work that is required.

9 Conclusion

If the dominant discourse around current emerging trends such as 'design for government/ public services/ policy' makes the case for such practice on the basis of increasing certainty about reaching the 'right' answer through a logical process (risk management around innovation and change), what

we are drawing attention to here is an alternative characterisation of what design does and what it produces. Its particular aesthetic idiom promotes design as a desirable, neutral and inclusive set of practices, in a way that masks the other things it might be functioning to do: dismantling resistance and enrolling subjects, and — through the seductiveness of design objects and practices, the clarity of the simulation — obscuring the political realities of change in government, or indeed the messy reality of governed subjects. As designers, the de-aestheticisation helpfully allows us to pass ourselves off as rational modernists, thus avoiding the need for political entanglement. But imagining or simulating the change will not do the hard work of making it happen, and it must not be taken as such. Taking a design approach to public sector change processes — instead of providing a straightforward path to an inevitable answer (as it might be marketed) — requires design practitioners, and those working with them through a design process, to make constant decisions, judgements, choices etc. about what, exactly, is made 'sensible', and how. Far from being neutral and rational, design practice is subjective and political--and must be so.

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Using the Product Impact Tool for Prospective Thinking

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The ever-rising role of products and technologies in humans' lives is increasing the call for ways to understand and investigate their influences, in the form of prospective analytical methods. This paper proposes one such method, based upon the Product Impact Tool. This Tool was developed to combine both philosophy of technology and design for usability perspectives. Its effects offer potential for prospective and reflective purposes, and can be used to investigate and structure ideas about the impacts of both current and future technologies. The proposed method offers an addition to existing tools within the field of prospective analysis. This added value is demonstrated through a case study of a concept for future personal transport. Through this case study, it is shown that the proposed method can help uncover information that remained hidden by conventional approaches, by inducing a critical investigation of the subject from multiple perspectives. Such information will aid analysts and strategists in their work, leading to more effective, desirable, and responsible technologies being developed and implemented.

product impact tool; prospective thinking; future planning; strategy development

1 Introduction

The role of technology has become ever more important in the daily lives of humans. The products that they use change who they are and what they do. This prominence brings with it a need for analytical methods to investigate and discuss the potential impact of future developments. Current methods for analysis and strategic development of new technologies mainly focus on economic and logistical aspects, like price and roadmapping. However, they often do not take into account aspects like societal impact and human-technology relations (Raub, 2017). This represents an opportunity for the development of investigation methods that do look at new technologies from this perspective. One means for such a method can be found in the Product Impact Tool (PIT) (Dorrestijn, 2012). This paper will propose and discuss an analytical method of using the PIT to study future innovations, in an effort to aid analysts and strategists in their work.

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In the first section, the PIT itself will be discussed. The focus will lie on both the prospective and reflective capabilities of the PIT's four quadrants. This section will also examine the potential for extending the PIT's scope beyond specific and material products, towards also more abstract concepts like (innovation) strategies.

The second section will present the proposed analytical method of using the PIT. Both this method and the PIT in itself are compared to existing strategic approaches, in order to discern its place within and relation to the field of prospective analysis.

The third section describes a case study, where the proposed method is applied to a concept for future personal transport by the Dutch Study Centre for Technology Trends (STT). The concept proposes a system wherein autonomous vehicles become a rentable service, that fulfils people's everyday needs for transportation. This system is analysed with the PIT, to investigate its impact on its users and on society as a whole. In doing so, it can be shown what added value both the PIT and the proposed method can bring to the field of prospective thinking.

2 Product Impact Tool

The PIT, as developed and refined by Dorrestijn (2012), consists of four 'quadrants', each containing three 'effects' (figure 1). The twelve effects together aim to represent the ways in which products and technologies impact the lives of individuals, as well as society as a whole. These effects originate from the fields of philosophy of technology and design for usability. The PIT is meant to induce reflection on the way technology influences humans. Descriptions of each of the effects can be found on the PIT's website (Dorrestijn, 2016). In the following, each of the PIT's quadrants and effects will be shortly discussed on their potential for reflective and prospective thinking. For the purposes of this paper, the most recent iteration as of writing will be used (Dorrestijn, 2017).

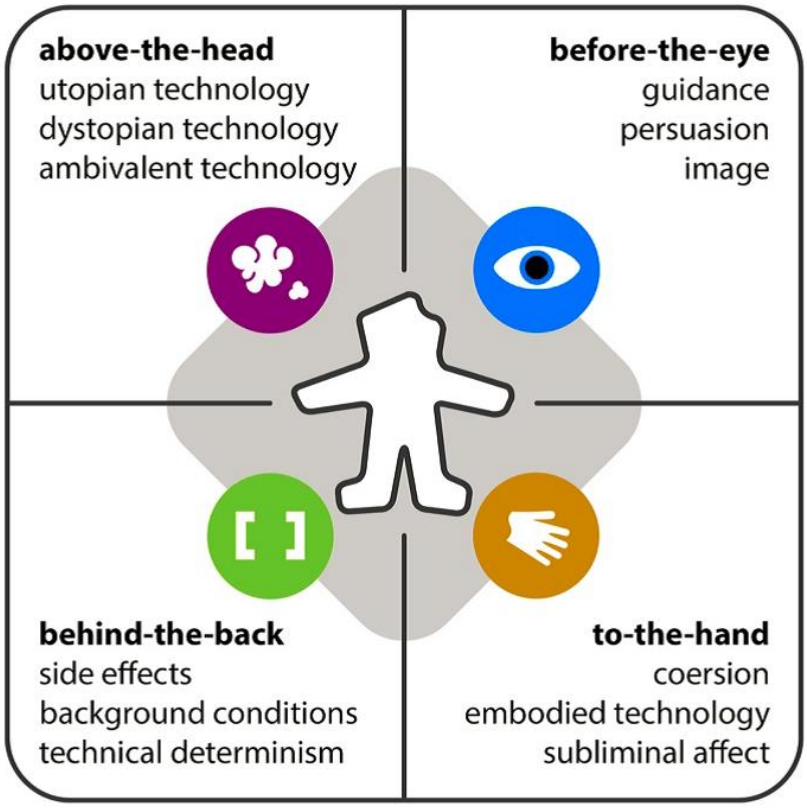

Figure 1 Product Impact Tool (Dorrestijn, 2016; http://stevendorrestijn.nl/tool/)

2.1 Before the eye

The before-the-eye quadrant details the ways in which technology influences the cognitive systems, often making use of humans' senses. Through this direction, products impact the decision-making process, by providing information and ideas to their user, while still offering them a free choice. This can for example be seen in the usage cues of products, like how the user interface of a washing machine communicates to the user what each of its settings means and does.

The effects in the quadrant can be used early on in the design process, to consciously plan the message that a product communicates, and how it wants its user to act, and align this with the design intentions. For a more reflective purpose, they can be used near the end of the design process to study the contents and quality of a product's communications and cues, so that they can be evaluated for their desirability, and thereby also provide information for potential redesigns.

2.2 To the hand

In the to-the-hand quadrant, the influences work directly on the user, skipping over the decision-making process. These effects need not always be physical to function as described. It looks at the ways that both users' actions and their routines can be restricted or changed. The effects are visible in for example the safety caps that are put on containers of medical and chemical products, or how supermarkets often use the smell of freshly baked goods to entice customers and make them feel comfortable in a subliminal manner that overrules the customer's conscious decision-making process.

The effects in this quadrant can be consciously added early on in a design process, in order to improve for example safety and effectiveness. As a reflective measure, it is viable to look at the direct influences that are present in a designed product, evaluating whether they are desirable and effective, and whether users will be willing to accept them.

2.3 Behind the back

The effects in the behind-the-back quadrant are more indirect in the impacts they represent than the other quadrants. These effects relate to the environment surrounding the technologies, and how technologies and the environment influence each other. For example, the introduction of mobile phones has had the side effect that humans now feel a need to always be available and in contact with others, and has moreover lead to a need for strong ICT infrastructure. These effects are difficult to consciously apply when designing a new technology, but should nonetheless be studied to minimize potential negative consequences or product failure.

During development of a new product, knowledge of potential consequences and conditions can be useful to ensure successful and desirable implementation. It can also serve as a reflective means, to look at the societal effects that an existing product has had, and what environmental factors played a role.

2.4 Above the head

The above-the-head quadrant focusses less on specific effects, and rather on general views on the role of technology in society. It is mainly meant for ethical reflection and discussion. These reflections can be used in a development process to think about how users may react to the introduction of the product that is being designed. It also forces one to look from a perspective that may differ from one's own, thereby potentially finding out new ideas. For a historical example, the deployment of the atom bomb near the end of World War II can be seen as a sort of turning point, that changed the widespread societal perception of technology from a utopian to a dystopian view.

When designing a new product, it can help to try to look at it from different angles, to more clearly see how it can change society overall in either positive or negative ways. Similarly, it can prove useful to also reflectively subject existing products and technologies to these perspectives, to potentially learn how negative consequences can be avoided in the future, while ensuring that the desirable ones will still be maintained.

2.5 Scope of the Tool

Up until now the PIT has mainly been used as a framework for product designers, with the goal of better products being designed that can lead to a more desirable future (Dorrestijn & Eggink, 2014). This scope can be extended further, to also be used for more abstract concepts, like innovations, strategies, and corporate identities. Strategic development carries with it a relation with society, much like product design does, with decisions that are made having an impact. The PIT could serve as an aid in this field, providing insight into the different relationships that are present. The strategists will be able to affect society in a more conscious and responsible manner. As such, more effective strategies can be developed that serve more desirable goals.

2.6 Proposed method

The PIT can be used as an analytical method in itself, to analyse (future) innovations and policies. Using its model's effects as a sort of checklist, different aspects of a particular subject can be listed and discussed. By analysing the chosen subject based on each of the PIT's twelve effects, one is forced to take a critical stance and to see things from more perspectives (Raub, 2017). The method is meant to be used by for example designers or strategists, in the form of workshops wherein the impact of a new idea is analysed. Diagrams can be used to complement the analysis with visual data (figure 2).

3 Comparison with existing tools

To gain insight into how this method relates to the larger field of prospective analysis, it has proven useful to compare it with existing analytical means. Within the field of prospective and strategic development, different tools exist. The choice was made to distinguish two types, namely between corporate- and innovation-oriented perspectives. For each of these perspectives, different tools exist. In the following, a selection of existing tools is discussed and compared for their relation to the PIT and the proposed analytical method. The selection was made based on prevalence within the field and literature (cf. Glaister & Falshaw, 1999; Johnson, Scholes, & Whittington, 2008).

3.1 Corporate-oriented tools

SWOT-analysis

SWOT-analysis serves as a strategic planning tool for businesses and organisations to analyse their position in the market, based on the four areas of Strengths, Weaknesses, Opportunities, and Threats (Osita, Onyebuchi, & Justina, 2014). SWOT largely focusses on investigating and structuring the results of a particular technology or policy, rather than looking at the particular explanations for those results. This relation to consequences of particular developments shows a kinship with the 'behind-the-back' quadrant of the PIT, specifically with the effect of 'side effects'. The PIT can add more user-interaction and societally related factors to SWOT's mainly economic and market-position focussed features. From this perspective, the right-hand side of the PIT's model (before-the-eye and to-the-hand) looks at factors mainly internally to the company, relating to SWOT's Strengths and Weaknesses, while the left-hand side (above-the-head and behind-the-back) looks at external factors, which in turn show similarities to the Opportunities and Threats of SWOT. The PIT can in this way supplement SWOT's information output.

Five Forces Model

The Five Forces Model of Michael Porter uses five dimensions that show the inherent potential for growth and profit in a particular market sector, and that need to be kept in mind by companies in order to successfully defend their position: the threat of potential entrants; the threat of substitute products; the bargaining power of suppliers; the bargaining power of buyers; and the rivalry among existing firms (Porter M. E., 1980, pp. 3-33).

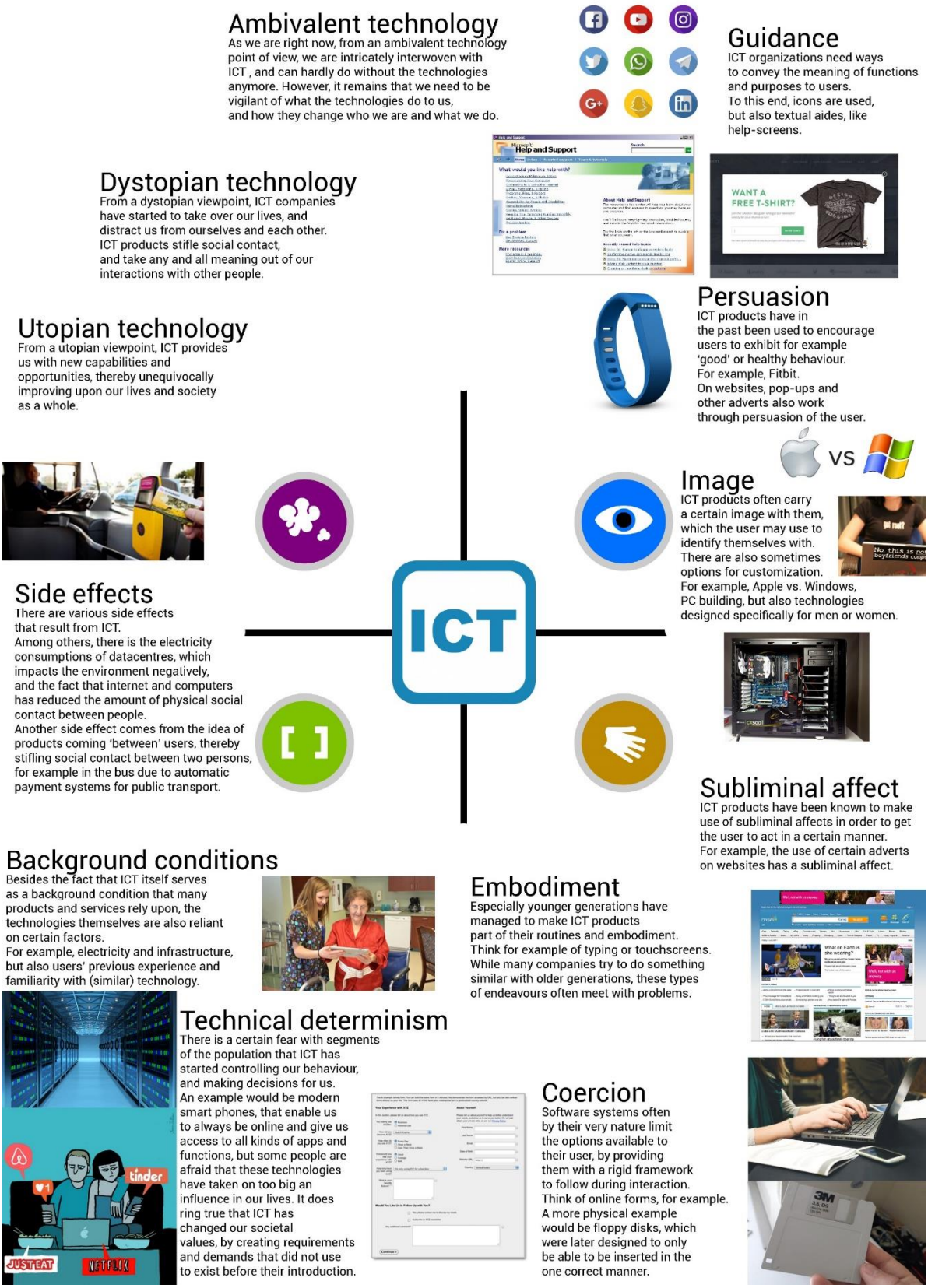

Figure 2 Example diagram of PIT, based on the sector of ICT Companies (Raub, 2017)

Porter's framework concerns itself with fairly abstract, business-focussed concepts, meaning less attention is given to the specific impact that a particular strategy or product can have in society. However, the Five Forces Model does relate to the 'background conditions' effect in 'behind-the-

back', as it looks at how external factors influence a proposed project. The two models handle these kinds of themes differently, with Five Forces taking a business-oriented approach, whereas the PIT looks more at societal and technological factors. Usage of both tools therefore can provide strategists and analysts with two important perspectives on which environmental factors may play a role.

PEST-analysis

PEST-analysis serves as a framework for analysing environmental market-factors, clustered in Politics, Economics, Social circumstances, and Technological developments, and for each of these factors, separate influences can be listed to provide an image of the industry being worked on (Johnson, Scholes, & Whittington, 2008, pp. 55-57). Comparison with the PIT shows a certain amount of overlap between PEST's focus on environmental factors and the PIT's 'behind-the-back' quadrant, particularly the effect of 'background conditions'. This can for example be seen in the model of ICT companies (figure 2), where it mentions the technologies' reliance on not only infrastructure but also users' familiarity with technology. Both tools aim to analyse the role of influences in the environment on a product, service, or organisation. The PIT however adds one extra dimension to the discussion, mainly through the 'technical determinism' effect. This effect signifies how society not only influences (technological) developments, but that the reverse also happens, with said developments impacting and changing society. In this way, the PIT adds a new perspective to the conventional PEST-framework.

3.2 Innovation-oriented tools

Technology assessment

Technology assessment encompasses the practice of analysing the societal impact of new technologies, and is a tool for advising political changes and decisions by anticipating positive and negative consequences of future developments (Porter A. L., 1995, p. 136; Van Est & Brom, 2012). Both technology assessment and the PIT wish to investigate the potential consequences that may occur as a result of a particular technology being implemented in society. For the latter, this is most apparent in the 'behind-the-back' quadrant's effect of 'side effects'. For both methodologies, awareness of these impacts and consequences is meant to ensure that they are used in societally beneficial ways. The PIT can aid in technology assessment practices by structuring the different factors that play a role, with possible (moral) issues being shown in 'behind-the-back', whereas 'above-the-head' shows potential directions in which a particular technology can take society. The model for ICT companies (figure 2) for example discusses how technologies can come 'between users', stifling interactions. Meanwhile, the 'before-the-eye' and 'to-the-hand' quadrants show the available means to 'steer' a particular innovation in such a way that beneficial effects are ensured and negative ones are avoided as much as possible.

Scenario planning

Scenario planning makes use of short narratives to analyse potential future situations that may come as a result of certain decisions and developments, helping analysts to consider and prepare for futures that are not readily apparent and may be overlooked (Schoemaker, 1995; Eggink, Reinders, & Van der Meulen, 2009). As has already been investigated by Dorrestijn, Van der Voort, and Verbeek (2014), there are certain ways in which scenario planning can be combined with and improved by the PIT. Overlap can mainly be seen in the left side of the PIT's model, in the quadrants 'behind-the-back' and 'above-the-head'. Within the proposed analytical method, the 'above-the-head' quadrant is used to present three scenarios of possible future states surrounding a particular development, as can for example be seen in the model of ICT companies (figure 2). Meanwhile, the findings listed in the 'behind-the-back' quadrant show the environmental factors and impacts that could potentially lead to those futures. In these ways, the PIT can be used to both create and improve scenarios, by raising understanding of the role of potential technologies in society.

Technology roadmapping

A technology roadmap presents a plan or strategy for how a particular new technology or product can be developed and implemented in society, meant to be made in cooperation with as many relevant stakeholders as possible (International Energy Agency (IEA), 2014). The technology roadmapping process starts with an analytical phase, in which the PIT can prove useful. During this phase, different environmental factors that play a role are investigated, showing a relation to the effects in the 'behind-the-back' quadrant, particularly 'background conditions'. By understanding the factors that a particular new concept relies on, and the potential impact that it can have, it becomes easier to determine a desirable means of implementation. Moreover, the 'above-the-head' quadrant, through the potential futures that it presents, can provide information applicable for the 'envisioning' stage of the roadmapping process. Lastly, the PIT could be used as part of workshops with stakeholders.

Technology forecasting

Technology forecasting concerns itself with anticipating and understanding future technological changes and innovations, looking also at potential (social) impacts that may come as a result of a particular technology's introduction (Firat, Woon, & Madnick, 2008). Technology forecasting uses various different tools in its pursuit of predicting future changes and impacts. Most of these take an economic or statistical approach. The PIT could be used to also add a philosophically and ethically oriented perspective that is not yet present. Looking at both desirable and undesirable consequences that may occur as a result of a particular technology's introduction can help when forecasting what possible futures said technology can lead to. The interaction-oriented effects in the 'before-the-eye' and 'to-the-hand' quadrants can help to show how an innovations effects can to an extent be 'steered' so that more desirable results are achieved. In these ways, the PIT can offer a valuable addition for the practice of technology forecasting.

Technological innovation systems

The approach of technological innovation systems seeks to analyse technological change by looking at the broader social structures that connect different companies and organisations, and how these institutions impact a particular technology or technological field (Suurs, 2009). Inherent to the technological innovation system is the idea that social structures influence and impact technologies. This shows overlap with the views of the PIT, most noticeably in the 'behind-the-back' quadrant. In this regard, the PIT however also adds the perspective of technology's vice versa influence on society. The PIT and proposed methodology can structure those ideas that are relevant when studying the innovation system of a particular technology, while also adding this aforementioned perspective of the overall interdependency of technology and society.

Technology acceptance model

The technology acceptance model provides different factors that play a role in whether a user will want to use a particular product, and how they will use it, mainly focussing on the two factors of 'perceived usefulness' and 'perceived ease of use' (Davis, 1989; Venkatesh & Davis, 2000). The technology acceptance model's focus on particularly the 'perceived' usefulness and usability can clearly be related to the PIT's 'before-the-eye' and to a somewhat lesser extent 'to-the-hand' quadrants. Study of these specific fields during analysis with the PIT can thus provide useful insights when determining whether a user will be willing to 'accept' a particular new product or technology. Moreover, the scope can be extended to not only look at whether users will accept a particular technology, but also to investigate whether said technology will be accepted by society overall according to its values. In this manner, the PIT can provide additional insights that further analyses using the technology acceptance model can benefit from.

3.3 Summary of results

It can be seen that the PIT can serve as a useful addition for the field of future planning and prospective analysis. In the investigations of the different existing methods, no explicitly notable

difference in potential was found between the two categories of corporate- and innovation-oriented tools. By looking at societal impact and human-technology relations, the PIT adds new perspectives and dimensions to the perspectives by the existing methodologies. Conversely, current methodologies also provided information that could serve as effective input for analyses that use the proposed analytical method of the PIT. In this way, the PIT and existing methods and models can complement and benefit from each other, leading to more useful information being found. It is expected that the knowledge garnered in this manner will in turn prove valuable when planning the implementation of new strategies or innovations, by allowing those responsible to do so in an effective, desirable, and responsible manner.

4 Case study of future transport

A case study will be presented to illustrate how the PIT can be used to analyse current and future concepts. Doing so can further demonstrate the added value that the PIT and the proposed methodology can offer to the field. While both corporate- and innovation-oriented subjects showed potential, the choice was made here to focus on an innovation-oriented subject. To this end, the following will first present a concept for future personal transportation, originally developed by the Dutch Study Centre for Technology Trends (STT), which will then be analysed using the PIT. STT serves as an institute that explores potential future concepts and scenarios surrounding innovative technologies, while also posing challenges and risks. Their approach can broadly be described as technology forecasting, to the end of which workshops are used with relevant stakeholders, as well as for example students, combined with desk research and interviews. For illustrative purposes, they also make use of scenarios. For the theme of future personal transportation, STT presents three concepts (Van Voorst tot Voorst & Hoogerwerf, 2014). While each of these have been analysed (Raub, 2017), the following will only present the analysis of one concept. In their report of the concept, STT themselves also offer an analysis of the potential impact (Van Voorst tot Voorst & Hoogerwerf, 2014, pp. 19-24), thereby offering a good point of comparison for the results that were found with the PIT.

4.1 STT's concept: Transportation on Demand

In the proposed concept, in the year 2040, personal transportation will largely take place using autonomously driving cars. Moreover, people will no longer own their own vehicles, because these cars will be rentable on demand. The concept includes a so-called 'digital journey assistant', which will be used to operate the rental system. The expected form of this 'assistant' is a smartphone app. Shorter distance transport would be taken care of by individual vehicles, which will also be able to transport passengers to 'transport hubs', where the passengers can change over to other forms of travel, like train or plane, for longer distance travel. After transport, the vehicles can find a parking spot and charging station by themselves, where they will wait until they are needed again. The concept envisions that these services will be provided by not only conventional automotive

In the following, this concept will be analysed using the PIT. The analysis was performed by the authors themselves. For each of the PIT's twelve effects, ideas were generated for the potential impact that this concept will have. These ideas will be further explained in the text. A visual diagram was made to summarise the findings (figure 3).

Dystopian technology

The concept of transport on demand will make humans more isolated, as they are driven around in their personal self-driving cocoons, disconnected from the world outside and from each other.
Especially the elderly will lose all contact with others, as they are constantly alone in their autonomous cars.
Brands will take control of people's lives, deciding over when, where, and how they will travel.
The newly added free time will lead to humans losing their sense of purpose, becoming bored and depressed.

Utopian technology

Transport on demand will allow people to travel more easily, and more often.
Both long and short distance travel will be made available for everyone, including those who currently cannot drive a car.
Travelling will become more enjoyable, and provide people with more time for leisure, as the burden of driving is taken off of their shoulders.

Guidance

The concept's 'digital journey assistant' will be a main form of guidance through information.
The user will need to know how and when they reach their goal.
The cars themselves will also need to make use of guidance and cues, to communicate not only with their passengers, but also with the people around the vehicles, using for example lights and sounds.

Persuasion

The service providers and owners of the different 'digital journey assistant' apps will want to persuade consumers towards using their particular products and services.
To this end, they can make use of adverts and special offers.
Persuasion will also need to used to lead users around the vehicles towards correct and safe behaviour.

Ambivalent technology

Society will need to understand that transport on demand may sound very convenient, but it also comes with certain risks and caveats.
It should be made sure that people, especially elderly, are not always travelling alone, and rather using their new free time in the car to connect with the people and the world outside.
The cars themselves should be designed in such a way as to allow passengers to spend their new free time in a valuable and worthwhile way.

Side effects

A first possible side effect of the concept is that certain jobs will become redundant.
Further, due to the large variety of service providers, not all systems will connect perfectly, meaning users will still have to experience wait times between transport.
There are also risks involved with putting citizens who are unfit to drive in a position where they may can or have to intervene with the cars' actions, leading to potential accidents.
There is also the question of what people will do with their newly gained free time, as boredom can potentially lead them towards undesirable behaviour or depression.

Transportation On Demand

Image

The new autonomous cars will be provided by different lifestyle brands.
Each seperate brand will bring with it a particular kind of image.
The choice in different brands can allow users to choose the image that best fits them, in regards to both their needs, but also their lifestyle.

Embodiment

The process of ordering a vehicle, sitting down in it, and then being brought to one's desination is meant to merge with its user's daily routines.
To do this, the service will need to be easily accessible, so that the activity can after some uses become natural.
After this, the user will more instinctively choose to use the services, whenever they need to travel somewhere.

Coercion

Once in the car, the vehicle will start driving on its own, following a pre-planned route, which allows little freedom of choice for users.
While it is moving, the passenger is confined in the car's interior, waiting until they reach their goal.
In these ways, the proposed concept limits the user's options and actions.

Background conditions

The proposed concept will require new laws and regulations, to allow the cars on the public roads.
Regulations are also needed regarding insurance.
Both users and other stakeholders in the traffic system would need to accept the new vehicles.
Travellers will need to trust the service providers, as well as the providers trusting each other, for example when it comes to exchanging of data.
There will also be a need for a reliable and robust ICT infrastructure to let the cars function.

Technical determinism

As people will no longer own their own personal vehicles, they will become dependent on the cars and the service providers for transport.
The value of independence may become less important, as becomes normalized for people to be driven to their destinations by the technologies.
It may also change what it means to be old, as the concept aims to allow among others the elderly to be able to travel more and more easily, thereby removing the stigma of them being immobile and also isolated from the outside world.

Subliminal affect

To encourage people to use the new services, companies will want to use subliminal affect.
With this in mind, the cars themselves should be as comfortable and convenient as possible.
By allowing for comfortable travel, and letting them do other things while in the car, like letting children play in a special area, the experience will be seen as more positive by the passengers.
In doing so, they will be subconsciously affected to use the services again in the future.

Figure 3 Analysis model "Transportation on Demand" (Raub, 2017)

4.2 Before the eye

The proposed implementation of rentable autonomous vehicles will need to convey information to its users and customers. Clear and neutral information will need to be given, but the service providers will most likely also want to apply persuasion. The concept specifically brings forward branding, so the effect of image will also play a part.

Guidance

Guidance in this concept will first come as part of the 'digital journey assistant', that provides users with information about the transport they requested. The app needs to clearly communicate how the users will reach their intended destinations. The concept does not go into detail about information that the vehicles themselves will provide, but guidance will be needed here too. This can be in the form of for example displays that indicate how far the user is from their destination, or sound cues. Another aspect that is missing is the information for other people around the car, like pedestrians and cyclists. These actors will require information about what the vehicle is doing or about to do, in order to increase safety, which could be communicated using for example lights or sound.

Persuasion

The service providers will want to persuade users towards using their particular cars. Though the concept does not go into detail about this, an idea about how this could be done is through marketing. Using adverts or special offers, vehicle providers can encourage users to choose their particular services. Similarly, the providers of the different 'digital journey assistant' apps will need to use such measures to convince consumers to choose their particular offerings. Another question about the concept is how it can lead people around the car, like pedestrians, towards correct and safe behaviour.

Image

According to the concept, different lifestyle brands will try to get a stake in the self-driving vehicle market. These different brands will each offer a certain image. The Apple-brand car would be considered modern and functional, whereas the Walmart-branded one is seen as convenient and affordable, to name a few examples. The technology and its experience are in this concept meant to be somewhat customisable. Users will be allowed to create a driving experience that fits not only their particular needs, but also their personal image and lifestyle. The overall image of the proposed self-driving vehicle system will most likely be one of convenience and ease. There will also, at least at first, likely be an image of luxury, as the act of being driven around reminds one of the image of having a personal chauffeur.

4.3 To the hand

This concept will interact with users in a direct manner as well. Coercive elements will be in place that limit the users' options. The technology is meant to merge seamlessly with people's activities. The self-driving cars will also have certain aspects of subliminal affect, that lead users to repeat usage of the services in the future.

Coercion

After a user sits down in the car they requested, the vehicle will start driving on its own. It will follow a pre-planned route, leaving the passenger with little freedom of choice. Moreover, while the vehicle is moving, the user will be confined inside, needing to wait until they reach their destination or the car is stopped. This last point is especially relevant, since discussions by both STT and others often focus on the idea that passengers will be able to do other things while travelling, whereas the fact that they will still be confined to the car's interior is often forgotten. These two aspects represent ways in which freedom of action is taken from users through the proposed introduction of autonomous vehicles.

Embodiment

The practice of ordering a self-driving vehicle, entering it, and then being driven to one's destination is meant to merge seamlessly with and become embedded in people's natural routines. To this end, the service will need to be easily accessible, so that it can become, after the first few uses, natural to the user to order a car this way. After it is embodied in this way, the user will no longer need to put active thought and effort into the ordering- and travelling-processes.

Subliminal affect

In order to encourage people to make use of self-driving vehicles, the service providers will want to make use of subliminal affect. A main factor in this is to make the autonomous cars and the transport they offer as convenient and comfortable as possible. By allowing customers to travel comfortably, and enabling them to do other enjoyable things during travel, users will associate the experience with positive feelings. Thereby they are subconsciously influenced to more likely use the services again in the future.

4.4 Behind the back

The concept will need to keep certain environmental aspects and factors in mind for it to be successfully implemented. Certain side effects may came as a result. The vehicles will also rely on certain conditions to function. Lastly, there is the potential for this technology to steer society, and change the values that are held.

Side effects

One potential consequence of the proposed concept is that certain jobs will become redundant, like taxi and bus drivers. However, the act of travelling will be made more accessible and easier, potentially improving humans' cultural and social development. A related advantage of the system that STT themselves mention is the added independence for for example older citizens or people with no driver's license, as they will now be able to travel more easily (Van Voorst tot Voorst & Hoogerwerf, 2014, p. 23). This may however also first lead to a reduction in social contact for these people, as they will no longer be driven around by friends and family, but second also brings forth the issue of putting people unfit for driving into a situation where they may still need to take on a supervisory role over the system. Another benefit that is listed by STT is the added free time for work or leisure, due to passengers no longer needing to drive themselves. It is unknown however what people will use this newfound free time for. While the intention is to raise productivity and happiness by allowing people to either work or relax during travel, there is the risk that passengers will start to experience severe boredom and lack of purpose. This in turn can potentially lead to undesirable actions like vandalism of the vehicles, or even lead to mental health problems like depression.

Background conditions

The concept itself lists certain 'preconditions' that need to be met to successfully implement the proposed system (ibid., pp. 20-21). First, new road laws will be needed to allow the vehicles to drive on the public road. There is also a need for new insurance regulations, so that the right actors can be held responsible in case of accidents. Second, autonomous vehicles will need to be accepted by both the users themselves, as well as other stakeholders in the transport system. Third, travellers will need to put their trust in the service providers, as well as the service providers trusting each other. For STT, this is specifically about the sharing of information and data, but in reality this need for trust will also concern subjects like safety. Besides these conditions, there is also for example a need for a strong ICT infrastructure, that can reliably handle the massive data exchanges that are needed to allow the self-driving vehicles to function.

Technical determinism

The introduction of 'transportation on demand' has the potential to bring certain changes to society and its values. First, people will become dependent on the system for their travelling, as they will no longer be owning their own cars. The value that is held for human independence may thereby also

be lessened, as it becomes normalised for people to be driven to their destination by technological systems. In addition, if STT's intentions are fulfilled, the meaning of for example old age may be changed, as elderly citizens become once more able to travel easily, removing the stigma of them being immobile and isolated.

4.5 Above the head

There are different perspectives through which one may look at the social impacts of this concept. One can look at it fairly optimistically, seeing the potential benefits it can bring to improve our human capabilities. Or one can see its dystopian side, focussing on its possibly undesirable side effects. A third perspective would aim to look at the concept in an ambivalent manner, seeing both the risks and benefits, and to understand how it could be implemented in the most desirable way.

Utopian technology

From a utopian perspective, 'transport on demand' will lead to people being able to travel more easily and more often than they are currently able. Both long and short distance travel will be made available for everyone, even those that currently cannot drive a car. The act of travelling will be made more enjoyable, as passengers can spend their time on leisure. With the burden of driving taken off the shoulders of passengers, they get extra free time, which they can use to work towards fulfilling their true potential as humans undistracted.

Dystopian technology

From a dystopian perspective, this concept will lead to humans becoming isolated in their personal self-driving cocoons, disconnected from the outer world and the people around them. Elderly citizens will lose the contact they had with others, as they are constantly alone while being driven around by autonomous vehicles. People's lives will become even more controlled by brands, as companies come to decide over when and how they travel. The free time that is supposedly added will only lead to people losing their sense of purpose, becoming bored and depressed.

Ambivalent technology

From an ambivalent perspective, society will need to understand that, convenient as 'transport on demand' may sound, it comes with certain risks and caveats. It needs to be ensured that people, especially the elderly, are not made to always be travelling alone in their autonomous vehicles, but rather use their newfound free time in the cars to connect with others. The cars themselves will also need to be designed to allow passengers to spend their travel time in a valuable and worthwhile manner that stimulates them.

5 Discussion

Analysis of the concept proposed by STT using the PIT showed that there is an added value in using it as a supplementary means of study. By ordering insight inspired by the PIT's twelve effects into the model, it became clear that certain aspects had been neglected by STT's conventional technology forecasting approach. Through use of the PIT, this missing information was found, and thus can be taken into consideration when planning the concerning technology's introduction into society.

The quadrants on the right side of the PIT's model (before-the-eye and to-the-hand) were largely used to theorize about how the proposed systems could function in detail, and other aspects that needed to be kept in mind with regard to usability and functionality. In doing so, details were added that were still missing from STT's own analyses.

The assessment of the concept by STT themselves could be considered fairly optimistic, if not utopian. Important negative consequences of the proposed plans had either not been found in the approach used by STT, or went unmentioned due to other reasons. That said, there were also certain positive effects and consequences of the concept that were not mentioned by STT, but were found out during analysis with the PIT. For example the increased accessibility and ease of travelling, which

can potentially improve cultural development. These types of aspects were mainly investigated through the quadrants on the left side of the PIT's model (behind-the-back and above-the-head).

Overall it became clear during the analysis that the added value of the proposed analytical method of using the PIT lies in providing new insights and perspectives. This is achieved by making the analysts look critically and from multiple sides on the subject they are working on. This also provides them with a more ethically oriented approach. The proposed method serves as an additional measure, that should be used in combination with the tools and methods that already exist. During the case study, it also became clear that this kind of intricate analysis of potential impacts can change one's perspective and opinion on the desirability and feasibility of a particular concept. By using this proposed method, strategists are provided with more information about the potential role and impact of their subject in society, aiding them in both studying its desirability and in determining the most effective and responsible manner of implementation.

6 Limitations and future work

Certain limitations and questions still remain within the research demonstrated in this paper. First, the present research did not include a critical assessment of whether the PIT includes all the necessary and relevant themes and aspects. The PIT may still require further refining and development. Improvements in the PIT will lead to the developed method functioning more effectively. Second, the research could benefit from the undertaking of a case study of a corporate-oriented subject, as the ones that have been done already are innovation-focussed. Third, the case study was performed by the authors themselves. The method has not yet been tested with experts in the field of strategic development and analysis. Doing so would garner more information about the added value of the method in actual practice.

7 Conclusions

This paper aimed to demonstrate the potential for using the PIT as an analytical instrument for prospective thinking about future strategies and innovations. The PIT's twelve effects were investigated, an application method has been proposed, and its position in relation to existing methods in the field has been examined. The method has furthermore been applied in a case study, to demonstrate its potential. In doing so, it was shown that usage of the PIT in this manner can provide analysts and strategists with new and relevant information. The method is explicitly meant to be used in combination with ones that already exist. Because of the reflective and human-centred nature of the PIT, analysts are aided in making decisions in the development of new technologies, so that these will have a more effective, desirable, and responsible impact in society.

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Using Heterotopias to Characterise Interactions in Physical/Digital Spaces

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This paper addresses the complexity of designing interactions in hybrid digital/physical spaces, in which notions of public and private are becoming increasingly blurred, by using a philosophical lens to characterise such spaces. In particular it references the ideas presented by Michel Foucault in his essay *"Of Other Spaces"*. It proposes the presence of a spatial division within physical and virtual, in terms of private and public, and juxtaposes them through a Heterotopical Model for Inter-Spatial Interaction through which designers can examine the coexistence of physical and digital interactions. The purpose of modelling this juxtaposition is to help designers understand the nature of connections that happen between physical and digital objects in these spaces and consider how meaningful interactions can respond to this complexity.

spaces; phenomenology; heterotopia; philosophy for design

1 Introduction

This paper illustrates how philosophical constructs should not be viewed as separate from design practice but rather can augment the design process using the example of how to characterise complex interactions that combine both the physical and digital aspects. We establish the presence of a philosophical division of space developed through the ideas presented by Michel Foucault in his essay *"Des Espace Autres" (Of Other Spaces)*. This division plays a pivotal role in the creation of a framework for Inter-Spatial Interaction, acting as a philosophical lens through which we define interactions between physical and digital aspects that traverse over an imagined *Real Space* and *Digital Space*. Referencing Foucault's idea of the heterotopia as the basis of this lens, we systematically define the presence of these alternate spaces and the nature of interactivity that could happen within them. Finally, a discussion is presented on the potential for designers to use this approach to understand the complex nature of objects that connect with digital interfaces and services in order to consider the "range of perspectives from which each device may be observed" (Lindley & Coulton, 2017) and thus comprehend the "complexity relating to the interdependence"

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between interactions, raising questions on the need for *'meaningful interactions'* between physical and digital in such environments.

1.1 The division of Space

Space is described by Tuan (1977) as, "an abstract term for a complex set of ideas", which he says comes from how, "people of different cultures differ in how they divide up their world, assign values to its parts, and measure them". His definition assumes space in relation to the "intimate experience [of man] with his body and with other people", wherein one, "organises space so that it conforms with and caters to his biological needs and social relations". Architecturally space is seen through an idea of dimensionality, where it can be measured, yet "spatial dimensions such as vertical and horizontal, mass and volume are experiences known intimately to the body" (Tuan, 1977, p. 108), this allows architecture to traverse the boundary between ***space*** and ***place***. Both terms "denote common experiences" (Tuan, 1977, p. 3) but they both expand on each other's definitions where "place is security, space is freedom: we are attached to the one and long for the other". Tuan's exploration of space/place is more towards the study and experience of Geography, but it can be appropriated to encompass the digital as we have done within the research, as such:

> *Consider the sense of an 'inside' and an 'outside', of intimacy and exposure, of private life and public space. People everywhere recognise these distinctions, but the awareness may be quite vague (Tuan, 1977, p. 107)*

The level of interaction a person might have within an open town square compared to their own house would be very different, as different amounts of trust would be associated with these 'inside' and 'outside' spaces. This space/place relationship transcends into our digital environments equally, with the "conceiving of cyberspace as a social space" (Slane, 2007, p. 12), it can be seen as being, "socially constructed, its meaning deriving from the uses to which it is put, and therefore capable of multiple simultaneous incarnations"—the word social here is taken liberally to include not only person to person interaction but also thing to thing interaction where digital terminals and objects would be included—therefore, a mobile phone would constitute as a personal space where as a message board online would be a public space only juxtaposed into a virtual world but in either case the interaction happens through a physical interface; here a mobile, or a laptop. These incarnations of digital spaces become more convoluted when imagining the plethora of Internet powered devices available, often with the *Smart* moniker preceding them; Smart Phones, Smart Watches, Smart TV's, and so on. A cluster of communications that have us "entangled within the heterogeneous network of interconnected objects or things that are readable, recognisable, locatable, addressable, and/or controllable via the Internet" (Coulton, 2015; Lindley, Coulton, & Cooper, 2017). A space can thus have multiple places residing within it, each with its own meaning which is unique to the actors interacting within them.

Often these virtual interactions tend to mimic older real-world practices; a diary can exist in a physical and virtual form, both can be closed or open to others. The complexity ensues when multiple points of interaction come in to play with objects connected to wider constellations of interactions for instance when a Smart Assistant such as *Google Home* needs to connect with a mobile phone or a switch among multiple other points in order to request access and gaining trust to switch on a light bulb, these raise questions such as: what is the nature of these interactions? Are they meaningful for the actors? And how can one better design them to be not only efficient but also worthwhile?

2 Methodology

Phenomenological research attempts to understand, "how people experience things and events", by examining, "perspectives and views of various social realities" (Leedy & Ormrod, 2010; Muratovski, 2015, p. 79). The Stanford Encyclopaedia of Philosophy defines phenomenology as the study of, "things as they appear in our experience, or the ways we experience things, thus the meanings

things have in our experience" (Smith, 2016) and expresses an interest in a "conscious experience as experienced from the subjective or first-person point of view". Philosophical approaches such as speculative realism, or object-oriented ontology put aside old philosophical dualisms and instead explore how objects "should be recognised for their indifference to us" (Cole, 2013, p. 106) and focus on the things they do "behind our backs" looking at their individual experiences as "actants", moving in and out of "assemblages, entering into collectives of their own making". Therefore, by seeing these interactions existing as a phenomenon we attempt to make sense of their complexity using philosophical references in tandem with real-life examples. By asking, "'What is it like to do or experience [something]?'" (Muratovski, 2015, p. 79), we attempt to empathise with these objects and see from their perspective what these Inter-Spatial Interactions are like.

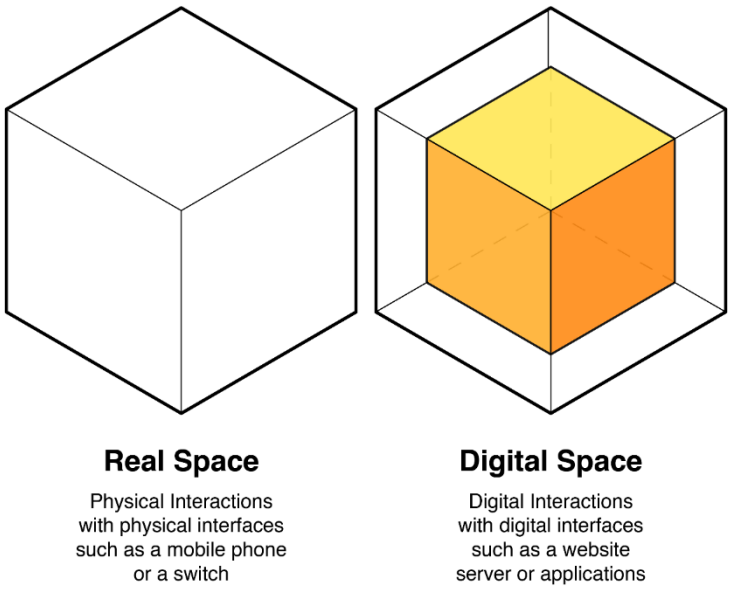

Figure 1. Imagining Digital Space as a subset of Real Space

For this philosophical lens, the actual space will be divided utilising Tuan's (1977) perspective of spaces containing a "sense of an 'inside', and an 'outside'", by presenting two realities; one being the physical reality that we have around us in which we physically interact (Real-Space or RS), the other being a virtual one where interactions through/with digital objects occur (Digital-Space or DS) (see Fig. 1). In this particular view DS resides as an 'inside' or a subset of RS, allowing for physical objects to be present within the same space alongside their virtual counterparts; one being tangible the other intangible. The idea of virtual being present alongside the physical has been discussed by others seeing it as a "Virtuality Continuum" (Milgram, Takemura, Utsumi, & Kishino, 1995), one where, "both the real and the virtual coexist" (Coulton, 2017). Virtual worlds are also seen as literal places that, "can be construed not just in terms of globalised online networks, but in terms of space, landscape, and localities as well" (Rymarczuk & Derksen, 2014). Descartes' explored the concept of a mind/body split which he called *res extensa* (extending things) and *res cogitans* (thinking things), commonly used to imagine the "physical world as having both extension and location in space" (Monk, 1997, p. 46), looking at psychological realities such as the virtual through this approach they, "do not have spatial dimensions, and their location is only metaphorically 'in the mind'"; therefore, the division of space can be justified through a philosophical embodiment of the virtual space as a similar yet altered parallel space to the physical residing within it.

The second step is to further characterise these spaces with their 'insides' and 'outsides', and in this particular case to consider: spheres of Private and Public. These spheres house information with which we physically and/or virtually interact with. As an example, take a public message board online to be analogous with a discussion in the park where others may very well hear you, similarly a

personal passcode protected digital diary can be related with a physical key and lock diary. Although this is only in terms of the immediate relationship one has with objects and spaces around the objects and as we shall see for connected objects these interactions become considerably more complex.

2.1 Grounding the Philosophy

Having acknowledged the spaces, we now see specific overlaps happening between spaces and spheres (see Fig. 2). Foucault once said: "What is interesting is always interconnection, not the primacy of this over that" (Brooker, 1999), keeping that in mind we come to the philosophical basis of this paper. In his essay *"Des Espace Autres" (Of Other Spaces)* Foucault (1967) introduced the concept of the *heterotopia* exploring how our lives are "governed by a certain number of oppositions that remain inviolable", calling them "simple givens", being, "between family space and social space, between cultural space and useful space", but more importantly, "between private space and public space" (Foucault, 1967, p. 2). He explains these as ideals that are "nurtured by the hidden presence of the sacred" and calls these heterotopias *placeless places* because of their deviation from the norm. He goes on to assert that, "we do not live in a kind of void, inside of which we could place individual and thing" (p. 3), rather, "we live inside a set of relations that delineates sites which are irreducible to one another and absolutely not superimposable on one another". These other spaces thus exist as a, "simultaneously mythic and real contestation of the space in which we live". For Foucault, "Heterotopias are places of Otherness, whose Otherness is established through a relationship of difference with other sites, such that their presence either provides an unsettling of spatial and social relations or an alternative representation of spatial and social relations" (Hetherington, 2002, p. 8). Hetherington (2002) explains on how these spaces are created saying that they, "bring together heterogeneous collections of unusual things" (p. 43)—the deviation from the norm—where they have no, "order established through resemblance". Furthermore, he discusses that what matters is the relationship seen "from the standpoint of another perspective, that allows a space to be seen as heterotopic".

This approach makes it safe to imagine unique interactions that exist within the overlaps of the Inter-Spatial Interactivity model as residing within a heterotopia—or a series of heterotopias. A grounding factor of these spaces is that in these, "places of Otherness", "unsettling juxtapositions of incommensurate 'objects'" are established each contesting, "the way our thinking is ordered" (Hetherington, 2002, p. 42); hence presenting an alternate ordering of things that is unsettling because they have "the effect of making things appear out of place" (Hetherington, 2002, p. 50). This particular aspect allows us to view interactions in these spaces in a manner of urgency and thus challenging their meaningfulness towards the actors and the act.

Although the concept of heterotopia has most commonly been used to define alternate physical spaces as those referenced by Foucault himself—such as the cemetery, a festival, or the library—it also is used to define more abstract structures as he explains with the, "rug [being] a sort of garden that can move across space" (Foucault, 1967, p. 6). Another analogy he gives is of the boat which he calls a, "heterotopia par excellence". Rymarczuk and Derksen (2014) discuss how the boat, "as a 'placeless place' applies to cyberspace as well, 'particularly when it is a network, linking terminals in different places and times into a unified environment'". They go on to assert through Sherman Young's point of view of how cyberspace can have [further] heterotopias as well".

2.2 Principles of Heterotopia

Foucault (1967) established six principles to explain his ideology of a heterotopia, to begin he affirms that all cultures display the ability to create, or have created, heterotopias though which they, "take quite varied forms" depending on causal relationships to the space they inhabit, the culture they are tethered to and other factors. Second, society has the ability to "guide, push, and make established heterotopias", in effect having of them, "change or adopt novel functions or new meanings" (Rymarczuk & Derksen, 2014). Foucault explains this in relation to the cemetery which having

evolved over time, “no longer the sacred and immortal heart of the city, but the other city, where each family possesses its dark resting place” (Foucault, 1967, p. 6). Third, is the “juxtaposing in a single real place are several spaces, several sites that are in themselves incompatible” (Foucault, 1967, p. 6). Rymarczuk and Derksen (2014) have expressed this to be a, “defining character of heterotopias”, allowing the, “merg[ing] of certain spaces”, such as public and private to exist. The fourth principle establishes a concept of heterochronies being that “heterotopias are most often linked to slices in time” (Foucault, 1967, p. 6), forcing an, “absolute break with traditional time”; cemeteries, museums, libraries, are examples of “becom[ing] heterotopias in which time never stops building up and topping its own summit”. Fifth, “Heterotopias always presuppose a system of opening and closing that both isolates them and makes them penetrable” (Foucault, 1967, p. 7). This can be imagined through metaphorical gatekeepers entrusted with responsibilities to allow certain things to enter and exit the heterotopia, digitally this can be imagined through payment, registration, and identification protocols. Finally, heterotopias have, “a function in relation to all the space that remains” around them. Foucault (1967) defines this as a function that, “unfolds between two extreme poles”, in a bid to, “expose every real space”, through creating an alternate, “space of illusion”, wherein defining a, “space of perfection to compensate for the flaws of real life” (Rymarczuk & Derksen, 2014).

As an example of a digital space being a heterotopia, Rymarczuk and Derksen (2014) uses the example of Facebook, affirming how it requires actors or in its case, “user[s] follow rules of conduct”, if they wish to, “start immersing themselves”, in its virtual world and have to agree upon, “terms of agreement — a contract essentially stripping away all property claims of information posted within this space”. They critique this aspect of the service saying that it is, “difficult to leave the space entirely”; recent updates of Facebook have added a deletion option though the design of the feature arguably discourages such activity which essentially aligns to the fifth principle of heterotopia. Moving on, they affirm that Facebook shows the, “distinct regime of time”, that Foucault describes in his fourth principle comparing it to museums that “accumulate time”, having it “share traits with but also combine them and add a dimension that marks it as an altogether new kind of heterochrony”, summing up that, “Facebook collapses past life, present life and afterlife into something very other”. They converge on the third principle by explaining how Facebook views privacy wherein the public domain, “is not invisible to the Facebook owners and administrators”, and at the same time individual, “social spheres form one big network, owned and administrated by Facebook”, and though individuals are divided into spaces, “the distinction between private and public does not hold”, because, “Facebook as a whole is not an undivided space”. Finally, for the sixth principle a discourse on the illusion that Facebook gives of connectivity which they, “characterise as a performance”, and give power to, “inauthenticity”, as people, “rejoice in the fact that it gives them the ability to present themselves to the world”.

2.3 A Model for Inter-Spatial Interactions

These principles can just as well be established for physical devices that interact with-through RS and DS and while online services such as Facebook can on their own be seen as heterotopias, the following model is proposed to explore how physical and digital interactions can coexist in the same instance as a heterotopia. Figure 2 shows the proposed heterotopical model, inspired by Foucault’s (1967) example of a mirror:

> *The mirror functions as a heterotopia in this respect: it makes this place that I occupy at the moment when I look at myself in the glass at once absolutely real, connected with all the space that surrounds it, and absolutely unreal, since in order to be perceived it has to pass through this virtual point which is over there (Foucault, 1967, p. 4)*

He describes it as a parallel space which appears to have traits of a “utopia” since you see yourself where you are not; or as he places it “in an unreal, virtual space that opens up behind the surface” (p. 4)—here the seeing of oneself is taken in the sense of the actor in that space, so a mobile phone, or a toaster that can connect to the Internet can be imagined similarly. The act of seeing your

activities on a Smart Phone, for example using Whatsapp, can also be understood from Foucault's example of the sounds on a telephone line which uses the same concept of the mirror analogy, wherein by talking to each other without being physically present in the same space and the hearing of each other's voice affirms their existence.

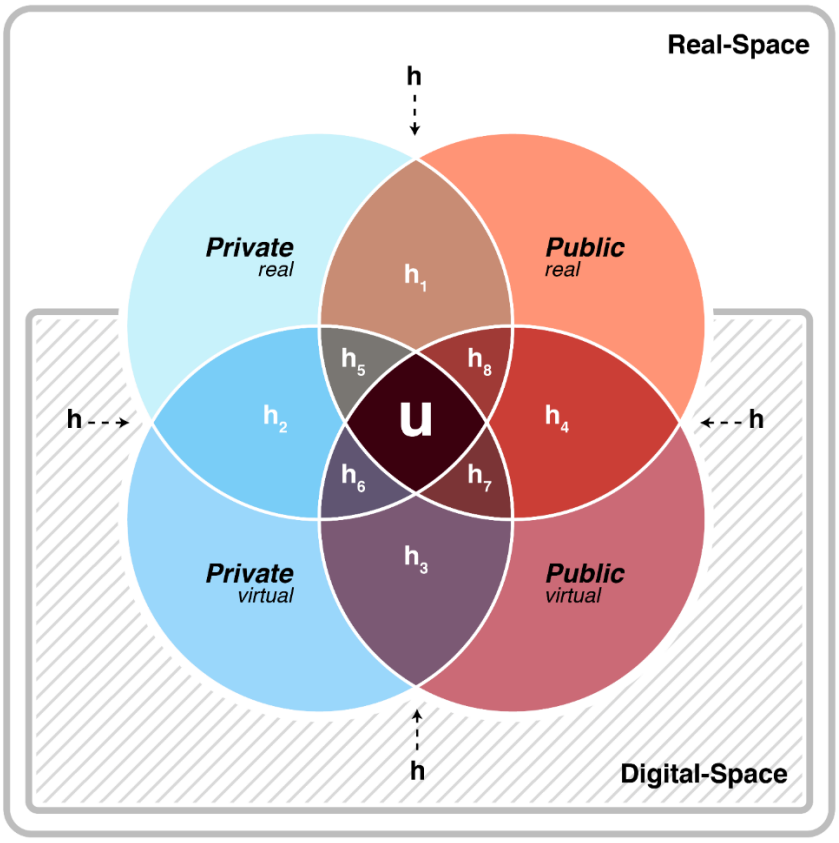

Figure 2. Philosophical Model for Inter-Spatial Interactivity

The model thus incorporates two spaces coexisting as one within the other each with its rules and regulations and encompassing individual spheres of privacy and publicity. The overlaps created can be characterised as: Private-Real (PrR), Public-Real (PuR), Private-Virtual (PrV), and Public-Virtual (PuV). Furthermore, overlaps are seen between the real and virtual iterations of privacy and publicity and they form the more unique and albeit complex heterotopias (h1 through h8).

Private-Real: One of the two divisions of RS, it encompasses ideals and information that are most intimate to us forming our inherent acknowledgement of the private. For instance, the physical space of a bedroom could be considered as a very real private space. Being a personal perspective it is hence of more importance to the individual to acknowledge it as such, but in order to function as a true 'private' it requires an understanding of a corresponding opposite;

Public-Real: Opposing general notions of privacy, it defines the private as much as it defines itself. An open reality that exists around us, governed by culture, society, government, policy, to name a few. The public exists as a platform of interaction that is open and valid for all to interfere/intersect with. Carrying on the example of a home, a communal living room could be accepted as real public space, and in a larger perspective a park where one can be easily seen and interacted with.

Private-Virtual: First of the two counterparts in DS, it incorporates rules that are defined by the individual to replicate their real notions of privacy. "The always-on, always-accessible network produces a broad set of changes to our concept of place" (Varnelis & Friedberg, 2008). Referring to the mobile phone as a "telecocoon" Varnelis (2008) discusses how it "maintains intimacy at a distance,

facilitating private encounters in public spaces", therefore creating the counter existence of the private in DS. A personal Smart Phone can be considered as a private virtual space within a physical object.

Public-Virtual: Second of the two counterparts this facilitates the public sphere through digital interfaces, Varnelis (2008) takes a cue from Jane Jacobs saying what "makes the public sphere vibrant is the continual contact with unexpected forms of interactions", the DS allows for a continuum of those interactions between Public-Real through to the virtual. A television can be seen as a virtual public space, one where interaction can be achieved through experiencing it, and since multiple people can experience the same thing together it allows for something akin to being at a concert.

Heterotopia 1: The first overlap to occur is between Real Private and Public spheres, here the interactions are those that happen in our daily physical lives influenced by very physical elements in the world around us. For the purpose of this paper and to aid understanding we will be using an example of fitness tracking to illustrate the differences within the model. An actor could imagine the physical steps they take as being a very physical private interaction that in truth is very public as the steps could be seen being taken by others in the same physical space. In both instances, the actor is in-charge of the act to happen becoming the gate-keeper, they take a step and in doing so have others potentially see it happen; an amount of time is accumulated in order to take each step and view it hence the acts are hetrochronies; each step being taken has an illusion of displacement which in this instance conform to the laws of physics and subsequently remove one from their initial stance (standing or moving) towards another.

Heterotopia 2: Moving clock-wise around the model shown in figure 2 the next overlap is seen between RS and DS, here using the same example of fitness tracking, this form can be seen when an actor uses a physical tracking device such as a FitBit to represent real steps in an alternate state, in this case numeric data. Although the information is the same, they both represent physical steps but due to the fact they are within two different spaces (RS and DS) they are visible in different ways. Variations of the Private clash together creating an alternate reality of privacy which exists only in DS hence it is in many ways similar to the illusion in Foucault's mirror; one version looks at the virtual version of themselves and grounds the others visibility in their own respective realms.

Heterotopia 3: Next we see an overlap between *PrV* and *PuV*, the interaction here should abide primarily by rules in the DS with little influence from RS. Continuing with our example, the steps saved to the fitness tracker are now allowed by the wearer to be saved to a server online. The reason this is a PuV interaction is because the server will be operated by other entities who could prescribe policies and regulations to oversee this information.

Heterotopia 4: The next overlap is between both iterations of public. Many interactions tend to exist in this space which are free to access through open data in order to create a publicly viable connection between the real and the virtual. Looking back at the steps taken example, imagine a wearable device that doesn't share data with its wearer but instead saves it immediately to a public server. A service such as *If This Then That (IFTTT)* could then be used to parse this data and initiate some action, for example, the step data is sent from the device directly then parsed into an online spreadsheet. Another way of considering this is through the example of a wifi light-bulb that's connected to a digital interface allowing you to turn it on or off via a mobile device. The bulb is in a room that can be operated through a public link on Facebook, anyone can access it and change the status of the physical bulb. The bulb exists as a physical object and has a digital presence accessible through the mobile device making it exist there as an alternate of itself. When turning the bulb on from the mobile there is no physical interaction being made with the bulb yet a very physical alteration occurs in the state of the bulb wherein it turns on. This makes this interaction a very public one where even though physical contact is not happening a very visible physical change occurs.

Heterotopia 5: The inner overlaps of the model are where more complicated interactions begin to appear governed according to orders. The first of which occurs as a *PrR-PrV-PuR* interaction. As this occurs primarily in *PrR* it would be more influential but the interaction would have traits of the other

spheres. Take our steps being saved from our FitBit, what if that data were to be synced with another device of another wearer and they could scroll through data that's been shared with them and vice versa? Although the information here is present in different versions (real steps and numeric iterations) the presence of another individual and their physical device can be taken as it being in both real and digital spaces

Heterotopia 6: Here we see a *PrV-PrR-PuV* overlap with things primarily grounded by the *PrV* but influenced by others. This can be imagined very similar to example in H5 but substituting the second device with a website where all data is synced and shared with a wider community. The use of social media can also be imagined here, your fitness tracker saves physical data it interacts with and sends that to a digital server which subsequently interacts with a social network such as Facebook and shares the information publically. The movement of this information from RS to DS and then again into DS but as a very different version of itself shows how simple data collection can be repurposed exponentially, with every jump changing the data to reaffirm according to the nature of the other space it inhabits.

Heterotopia 7: In a *PuV-PrV-PuR* overlap a more digital approach of trust can be observed. The IFTTT protocol earlier imagined to save data to a spreadsheet can be reconsidered, only this time instead of saving to a personal spreadsheet the data is visualised on a public device such as a digital display in an office telling all its employees about how many steps have been taken in the office only by the employees.

Heterotopia 8: Finally, in a *PuR-PuV-PrR* overlap one can see a physical dominating the virtual. A way to picture this interaction would be with a door that can monitor people going in and out of it using wearable RFID tags. The data is coming from a physical source and returning to a physical source by being displayed publicly but what makes this unique from the H7 is that here the data is taken directly from the physical source and not through any virtual channels, alternatively to make it more interesting, the PuV can be a source of information that could be syncing a particular individual according to their interaction with the door. So, imagine a shoe with an RFID tag, it moves between the door and registers the wearer syncing fitness data that is tracked by the shoe, this in turn is returned to a physical output like the same bulletin board but this time through direct physical interaction.

Previously we discussed the many interactions happening in the model, but at the centre much more complex interactions take place. Utilising from the mirror analogy of a utopia this space has been marked ***U*** and here is where a ***virtually*** *private-public yet simultaneously* ***physically*** *private-public* interaction takes place. In order to imagine this, levels of permission and trust need to be facilitated and that can only happen if the different interactions allow for major alterations in the nature of information handling. Imagine a scenario where your fitness data is tracked to your FitBit, that in turn sends data to a digital server, which allows access to physical devices to relay that information when and where they wish, now picture going into a gym and seeing a wall light up with your specific information keeping track of your steps and sharing it with you but very openly so others can see and possibly interact with it as well. Such an interaction can only take place when levels of permissions have been allowed over different spaces through policies, regulations, different terms and conditions and so on. By making this interaction between user-device-service-institute and so on new heterotopias are dynamically created where the rules differ and thus the device has to operate in that particular way; any change happening in any of those rules reverberates through the entire constellation.

3 Conclusions

In this paper we have presented a way of characterising digital and physical interactions by imagining a relationship between spaces and levels of permission explained through a philosophical lens of heterotopias. It can be seen through Figure 3 that the closer one gets to the centre of the Inter-Spatial Interactivity Model the greater the complexity of interactions occur. The increased levels of complexity, which includes increasingly diffused relationships of trust, raise a question into the

meaningfulness in how these interactions happen. Interconnectivity between physical and digital interfaces are becoming more and more common with IoT surfacing in newer more seemingly efficient forms often as designed artefacts. But the complexity that ensues from these interactions means that a lot of information is either lost, ignored, or deliberately obfuscated. When various previously clear relationships of trust are being altered, is the interaction still worth it to the actor? Are there any measures that can be taken in order to renegotiate this trust or indicated that it has changed?

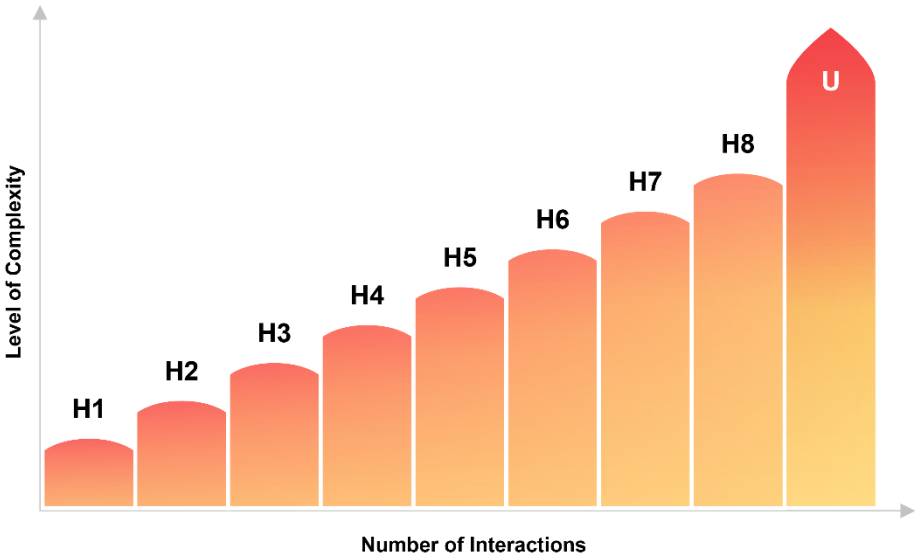

Figure 3. Relationship of number of interaction to level of complexity within Inter-Spatial Interactivity Model

Though Human-Centred Design (HCD) "has become the de facto modus operandi" (Lindley et al., 2017) for designing for IoT, concerns have been raised over how this approach "obscure[s] underlying complexities from users". Designers have always affected the "well-being and lives of users and society at large" (Stam & Eggink, 2014), Stam and Eggink (2014) have argued for the use of philosophy in design saying that "encouraging designers to engage with deeper philosophical issues about their practice and research will contribute to a more profound understanding of design" (p. 5), this approach of using philosophical constructs as a support structure to look at the larger picture of a design problem can allow designers to be "more aware of the power of design and help them to envision how their designs can contribute to a more desirable future" (p. 5). The use of Michel Foucault's philosophies as a basis for studying complex digital/physical interactions is in effect a way to help better understand HCD pitfalls when designing for these kinds of interactions. Using the above model in conjunction with philosophical constructs such as Object-Oriented Ontology (OOO) it is possible to use philosophy further as a tool to help in design research with relation to dissecting the inevitable *messiness* that is associated with digital and physical interactions seen in IoT devices.

Lindley et al. (2017) have referred to the interaction between people and technologies as a "Pandora's box of possibility" being opened, this model and approach allows to mitigate these possibilities and force us to focus on individual interactions to see them as acting indifferently to their surroundings raising questions for other areas of study that could benefit from the information extracted in this process. One particular direction to move on from here could be looking at where value for stakeholders lies in this model? When seeing physical/digital interactions happen in this fashion, is it possible to further utilise it to see how design could be used to benefit or contest any political or economical interests? Foucault once defined discourse as "going outside of oneself ultimately to find oneself" (Foucault, 1987, p. 16), using philosophy as a discourse building activity to better understand the complexity of design problems—as in this case giving meaning and purpose to objects and spaces in order to understand physical/digital interactions—can prove as a strong tool in

a design researchers belt and possibly help in establishing the need for meaningful interactions to be taken into consideration through larger perspectives as well as individual ones.

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DRS Design Research Society 2018 Catalyst

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DRS Conferences: barometer and mirror of theoretical reflection of design discipline

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The so-called "Design Methods Movement" emerges in Europe in the late 1950s, connected with the on-going technological developments, and new theories –systems and problem solving– within an economic-social-cultural space where new productive-economic paradigms, new social demands, environmental issues, etc., will compel designers to deal with complexity, using methodological (ergo theoretical) tools. "Design Methods", different than "Scientific Method", will improve the approach to design process problems –a non-predetermined process; at the same time rational and creative. Design reflection will elaborate conceptual constructs that, today, have already gone beyond design discipline itself such as "design thinking" or "designerly ways of knowing". The first “Theory and Design Methods Conference” will give rise to the Design Research Society (DRS), which will organize Design Research Conferences, until today. The present work will describe –over the timeline of Design Conferences, from 1962 (pre DRS) until 2016 (last DRS Conference)– the evolution of theoretical design reflection regarded in a wide context, in order to provide a new theoretical perspective, contributing to critical visions and disciplinary discussion.

design research; design theoretical evolution; design praxiology; design phenomenology; design epistemology

1 Introduction

The present work is an effort of comprehension regarding the visions, approaches and emphases that have been produced during the last, almost, 60 years in design research and design theory.

The emergence (origin) of methodological reflection in Design is closely associated with the new post World War II scenario, where the same technological advances that served both to carry out, and to finish of that conflict would have changed society forever, as a result of new productive and economic paradigms, new social demands, environmental issues, etc.

As Nigel Cross described:

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> *The origins of the emergence of new design methods in the 1950s and 60s lay in the application of novel, 'scientific' methods to the novel and pressing problems of the 2nd World War - from which came OR and management decision-making techniques - and in the development of creativity techniques in the 1950s. (The latter was partly, in the USA, in response to the launch of the first satellite, the Soviet Union's 'Sputnik', which seemed to convince American scientists and engineers that they lacked creativity.) The new 'Design Methods Movement' developed through a series of conferences (De Vries, Cross, Grant, 1993, p. 16)*

In that scenario, with technological developments in progress, and the influence of new theories —Morphological Method (Zwicky, 1948), General Systems Theory (developed from 50s to 60s), Synectics (50s), Cybernetics (late 40s to 70s) — Design would have to takeover the complexity of — in engineering words— an "open system of decisions" (Gregory, 1965, p. 83), where would be unavoidable methodological tools, that is, theoretical.

At the beginning, visions and theoretical conceptions regarding the design process install fundamental questions regarding a process that is not predetermined –at the same time creative and rational– where an essential aspect is decision-making.

Some simple —and revealing— questions contained on the initial reflections are:

> *Is there a science of design? (Gropius, 1947, in Gropius, 1955, p. 30)*
>
> *If science is concerned with knowledge and design is concerned with action, is it reasonable to speak of scientific method in design, or a science of design? (Esherick, in Jones & Thornley, 1963, p.78)*
>
> *What is it that makes a form-making process good or bad? (Alexander, 1964, p.36)*
>
> *What is a decision?*
>
> *How are these decisions made?*
>
> *How does a designer decide what information to feed in next, and how much of it, and in what detail, and how does he decide when to do it?*
>
> *How does a designer decide what to do with this information, when and how to carry out consistency testing or comparison and selection?*
>
> *And, in making these decisions, how much discretion has he?*
>
> *What is it that limits his freedom to exercise this discretion?*
>
> *(Levin, 1966, reprinted in Cross, 1984, p. 107-115)*

The methodological reflection who was trying to answer those questions will find a convergence space, at the so-called Conferences on Design Methods, whose first version was organized by John Christopher Jones and Peter Slann, in 1962, in London, with a very simple purpose at that time, in Jones's words:

> *It was the first conference of its kind and enabled everyone who had an interest in 'systematic and intuitive methods' on design to get to know of each other's existence. (Jones, 2002)*

Jones, at that very Conference, will define design methods as "a means of resolving a conflict that exists between logical analysis and creative thought" (Jones & Thornley, 1963, p.54).

Later, in 1970 Jones will publish his book *Design Methods, Seeds of human futures*, reflecting about design, designers, their role, their performance in the world, and specially making a compendium of

methods –a taxonomy– that would allow to value and differentiate the way in which design process can be approached.
At the time of publication of *Design Methods ...* there were still more questions than answers in methodological reflection, and those questions revealed the uncertainty, inherent to a theoretical attempt, that would propel the searching for answers through design research, initiating the construction of a theoretical "corpus" which is still in process.
Thus, the Conferences, from the beginning, will receive the theoretical concerns of the discipline, materialized in research works, proposals and methodological reflections, case studies, etc. Thereby, the Design Conferences have become a space of visibility and dissemination of design theoretical effort.

2 About the research

2.1 Core questions of the present inquiry

What kind of theoretical approaches have emerged in these, almost sixty years? How do these approaches reflect, confirm, or deny emerging interpretations around "Design Methods" or "Design Theory"?

2.2 Objectives

General Objective

Visualize the evolution and state of the art of design's theoretical effort in order to collaborate in understanding the role of theory and research in design discipline.

Specific Objectives

- Stablish a synchronic panorama, review and discussion of results.
- Collaborate with a more wide insight about the “invisible threads” of design theoretical reflection, closely engaged with the origins, birth and growing of the DRS and DRS Conferences.
- Collaborate with a more wide understanding of the influences and the way that influences have impacted the development of the discipline in other scenarios, such as the Latinoamerican.
- Create a database of proceedings of all the DRS Conferences over almost 60 years (and back to the origins in the 1962 Design Methods Conference), accessible to other scholars.

2.3 Working hypothesis

The topics addressed at the Conferences on design Methods reflect the evolution of design and methodological reflection and reveal the predominant research areas of the discipline.

2.4 Description of the inquiry

This work, in its first stage, consists in visualize the key areas of research —and reflection— that have been addressed in the Conferences on Design Methods, Design Theory an Design Research from 1962 to 2016.
To do so it will utilize the taxonomy proposed by Bruce Archer in 1980 (Jacques & Powell, 1981), where he identifies ten areas of design research, as follows:

1. *Design history. The study of what is the case, and how things came to be the way they are, in the Design area.*
2. *Design taxonomy. The study of the classification of phenomena in the Design area.*
3. *Design technology. The study of the principles underlying the operations of the things and systems comprising designs.*

4. *Design praxiology. The study of the nature of design activity, its organisation and its apparatus.*
5. *Design modelling. The study of the human capacity for the cognitive modelling, externalisation and communication of design ideas.*
6. *Design metrology. The study of measurement in relation to design phenomena, with special emphasis on the handling of non-quantitative data.*
7. *Design axiology. The study of worth in the Design area, with special regard to the relations between technical, economic, moral, social and aesthetic values.*
8. *Design philosophy. The study of the logic of discourse on matters of concern in the Design area.*
9. *Design epistemology. The study of the nature and validity of ways of knowing, believing and feeling in the Design area.*
10. *Design pedagogy. The study of the principles and practice of education in the matter of concern to the Design area.*

    (op. cit., p. 33)

Archer synthesizes these ten areas into three broad areas:

1. *Design Phenomenology, in which I would include, for the time being, design history, taxonomy and technology, as I described them earlier;*
2. *Design Praxiology, in which I would include design modelling and metrology; and*
3. *Design Philosophy, in which I would include design axiology, epistemology and pedagogy.*

   (op. cit., p. 35)

To clearly differentiate these three categories and considering that "Design Philosophy" refers to *knowledge* (its acquisition and value), it has been decided to name this category according to the proposal of Nigel Cross (Michel, 2007, p. 48), also based on the same Archer's categories:

Design phenomenology – study of the form and configuration of artefacts

Design praxiology – study of the practices and processes of design

Design epistemology – study of designerly ways of knowing

2.5 Research domain

Includes the papers published at the Conferences on Design Methods and Design Theory, between 1962 and 1967, in England, and those organized by the Design Research Society (DRS) from 1971 to the present days.

The time range is 1962 to 2016, according to the following list:

Foundational Conferences on Design Methods (pre DRS)[1]

1962	Conference on Design Methods	London, UK
1965	The Design Method	Birmingham, UK
1967	Design Methods in Architecture	Portsmouth, UK

Design Research Conferences organized by the DRS

1971	Design Participation	Manchester, UK
1973	Design Activity	London, UK
1976	Changing Design	Portsmouth, UK
1978	Architectural Design: Interrelations among Theory, Research, and Practice	Istanbul, Turkey
1980	Design: Science: Method	Portsmouth, UK
1984	The Role of the Designer	Bath, UK
2002	Common Ground	London, UK
2004	Futureground	Melbourne, Australia
2006	Wonderground	Lisbon, Portugal
2008	Undisciplined!	Sheffield, UK
2010	Design & Complexity	Montreal, Canada
2012	Research: Uncertainty Contradiction Value	Bangkok, Thailand
2014	Design's Big Debates	Umeå, Sweden
2016	Design + Research + Society Future-Focused Thinking	Brighton, UK

Other DRS Conferences not included

Since not all the Proceedings of the Conferences have been published, there are five Conferences of which, at the moment, there is no detailed information available[2].

1964	The Teaching Of Engineering Design	Scarborough, UK
1972	Design And Behaviour	Birmingham, UK
1974	Problem Identification For Design	Manchester, UK
1982	Design Policy	London, UK
1998	Quantum Leap	Birmingham, UK

[1] The Design Research Society was founded in the UK in 1966. As it is described in its website: the origins of the Society lay in the Conference on Design Methods, held in London in 1962, which enabled a core of people to be identified who shared interests in new approaches to the process of designing. Since 1971 the DRS organize International Design Research Conferences. See: https://www.designresearchsociety.org/cpages/history

[2] See: https://www.designresearchsociety.org/cpages/publications-1

3 Methodology

3.1 Management of data

Collection of Conferences data

The papers have been collected, counted, and all data has been represented in tables and charts allowing comparison of quantity of research works published at the Conferences.

On doing this count, it has been left out the *keynote speeches* and *introductions* of each session.

Figures 1 and 2 depict this first stage.

VENUE PLACE	YEAR	PAPERS
London, UK	1962	16
Birmingham, UK	1965	35
Portsmouth, UK	1967	18
Manchester, UK	1971	20
London, UK	1973	105
Portsmouth, UK	1976	22
Istanbul, Turkey	1978	45
Portsmouth, UK	1980	35
Bath, UK	1984	60
London, UK	2002	91
Melbourne, Australia	2004	203
Lisbon, Portugal	2006	233
Sheffield, UK	2008	112
Montreal, Canada	2010	130
Bangkok, Thailand	2012	148
Umeå, Sweden	2014	127
Brighton, UK	2016	241
	TOTAL PAPERS	1641

Figure 1: Summary table showing Conferences, Years, Venue Places and quantity of papers. 1962-2016.

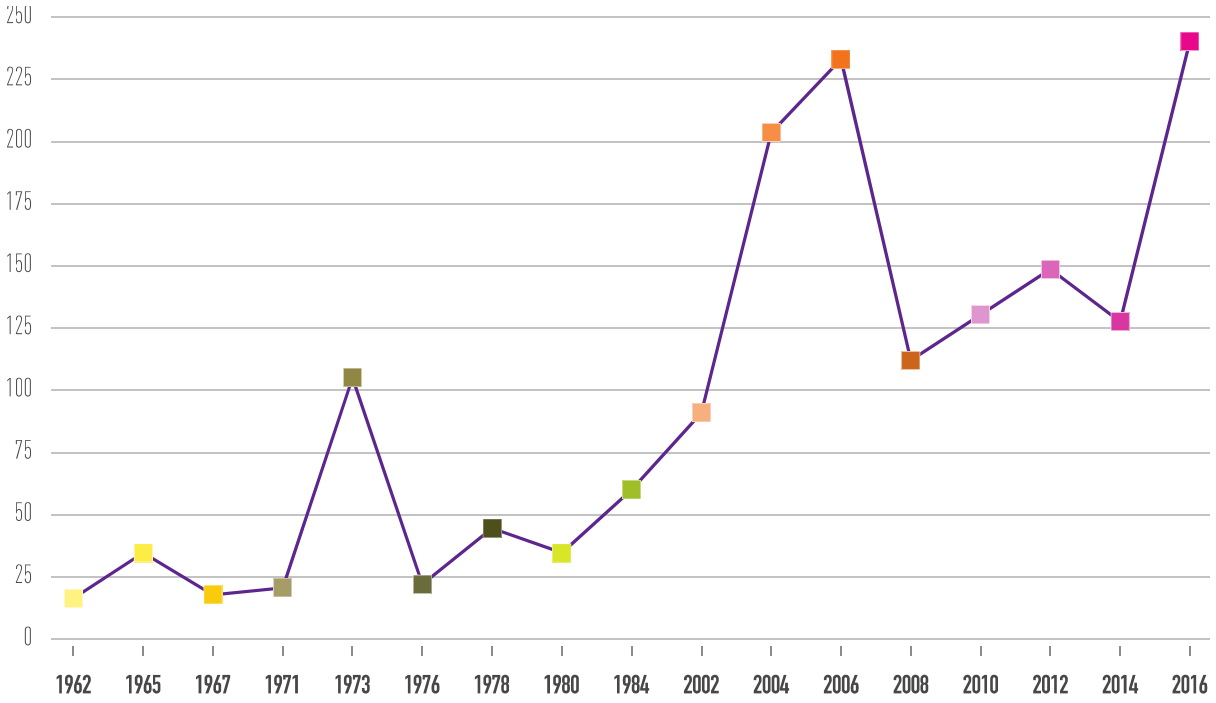

Figure 2: Comparative chart, quantity of papers on each Conference. 1962-2016.

These two figures allow appreciating the growing publication of papers in the Conferences.

Papers grouped by Session Titles or Chapters Titles

For each Conference, the papers have been separated by *session title*, according to available digital Proceedings and Conference Programs (e.g. “Design Culture" or "Sustainability").
In the case of printed publications (specifically the pre-90's Conferences), were considered the chapter’s titles of the publication (e.g. “User Participation" or "Products and System research").
In the case of the Conferences of 1962, 1967 and 1971, these Proceedings did not organize the papers into chapters so, for the moment —since there is no information about daily programming— it has been considered the title of the book (printed Proceedings) as a category/concept (i.e. 1962 and 1967: “Design Methods”, 1971: “Design Participation”).
Figures 3a and 3b allow visualization of all sessions titles as well as the number of papers per session.

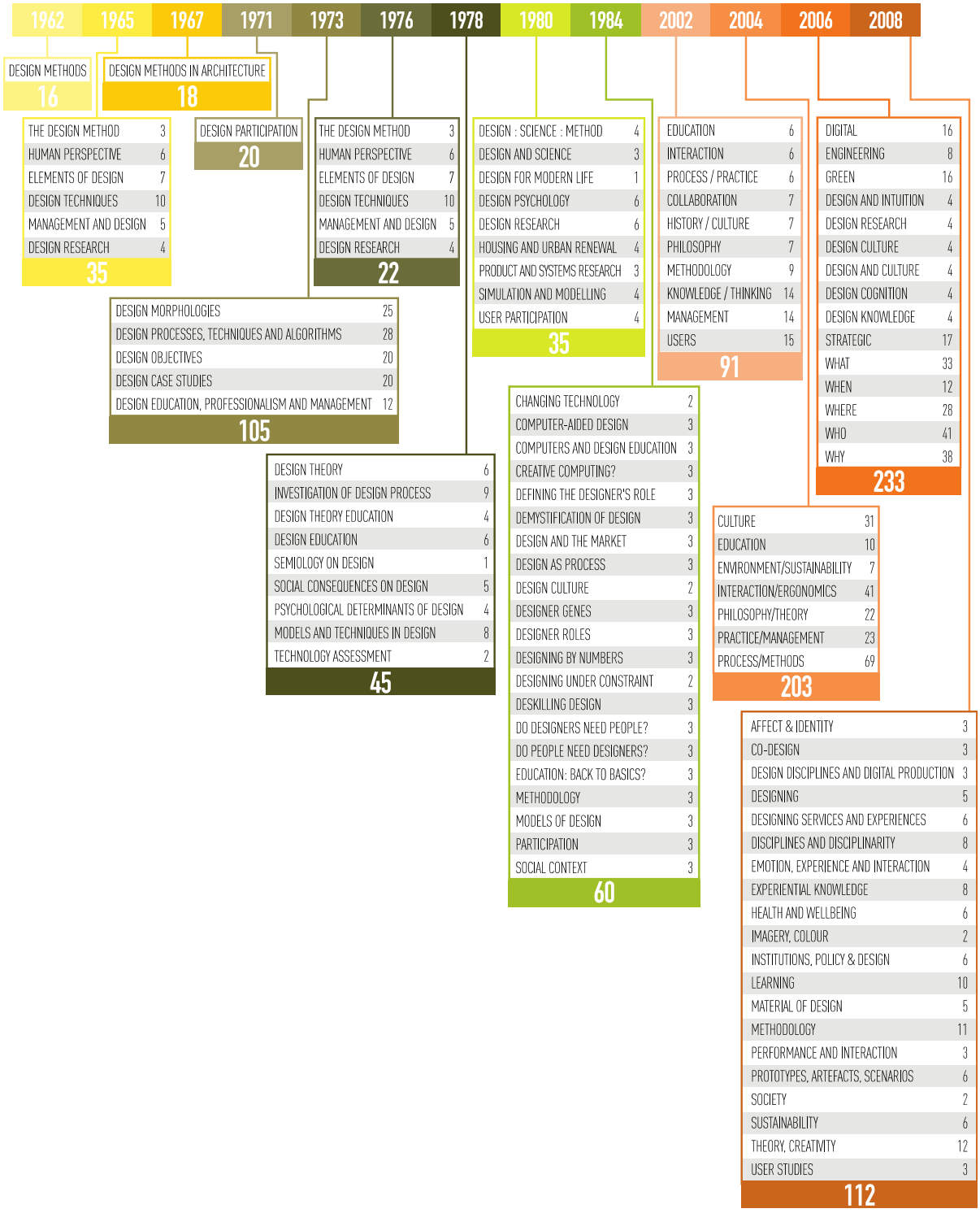

Figure 3a: Detailed information about session or chapters titles, and quantity of papers on each one. 1962-2008

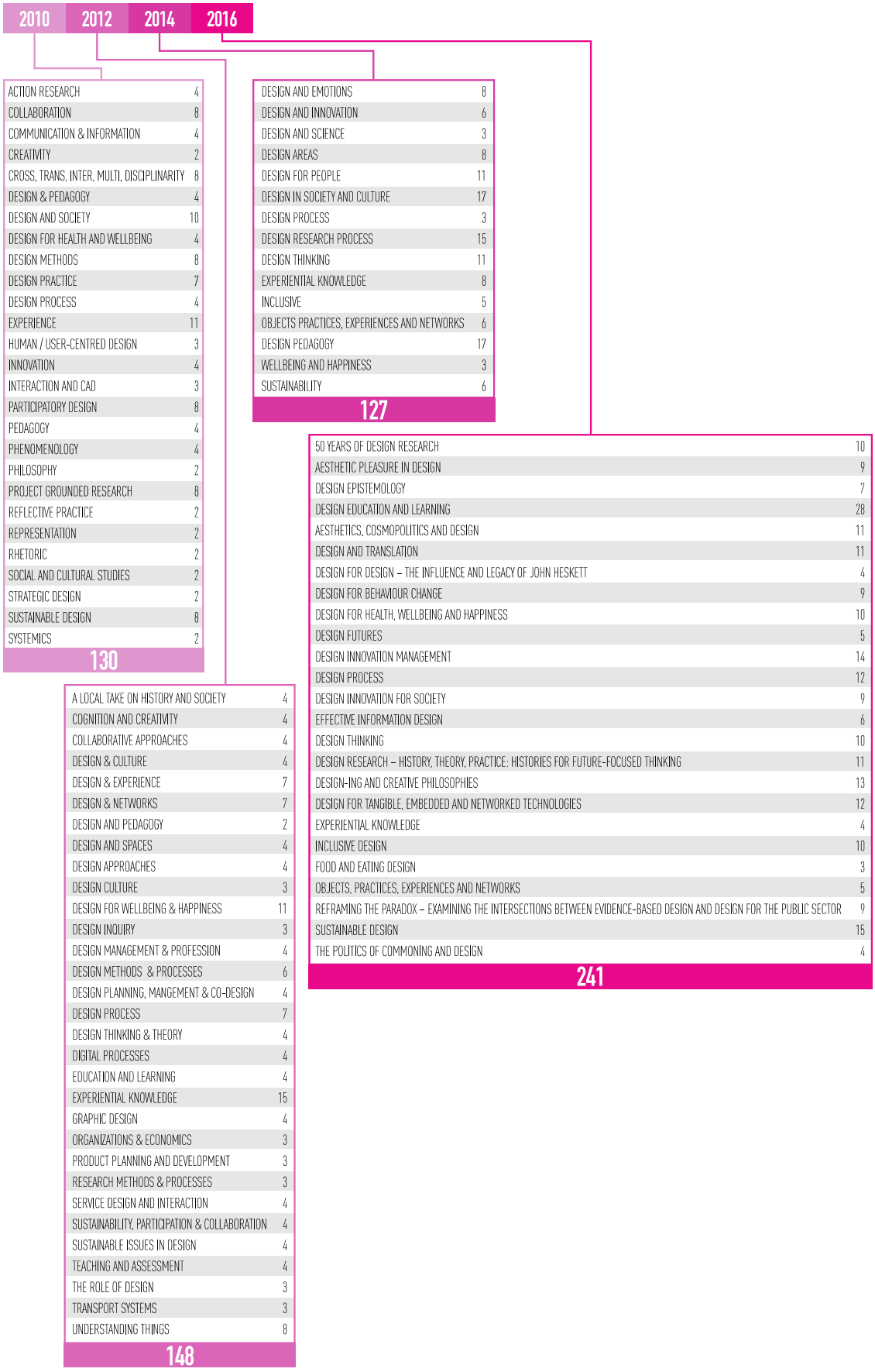

Figure 3b: Detailed information about session or chapters titles, and quantity of papers on each one. 2010-2016

Categorization criteria

Once the list of topics and the quantification of papers by theme has been made, the next stage has been the classification of each topic (and the papers within each one) in one of the three defined categories of design research:

Design Phenomenology, *Design Praxiology* or *Design Epistemology*

Figures 4 and 5 allow visualization of the existence, ascent and/or descent of each kind of design research category.

This process has been carried out considering the affinity of the concepts expressed in the titles of the sessions (or chapters/sections in printed texts) with one of the three design research categories. Also, in some cases, when the session title is not clear enough, or is not descriptive enough, the procedure has been to review the titles of the papers and their keywords.

VENUE PLACE	YEAR	PAPERS	design phenomenology	design praxiology	design epistemology
London, UK	1962	16	0	16	0
Birmingham, UK	1965	35	6	25	4
Portsmouth, UK	1967	18	0	18	0
Manchester, UK	1971	20	20	0	0
London, UK	1973	105	40	65	0
Portsmouth, UK	1976	22	22	0	0
Istanbul, Turkey	1978	45	18	17	10
Portsmouth, UK	1980	35	9	7	19
Bath, UK	1984	60	22	23	15
London, UK	2002	91	28	33	30
Melbourne, Australia	2004	203	79	102	22
Lisbon, Portugal	2006	233	109	78	46
Sheffield, UK	2008	112	57	32	23
Montreal, Canada	2010	130	69	49	12
Bangkok, Thailand	2012	148	92	47	9
Umeå, Sweden	2014	127	64	35	28
Brighton, UK	2016	241	127	66	48
	TOTAL PAPERS	**1641**			

Figure 4: Table with quantity of papers categorized in one of the three research areas. 1962-2016

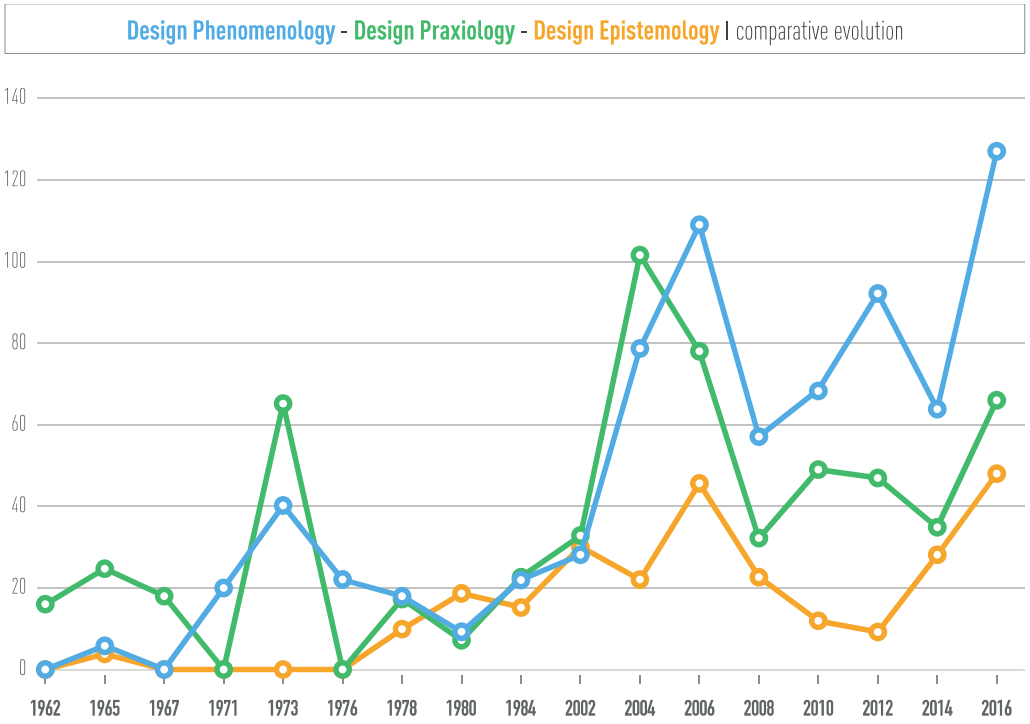

Figure 5: Chart comparing quantity of papers categorized by one of the three research areas. 1962-2016

3.2 First discussion about categorization criteria

The categorization of papers by topics in the Conferences, in some cases, could not give a true account of the precise meaning of a specific work within that category. Therefore the assignment of them to the major research categories - Phenomenological - Praxiological - Epistemological - should be adjusted, at a later stage of the investigation.

To verify the results it could be necessary re-categorize the papers based on a new reading considering hypothesis and research objectives. The new categorization should be compared with the first one. This will be particularly relevant in the Conferences of 1962, 1967 and 1971, where, the categorization criteria have considered the general theme (title) of the Conference.

4 Construction of a synchronic time-line

A comprehension exercise that is still in process.

4.1 Methodology

Organization of data over a time-line

The total papers, ordered by year, and classified on one of the three categories will be displayed on a timeline, where it will be possible to appreciate range of time between Conferences.

Also, some relevant facts have been added to this graphic:

- First specialized publications on design.
- Emergence of first design organizations or associations.
- First conferences organized by these groups, which continue to this day.

Figure 6 shows a big picture, where Conferences have taken place in the last almost sixty years.

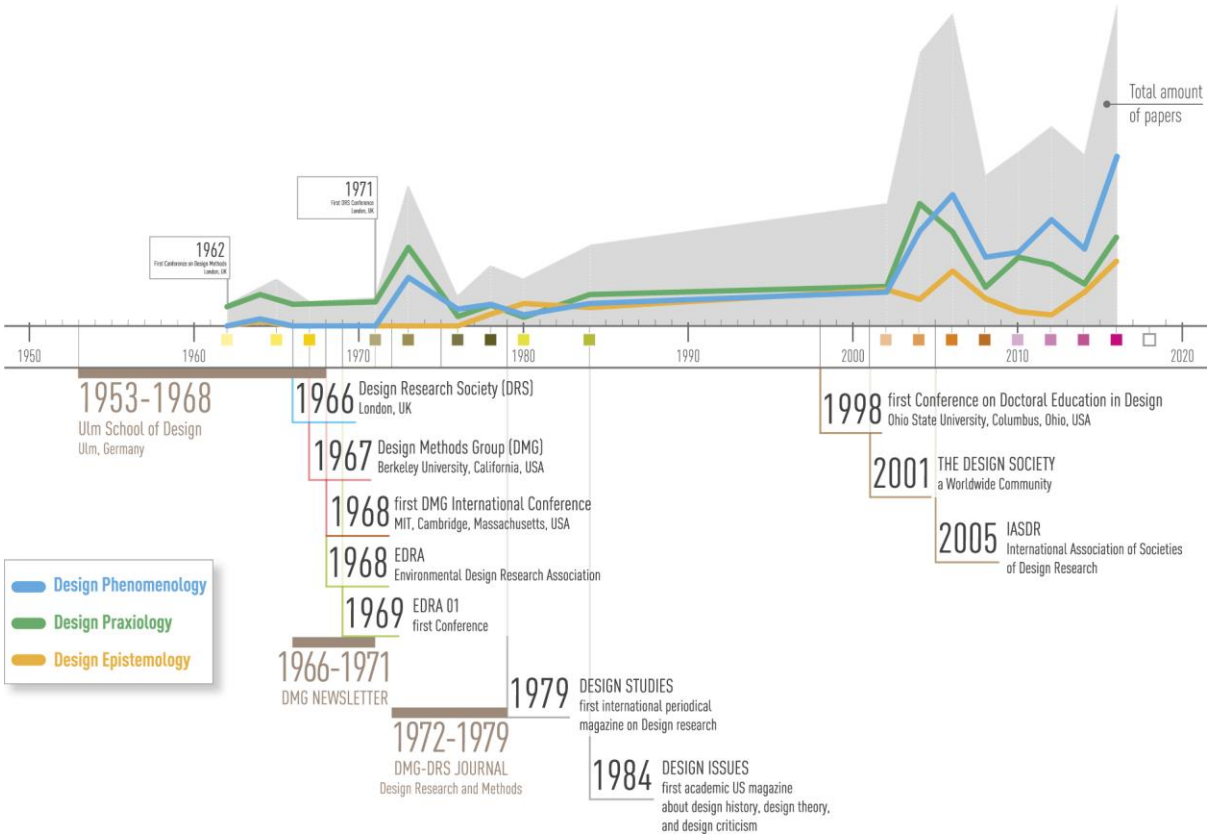

Figure 6: Synchronic timeline showing Conferences in historical "Design context".

4.2 First descriptions about relationship between Conferences and "Design Context"

a. As a first way of interpreting the relationship between the Conferences and the design context, the concepts of Horst Rittel (1972), identifying two 'generations' of Design Methods, will be used as a tool.

Figure 7 includes two vertical strips that mark the range where, according to Rittel, these two different emphases occur. *First generation***:** In the sixties, Operations Research predominance, with "a particular type of systems approach" (Rittel, 1972). *Second Generation***:** Early seventies, where design problems are defined by Rittel as "wicked problems" (Rittel, 1973).

Some relations observed:

- *First generation:* As can be seen in Figure 7, during the 60s the focus of design research work is predominantly aimed on procedures (Design Praxiology).
- *Second Generation:* At the beginning of the 70s, along with the praxiological line, the line of Phenomenological research emerges and grows.

b. A second "tool" that allows to "read" the relations between Conferences and context, is the research work carried out by Fatima Saikaly (2004), who offers a detailed overview about doctoral research in design.

Figure 8 highlights the space of time where there is an absence of International Conferences organized by the DRS. In this period, according to Saikaly, the first PhD programs begin in the United States, Australia, Europe and Japan.

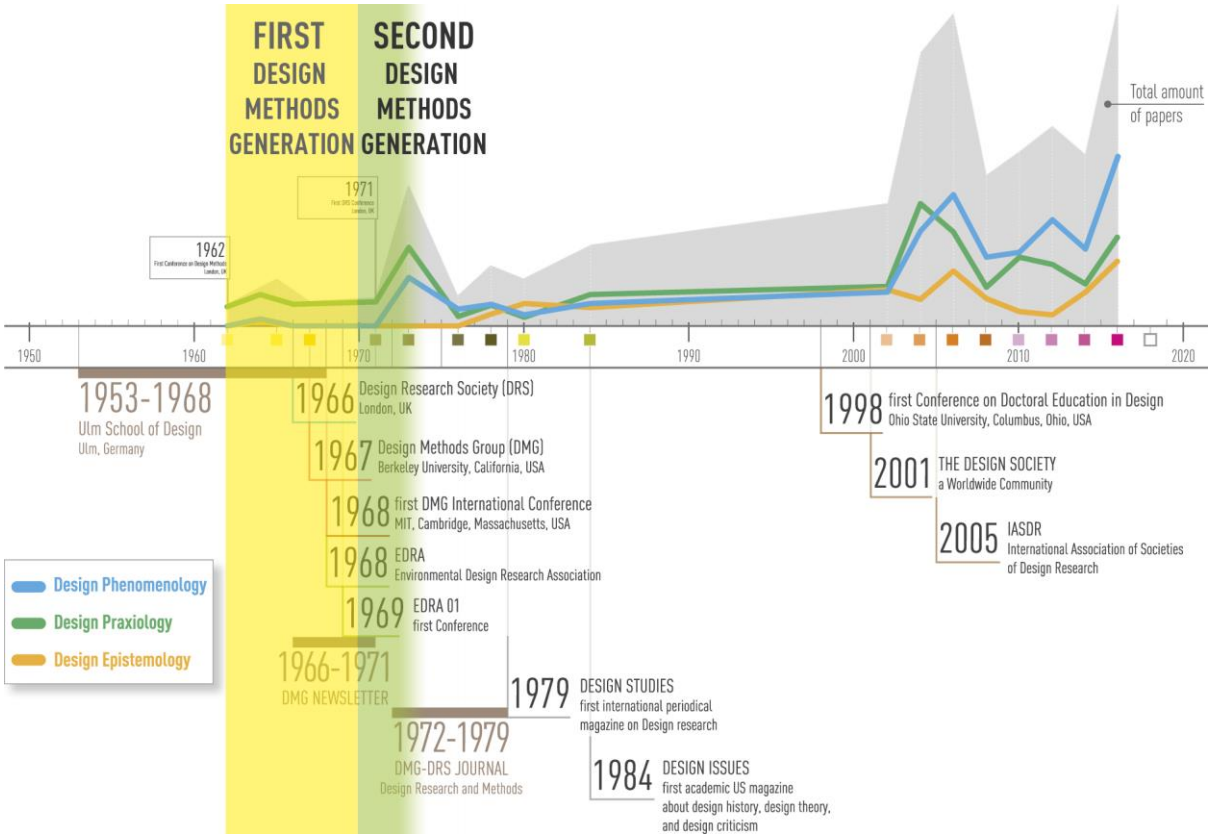

Figure 7: The Rittel's First and Second Generation Design Methods, viewed over the synchronic timeline.

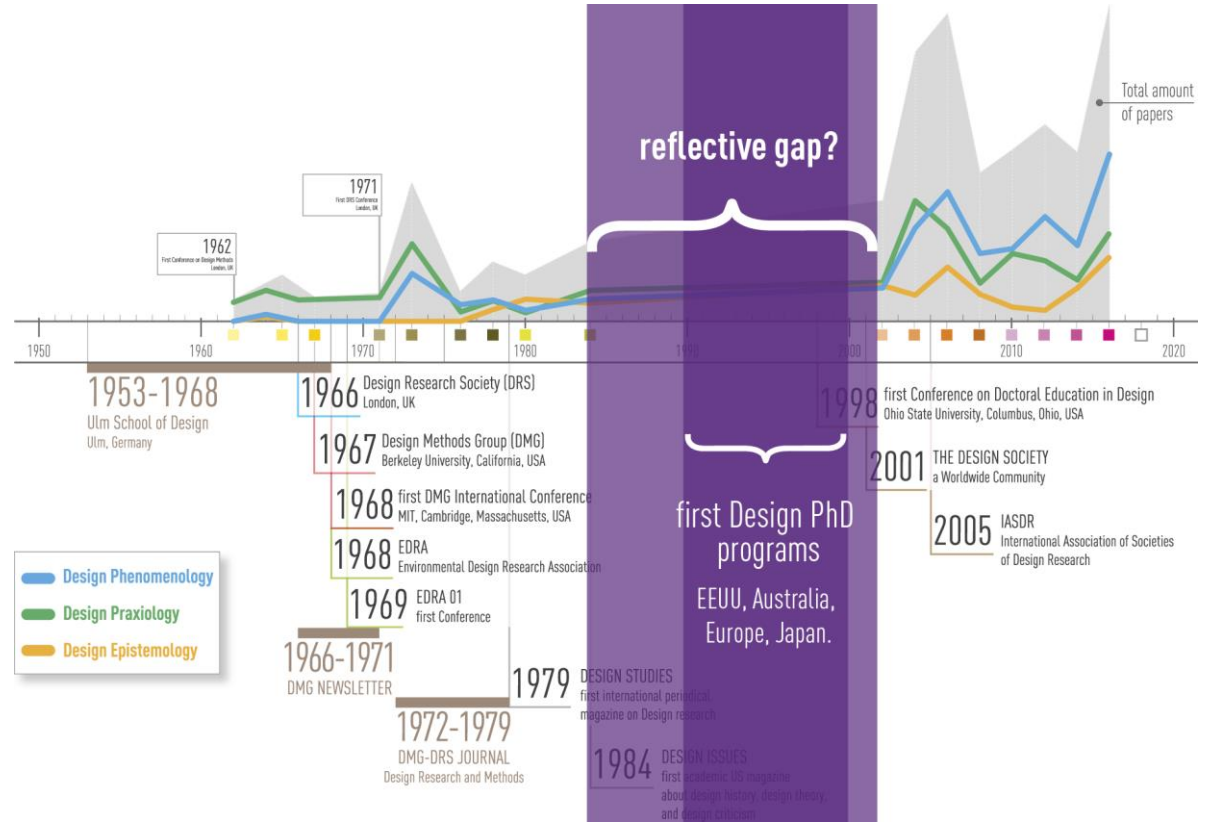

Figure 8: The relationship between the "gap"produced within international DRS Conferences, and the emergence of PhD Programmes in Design.

4.3 About the hypothetical "reflective gap"

As it was explained before, the research domain of the present work does not include five Conferences (1964, 1972, 1974, 1982, 1998). One of them –the DRS 1998– took place within the period highlighted in Figure 8.

However, considering that the period described covers eighteen years - between 1984 to 2002 - within this period only the Conference of 1998 was held.

5 First discussion

The construction of a timeline based on (or describing) design activity has already been carried out by other researchers. In the present paper, one of these approaches has motivated a comparison exercise, and then a first discussion.

The Gui Bonsiepe's Hypothetical timeline:

In 2004, Gui Bonsiepe proposed a timeline that he called "Hypothetical Timeline of the designdiscourse", then, in 2007, the same timeline was published in his article "The Uneasy Relationship between Design and Design Research" (Michel, 2007, p. 25-39).

Figure 9, depicts his speculation about the evolution of "designdiscourse", from the fifties to the nineties.

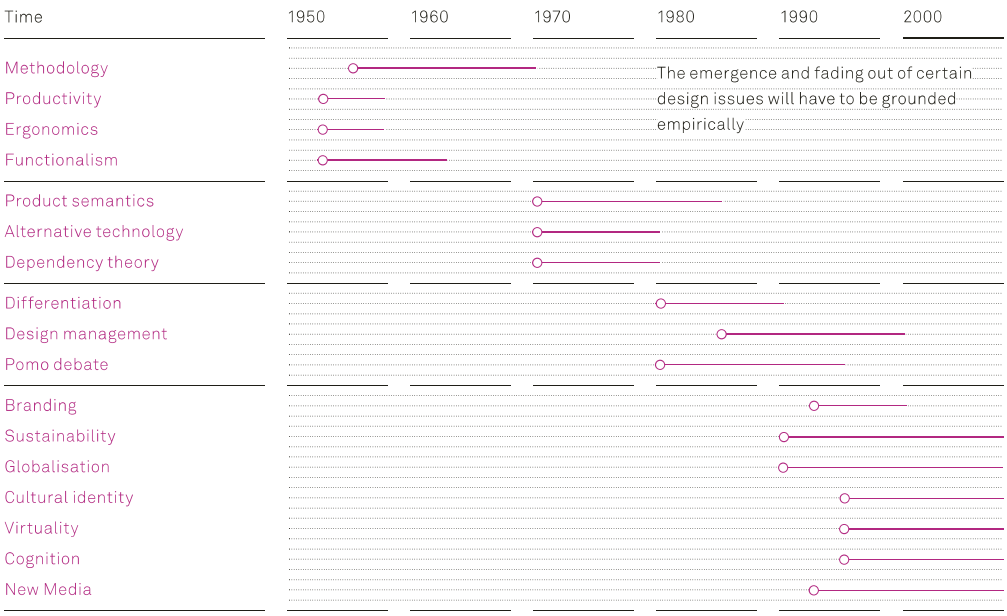

Figure 9: Gui Bonsiepe's Hypothetical Timeline of the designdiscourse.
(© Gui Bonsiepe 2004, On the Ambiguity of Design and DesignResearch)
From: Michel, R. (2007). Design research now: Essays and selected projects. (p. 33) Basel, Switzerland: Birkhäuser. Reprinted with permission.

According to Bonsiepe, the 50s were predominantly focused on: Methodology, Productivity, Ergonomics and Functionalism, which can be categorized within the areas of Praxiology and Phenomenology. Nevertheless, the 50's period is not considered within the range of Conferences of the present paper.

In the 60s, the main "designdiscourse" appear to be Methodology and, –in part– Functionalism. The taxonomy constructed in the present work shows a Praxiological emphasis at that period, that means the kind of issues that researchers would be more focused on is design processes.

The 70s would be focused on Product semantics, Alternative technology, and Dependency theory. Compared with the results of this inquiry, they correspond to Phenomenology and Praxiology.

In the 80s, the “Pomo Debate” (Post-Modern debate) appears to be the first different focus, a Phenomenological view that, looking the results of this inquiry, is consistent.

Finally, in the 90s, according to Bonsiepe, emerge many subjects of discussion (and “designdiscourse”): Branding, Sustainability, Globalisation, Cultural Identity, Virtuality, Cognition, and New media. All of them seem to be closer to Phenomenology too.

6 First conclusions

a. Results of the present work show an increase of design research works within the period studied; this would reflect the growing number of researchers and also the need of this reflection for the discipline. In general, Phenomenological and Praxiological lines of design research have tended to be prevailing against the Epistemological line. One possible interpretation is that the epistemological reflection would not have had the urgency of the other two, at least from the 60s to the 90s. However, Phenomenological line has prevailed in the last three Conferences. This tendency would reflect that theoretical approaches and inquiries have been predominantly oriented towards the users and contexts in which Design acts as well as the procedures that allow carrying out the design process. Besides, an increasing of Epistemological research (in the same last three Conferences), would reveal an emerging focus on design knowledge, and, also design education. However, the upward trend of the Epistemological line will have to be evaluated (confirmed or not) after a review of, at least, the two Conferences programmed in the current decade (2018, 2020).
b. After contrasting the Rittel ideas about “Generations” there is a consistency between the emphasis shown by the Design Research areas, within the Conferences, and Rittel descriptions. It is very clear that in the sixties (First generation) the big focus was in Praxiological issues. Then, in the following years (Second Generation) it take place a Phenomenological turn. In the same way, Saikaly results of research, fit with a stage where the efforts were oriented predominantly towards a reflexive activity.
c. Regarding the comparison made with the hypothetical timeline of Bonsiepe, the subjects that “designdiscourse” has addressed, and its relationship with design research areas –or emphases–, reflect the almost absence of epistemological research efforts between the 60s and 90s. In general, the hipothetical timeline of Bonsiepe is consistent with the evolution described in this investigation.

7 Further inquiries

Faced with these first results, new questions arise, in order to describe more precisely the scope of investigation of each paper, considering their particular hypotheses and research objectives.
Another research issue would be to explain the fluctuation of certain lines of research over time, considering other aspects, such as technological, cultural and social context in which these reflections take place and the specific historical moment in which they occur.
This research could take several future paths, trying to answer new questions and, with them, other hypotheses will also arise regarding the kind of theoretical approaches that are observed and also with respect to those that are not yet reflected in the DRS Conferences.
Finally, this research should address the relationships, influences and connections between the DRS Conferences and the beginning –and evolution– of theoretical reflection in Latin America, where the first design schools will emerge in the late 1960s, not so far from the first Conference.
The inquiry adventure is ongoing.

Design Research is not equatable to scientific research.
It is designerly enquiry, not Design Research.
Bruce Archer (1980)

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Section 4.

Open Track

DRS Design Research Society 2018 Catalyst

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25th–28th June 2018

The Interconnected Process of Design and Science: a method for mapping concepts and knowledge

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Innovation is often perceived as an unmanageable phenomenon. Design introduces creative problem definition, such that science knowledge can lead to innovation. Simon (1968) alludes to the tension between science and its practical applications in his discussion, *The Sciences of the Artificial.* This paper explores the relationship between the two fields of science and design through C-K Theory. Four case studies are analysed through the deconstruction of a C-K map - a tool that allows a project to be described based on the way ideas and information have developed over time. The findings present three new models within the C-K theory construct; (i) the E-ladder; (ii) the K-space spiral and (iii) the double helix. Implications and future work for these three new models are explored and presented.

design process; c-k theory; science innovation; design innovation

1 Introduction

Innovation has been defined as "the multi-stage process whereby organisations transform ideas into new/improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace" (Baregheh, Rowley & Sambrook, 2009, pp. 12). The relationship between design and innovation has been explored by a variety of fields such as design (Wrigley, 2017; Verganti, 2009), business (Brown, 2008), and management (Martin, 2009). This is largely due to design being viewed as a critical strategic resource, revealed through the success of organisations such as Apple, Proctor and Gamble, and General Electric. Design, and the notion of design thinking and design innovation, is offering alternative approaches to traditional, internal improvement approaches as the key source for innovation. The value of design comes through capturing new knowledge and the designer's ability to consistently reframe scenarios and possibilities in close creation with users. Traditionally, design has been practiced in a fairly deductive manner – working from a broad range of ideas and concepts and gradually placing constraints around those concepts through prototyping and observation. However, the Oxford Dictionary (2017)

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defines the scientific method as a process of "systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses". It is this process of questioning and testing that, in its rigour yet simplicity, has established both fundamental scientific laws and conceptual future technologies. Conversely, it would be myopic to assume that the scientific method is all that is needed for science to truly achieve innovation. This raises a question of metrics – how is "good" or "successful" scientific achievement measured? In traditional research contexts, it is almost exclusively the case that publications and patents designate the success of a research process. Yet a brief exploration through historical inventions reveals that this does not suffice. For example, the invention of the laser (Gould, 1959) stemmed from extensive reputable research in optical and quantum physics, yet the majority of its practical uses in electronics and spectroscopy were not established until decades later. Conversely, an invention such as Google Glass had copious investment in prototyping and user trials long before the details of its design and technology had been sufficiently defined, and the product was thus discontinued (Crothers, 2015). From the perspective of science, the invention of the laser would be called an instant success (new knowledge and publications) and Google Glass a failure (lack of knowledge resulted in a weak product). But an intuitive conclusion would be that *neither* of these inventions were able to achieve *innovation*. There is currently a gap in understanding that the scientific method cannot close on its own, and that is in how we understand the value, and impact of research – how we create innovation. Therefore, this study aims to explore the role of design as an invaluable tool to improve both scientific process and outcome, in its ability to bring new meanings and directions to research. Through an exploratory case study approach, C-K theory (Hatchuel & Weil, 2003) was implemented as the analysis framework.

2 A brief history of design and science

Science in its most traditional forms does not generally extend beyond knowledge and into the field of design. Simon (1968) pinpoints the issue as a perceived risk of losing scientific rigour in the creation of a design artefact. However, it is in fact design, this "interface between the inner and outer environments" (Simon, 1968, p. 113), that ensures scientific knowledge can be more than just knowledge, exploring the breadth of applications while retaining depth of information. Cross, Naughton and Walker (1981, p.1) suggest that the hesitation to deviate from pure scientific method is not due to the innate value in these methods, rather the value in *science* as is – "rationality, neutrality, and universalism". This opens up doors for conjecture – traditionally, science would reject speculation, while their argument is that all scientific theories in themselves rely on hypotheses of the unknown, and their ability to be falsified. The boundary between design method and scientific method is blurred, as while they are varied approaches to problem solving, both are seeking the problem to be solved.

This is also explored in Willem (1990) study Design and Science, explaining that science and design be two different pursuits of the same thing – understanding of the world. While science is deemed to be a continuous process of building knowledge, design is less concerned with production and more the application of knowledge. However, Willem (1990, p. 45) states that the two are intertwined, in that "it is only through design that science is made visible". Here, design is seen as a "lens" into the world of science: that "science knowledge is part of the fabric with which designer's design" (Willem, 1990, p. 44). Science is described as the foundations of design, with design the necessary intelligence that perceives and meets a need. Design introduces creative problem definition, such that science knowledge can lead to innovation.

Bonsiepe (1995) and Luo (2015) extend the discussion that there is a need for collaboration between the realms of design and science by describing the interconnected process of innovation. *Science* innovation is described (Bonsiepe, 1995) as being evidential and cognition-based, pursuing the goal of truth (knowledge). *Design* innovation involves evaluation and ideation, creating novelty in

possibilities (Bonsiepe, 1995). The notions of technology and entrepreneurship sub-processes also highlight that both science and design are grounded by the "real world" and the need to "continually experiment, collect feedback, and learn through trial and error" (Luo, 2015, p.8). Both works emphasise that each process is co-dependent and the path to innovation is non-linear – all are mutually beneficial, and if any are lacking, true innovation halts.

This concept is brought to the context of a research organisation by Simpson and Powell (1999). Driven by the idea that the innovation output of a team is a direct result of its organisational structure, they describe four design archetypes for a research organisation:

- Solitary Genius: a traditional view of autonomous scientists pursuing knowledge for the sake of discovery, but struggling in response to rapid lateral expansion in complex technology.
- Technology Push: shifting focus to product and process development, with "a strong emphasis on the progressive refinement of specialist expertise" (Simpson & Powell, 1999, p. 442) – at the risk of impractical segregation into single-discipline teams.
- Market Pull: an antithesis to the Technology Push, relying on market driving forces to direct the flow of research, introducing non-traditional roles for those outside scientific industry – but ultimately sacrificing creativity.
- Multiple Project: a middle ground between the latter two archetypes, where a balance of creative invention and grounding in market reality is met – the ideal research team.

This quest for common middle ground yet again adamantly asserts the "coupling between science, technology and the marketplace" (Simpson & Powell, 1999, p. 443), this is also supported by Bonsiepe (1995) and Luo (2015). It is clear that there is a need for collaboration between design and science, or even an assertion that the two are inseparable to begin with. However, what is still to be explored in depth, is how this is achieved as an approach and process.

3 Exploration of C-K theory

Hatchuel and Weil (2003, p.1) introduce C-K theory, motivated by the notion that "design theory should have robust theoretical roots linked to well recognised issues in logic". Design is portrayed as a process by which knowledge can evolve, while still achieving a goal of creativity and imagination. In essence, it establishes two spaces: K, the "knowledge space", and C, the "concept space", such that we "define design as the process by which a concept generates other concepts or is transformed into knowledge" (Hatchuel & Weil, 2003, p. 9). A proposition of K (essentially 'a piece of knowledge') is required to have some logic value – be it true/false, fuzzy logic, or another defined status.

Conversely, concepts in the set C are considered impossible to prove and hold no logic value. The power of the model lies in the interactions between the C-K spaces in terms of external (K→C, C→K) and internal (K→K, C→C) operators:

- **K→C:** this is referred to as "disjunction", where current knowledge is reimagined into concepts and ideas, expanding the C space,
- **C→K:** this is referred to as "conjunction", in an attempt to transform a concept into a finished product, becoming accepted knowledge,
- **K→K:** this is the trivial expansion of the K set, where available data and knowledge are added and subtracted from the process as required, and new knowledge is created from existing knowledge,
- **C→C:** this is the exploration and development of concepts mapping to new concepts.

These four operations can be visualised in the 'design square' (Figure 1). Each side of the square describes the process by which a C-K operator is performed. Further, a C-K map can be derived as a visualisation of the project's design process, as seen by the generic example in Figure 2.

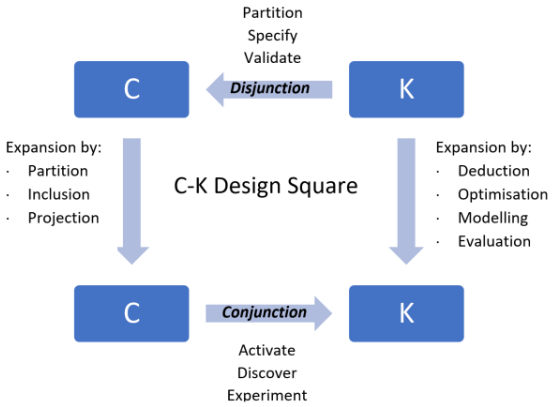

Figure 1 C-K Design Square. Adapted: Hatchuel & Weil, 2003; Potier et al, 2015.

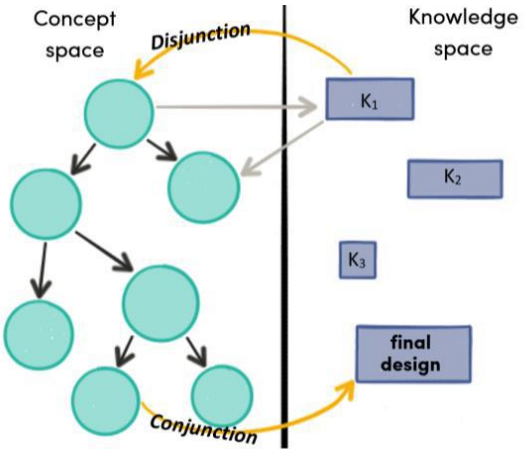

Figure 2 C-K Map, showing hypothetical operators and Ki propositions. Adapted: Hatchuel & Weil, 2003.

Hatchuel, Le Masson and Weil (2004) later express that scientific research is thus innately a 'design issue', since it "aims to create K-expansions, yet these expansions should be driven by some C-expansions; thus, it could help to consider research as an innovative design situation" (Hatchuel, Le Masson & Weil, 2004, p. 5). Two main approaches to the C-K mapping process are further outlined, depending on if the research is part of a science-based project (SBP) or creativity-based project (CBP). SBPs generally exist within a specialised but narrow K set (Large, 2017), and are searching for outside-the-box applications of niche knowledge. Hatchuel, Le Masson and Weil (2006) describe this to be a breadth-first approach, where despite limited knowledge, we expand on a variety of C sets and apply narrow K in non-classical scenarios by expansive partitions. Alternatively, CBPs are often expansions of a very general or common knowledge base, and run the risk of being overwhelmed by an unlimited C set. More suitably, a depth-first approach refines the conceptual process to avoid growing overwhelmed by attractive but potentially unviable choices. This is where the visualisation of a C-K map becomes integral – its depth and/or breadth can be used to estimate the success or failure of a project (Hatchuel, Le Masson & Weil, 2006). Here we are presented with a rigorous design paradigm that not only formalises the research process, but assists in the assessment of a successful research project by alluding to an ideal C-K map layout. Perhaps a C-K map of the aforementioned laser would reveal too narrow thinking, or Google Glass an uncontrolled or shallow ideation process.

Despite this clear need and ability of C-K theory to promote innovation, there is a gap in the literature in terms of a model or framework for the application of C-K theory to scientific research. The proposal to use C-K theory to establish common ground (Chen et al., 2017) is a critical one – for collaboration to occur, parties must first speak the same language. The success of this

expansive design dialogue in the business field, combined with the known value of using C-K theory in collaborative contexts, allows us to consolidate the previous gaps in knowledge, and raise a new research question: How can C-K theory be used to initiate, direct, and realise innovative scientific research?

4 Case Study Analysis

A series of innovative case studies were explored in terms of their research and design process. Three separate modes of data were collected from secondary sources. Multiple data sources were sourced to gain the broadest possible range of information from a variety of perspectives to ensure coverage, range and triangulation. All data came from publicly available third-party digital resources such as websites, social media pages, online trade publications and annual company reports. The data collection for each case study began with a search of the company's website; annual reports and other publically available information were analysed to gain an overview for each one. Following this, web searches were conducted as a precaution to discover any information not present on the other data sources. This information was mapped onto a predesigned data sheet developed by the research team. Having captured data across a diverse set of sources, the authors were able to increase the reliability and validity of the analysis by means of data triangulation (Thurmond, 2001).

4.1 Analysis Framework

The research followed a deductive structured qualitative content analysis approach (Elo & Kyngäs 2008; Nusem, Wrigley & Matthews, 2017; Straker, Wrigley & Rosemann, 2016) utilising a predetermined categorization matrix (Mayring, 2004). Having selected a categorization matrix, data were able to be coded in accordance to the predetermined categories featured in the matrix, and aspects of data which did not fall into the predetermined categories were able to be filtered out (Elo & Kyngäs, 2008). The C-K mapping process first involved an overarching description of the scope of the project. The starting point was defined as either a Concept or piece of Knowledge – questioning if the project was motivated by a need or idea (Concept) or by a gap in knowledge that needed to be filled (Knowledge). Each stage of development, as publicly reported by the research teams, was then described through C-K operators, until the final design (in this case, products) was reached in the K space. Through this attempt to infer a possible C-K process implemented by the scientists and designers involved, visualisations of innovative research were made.

4.2 Case 1: DuoSkin

The first case study is of a recent innovation in the MIT Media Lab, where there has been developed wearable technology in the form of gold leaf "tattoos" known as DuoSkin (Kao et al., 2016). The research team was inspired by the recent applications of on-skin devices in medical purposes (such as drug delivery or monitoring), and sought to bring this technology into the everyday world. Further, they worked within known outcomes in body-compatible interfaces by "repurposing accessible materials (e.g. gold leaf, thin tattoo paper) and tools (craft electronic cutter)" (Kao et al., 2016, p. 2). In C-K terminology, the MIT Media Lab performed a K→C disjunction of the known scientific and technological space in order to appropriate knowledge into new concept spaces. A process of technical evaluation in terms of user experience and product durability was implemented (driving C→C expansions). Ultimately, with the invention of a successful product, C→K conjunction was achieved (Figure 3).

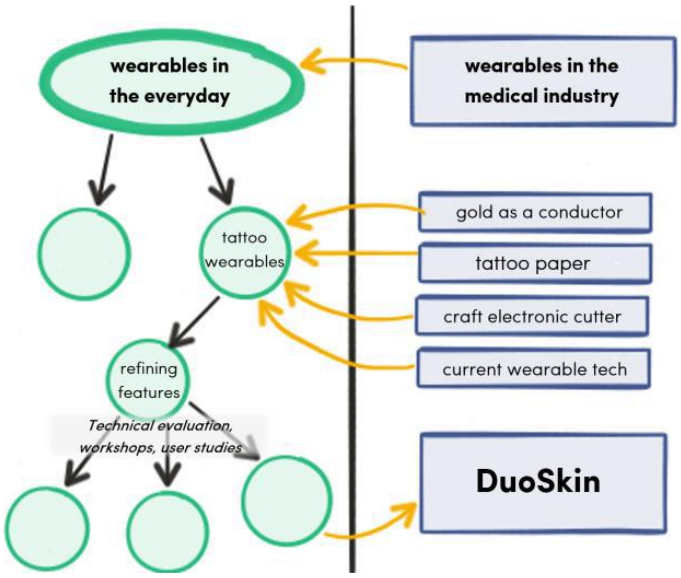

Figure 3: Hypothesised C-K map for the MIT Media Lab design process

4.3 Case 2: Algae Printing

Marin Sawa is a researcher at the interface of design and biology, seeking to bring real world meanings to scientific innovations. Algae Printing, a novel technology that involves developing bacterial cultures on surfaces, was in fact birthed within a biotechnology research laboratory in the Imperial College of London. Sawa (2016) proposes an intensive collaboration technique wherein designers are invited within the research laboratory through an 'observation day'. Her hypothesis was that by harnessing the collaborative physical and social space of a research laboratory, combined with the rigour of the scientific method executed through a designer's perspective, new innovations could be brought about. It was found that the presence of a designer disrupted systematic routine and sparked 'non-standard scientific questions' (Sawa, 2016, p. 68). These led to new conceptual directions, and her early innovation of using inkjet printers to print algal cells. In contrast to DuoSkin, here lies a project starting in the C space – Sawa's hypothesis on the nature of scientist-designer collaboration was conceptual at first, then rooted in knowledge upon establishing herself within the Imperial College Photosynthesis Lab. New knowledge from the unfamiliar K space continually and broadly feeds into the C→C expansion, leading to unexpected concepts, and a final C→K conjunction that establishes new knowledge potential (Figure 4).

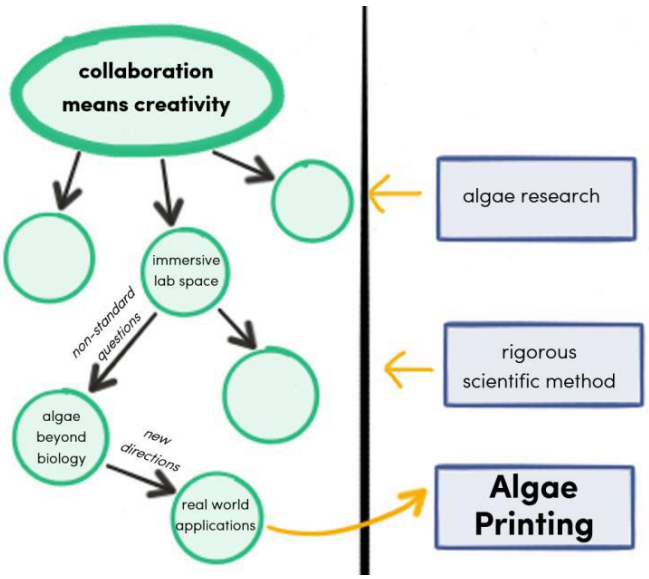

Figure 4 Hypothesised C-K map for Sawa's design process.

4.4 Case 3: Organs-on-chips

Research at the Harvard Wyss Institute was driven by a glaring need in the medical industry for reliable and fast means to develop and test chemical therapies (Henry et al., 2017). The problem space they defined was that drug development is a lengthy and costly process that, being heavily reliant on animal testing, has great implications in accuracy and ethics. Hence the development of organs-on-chips, a microtechnology wherein human organs and biological functions are replicated in a clear polymer chip, allowing medical researchers to effectively test and visualise the behaviour of new compounds. The technology has now been commercialised; Donald Ingber of the Wyss Institute outlines how they "took a game-changing advance in microengineering made in our academic lab, and in just a handful of years, turned it into a technology that is now poised to have a major impact on society" (Wyss Institute, 2017). This is a textbook example of an in-depth K space (knowledge of current medical research and microtechnology) undergoing a K→C disjunction that allows researchers to extend their work beyond what is conventional or 'known' into a conceptual sphere. The K space is expanding with scientific research, but having a well-defined problem space ensures that disjunctions direct the K→K expansion towards a clear goal and final C→K conjunction (Figure 5).

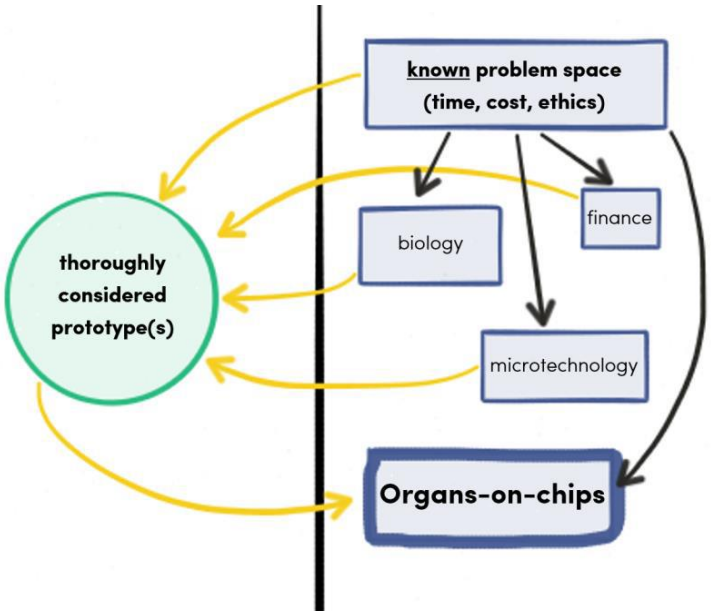

Figure 5 Hypothesised C-K map for the Wyss Institute design process.

4.5 Case 4: Liquidity Naked Filter

The Naked Filter is a nano-engineered water purification device, compartmentalised into a water bottle. Liquidity, the start-up behind Naked Filter, is unique in its establishment – aside from the commercialisation team, there exist dozens of academics and students at Stony Brook University continually developing the nanofiber technology. The founders commenced their research based on a proposition that electro-spinning can be used to create a filtration membrane (Lee et al., 2017). This hypothesis drove years of research efforts, fuelled by industrial funding, before a final patent. The next stage was forming the Liquidity 'Dream Team' and commercialising the product. Research is currently continuing in terms of increasing the scale, applications, and efficacy of the filtration system (Naked Filter, 2017). This cyclical process of questioning, researching and applying has led to the company's success and can be visualised through C-K theory. There is simultaneous iteration in the C and K spaces, with K→C disjunctions leading to innovative new concepts backed by in-depth research knowledge, and C→K conjunctions leading to prototypes and product development (Figure 6).

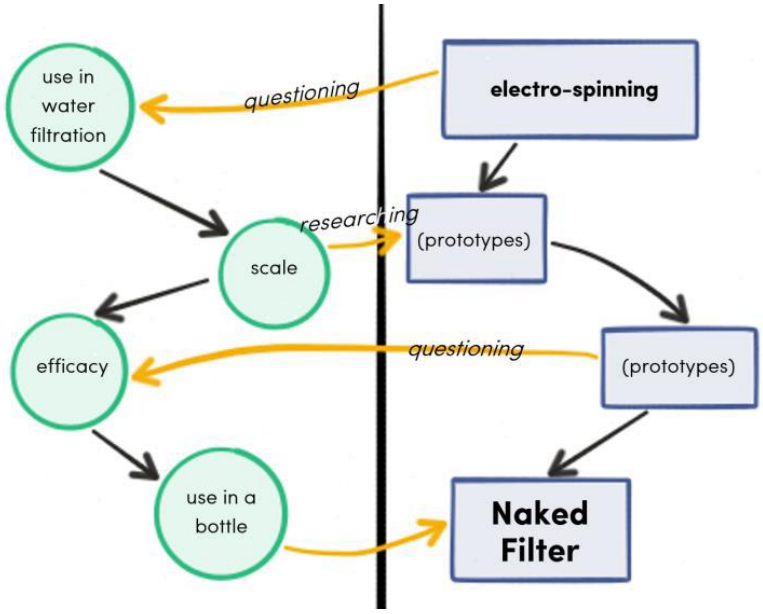

Figure 6 Hypothesised C-K map for the Liquidity design process.

5 Discussion: Three New Models

The authors propose three new models from which can be derived from C-K mapping; (i) the E-ladder; (ii) the K-space spiral and (iii) the double helix. Each are detailed below with respect to the case studies in which they were identified.

Mapping the design process in C-K theory for each of these case studies yields quite distinct paths – and this is expected, as research projects are seldom identical and will of course follow different courses. However, in terms of overall driving forces and design processes involved, some interesting inferences can be made. Comparing the cases of DuoSkin and Sawa's Algae Printing, these are both examples of Hatchuel, Le Masson and Weil's (2004) creativity-based projects (CBPs). These projects are sparked within a conceptual space of excitement, inspired by the potential for science (traditionally, K propositions) to direct innovation. Both are successful because they further follow Hatchuel, Le Masson and Weil's (2004) recommended depth-first approach, where instead of allowing overwhelming ideas dominate, concepts are continually grounded in an expanding research space. The hypothesised C-K maps visually reveal this, where specific technologies (in the case of DuoSkin) or general scientific input (in the case of Algae Printing) direct C→C expansion. This is not simply a depth-first process, rather outward branching into research (the K space) becomes a very significant contributor that ensures the C-space remains relevant and has substance from which to develop.

The C-K map model called the 'E-ladder' is where the backbone of the 'E' maps the C→C depth, and the 'arms' of the 'E' create roots in the K-space (note that the three arms of the 'E' are arbitrary, and a process may have more/less as needed) (Figure 7).

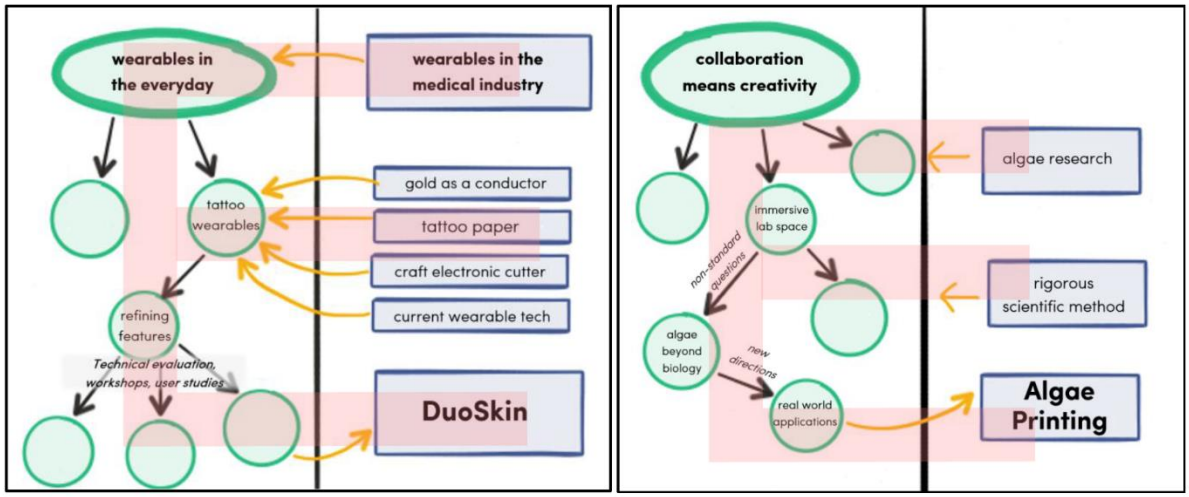

Figure 7 E-ladder superimposed on the C-K maps for DuoSkin and Algae Printing, highlighting the presence of a C→C backbone and K-space roots.

The 'K-space spiral', seen in the Organs-on-chips case study and is an example of a science-based project (SBP) emerging from a narrow and refined knowledge space. However, on creating a C-K map, we do not see (from the information available) an attempt to perform breadth-first concept expansion to find new applications for this niche knowledge (Figure 8). So, what makes this still a successful innovation? It is most likely due to the constant recurrence of a well-defined problem space. This ensured that research efforts were driven by a known need, such that the K→C disjunctions lead to concepts that were already solving a problem. This equipped the consequent C→K conjunction, and thus Organs-on-chips were invented. This process could potentially be named the 'K-space spiral', since all propositions in K return to a common problem before iterating through the evolving concept.

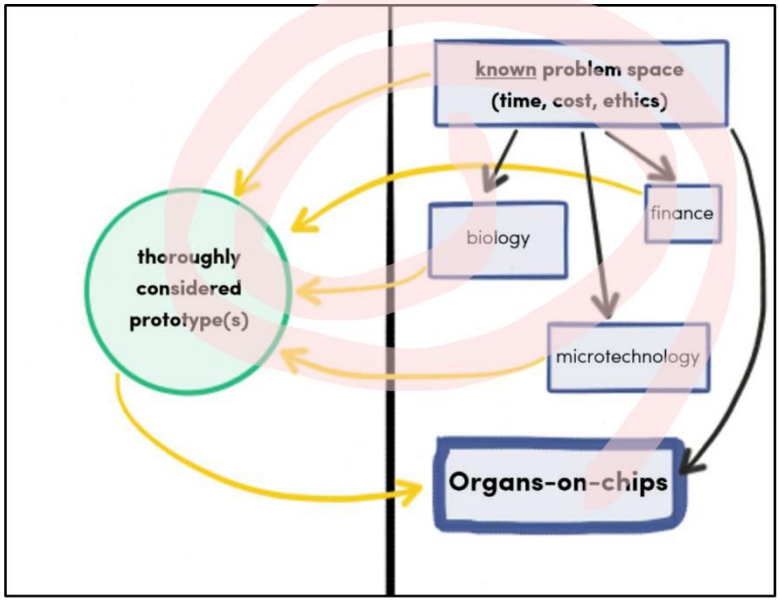

Figure 8 "K-space spiral" superimposed on the C-K map for Organs-on-chips, highlighting the recurrence of the problem and how all K propositions feed into the C concept.

The Naked Filter shown through the 'double helix' is another SBP with a similarly iterative design process, except the focus is shifted from a problem definition to a scientific opportunity. By promoting expansion in *both* C *and* K, Liquidity was able to find creative concepts while widening the initially narrow knowledge space. The proposed model for this type of SBP is the 'double helix', with two 'strands' of concept and knowledge (Figure 9). Innovation occurs at the intersection of these two expansions, through questioning and researching.

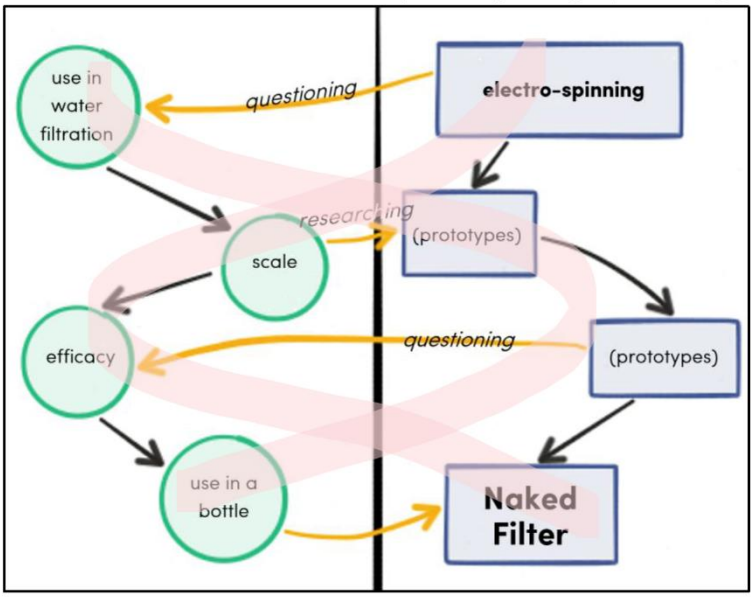

Figure 9 "Double helix" superimposed on the C-K map for Naked Filter, highlighting the simultaneous C and K expansions, and C→K and K→C connections.

The suitability of design as an approach for the translation of scientific knowledge into application, is due to its position as a future oriented activity. The designer is situated between the world as it is, and the space that it could be (Margolin, 2007; Krippendorff, 2006; Seymour, 2008).The notion of concepts and knowledge as formal artefacts has been explored in design literature. It is widely recognised that a design outcome is not necessarily a physical object or product, rather any contribution to or expansion of knowledge (Zimmerman, Forlizzi & Evenson, 2007). Conversely, a concept is an abstract notion that results from iterative ideation – an idea to be continually refined (Zimmerman, Forlizzi & Evenson, 2007). In light of these models, the knowledge space (K) contains more than just facts and products, as it opens up the research process to any contributions to design theory and advancement of knowledge. These models provide both retrospective and proactive frameworks for science innovation through design. Possible applications could include:

- Mapping the research decisions made by a scientific research group at a university to not only visualise their path so far, but also identify potential pain points where perhaps there was not enough exploratory research (C-expansion), or insufficient questioning followed by grounding in research (as is shown to be necessary in the Double Helix model).
- Alternatively, a proactive approach could see, for example, a technology start-up on the journey of commercialisation referring to these C-K models as a guideline to promote scientific innovation. This could involve making conscious business or design choices to continually ground their concepts in the evolving research space (as seen in the E-ladder model).

The application of these models is in taking well-defined notions of logic, and applying them to expansive problem solving situations to cultivate innovative research.

6 Summary and future work

The analysed case studies confirm the assertions from literature over the past fifty years – that science and design are two paths to the same goal. However, this study has demonstrated that the shape of this path is critical in whether or not the right goal is achieved. Design, in the form of C-K theory, has been the interface between the scientific process of invention and its realisation in society, as predicted by Simon (1968). In the literal sense of a visualisation, but also in its exposure of a detailed research process, C-K theory has made the science process visible by design (Willem, 1990). C-K theory is also shown to be an effective tool for analysing research projects after their completion, by mapping out the entire design process in a highly visual technique.

The study also reveals several areas of future research, in terms of how a research collaboration could practically establish a common ground to co-generate:

- What does a successful *collaboration* look like, and what makes it successful?
- How can C-K theory or mapping be employed by a research organisation to *prevent* implausible or ineffective research outcomes?
- What new directions are possible for research organisations that employ C-K theory?

This exploratory study examined the tension between science and design in literature, and how design can fill the gap that takes scientific research from pure knowledge to innovation. There is an opportunity for the design model of C-K theory, in harnessing the collaborative nature of both science and design, to provide a framework for this innovative research.

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Three Arguments About the Current State of Scientific Design Process Theories

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The design process is a central object of inquiry in design research. Many scholars have studied designing and presented their findings in the form of models, frameworks, and schemas. A general understanding of designing is an interesting prospect, and yet there seem to be fewer theories about the design process achieving (or aspiring to achieve) scientific status. In this paper, we explore possible reasons why this may be the case. Based on ongoing research about design theories (n=175), we explore the possibility that there are fewer scientific theories about the design process. Then, we propose three possible arguments as to why, including: (1) Scientific theories about designing are not useful to practitioners, (2) design research is building its own intellectual culture, and (3) different ways of understanding scientific theories may yield different results.

design research; design theory; research methodology; theory

1 Introduction

There are many different reasons for studying designing. Researchers may want to understand concrete details of the design process (e.g. sketching, client interviews, and so forth). Others may take a more practical approach with the goal being to improve design practice. Still, others may seek a general understanding of designing. That is, they may wish to achieve a general explanation of designing assumed to hold across a wide array of specific instances (Sutherland, 1975). Each of these approaches has the potential to generate knowledge at higher levels of abstraction and, thus, potentially, broader applicability to other researchers and designers in the field. Moreover, it may be the case that each of these three approaches aspires to develop theory *if* theory can be understood as a category of abstract knowledge (Höök & Löwgren, 2012) produced in a field of study.

Design research is a complex field that encompasses different approaches to inquiry. Researchers in the field thus ascribe different values to different kinds of theory. Some researchers value scientific theory, and others do not. Some value the possibility of making "designerly theory," and others do

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not. The kind of theory researchers value depends on many things, such as their intellectual standpoint, and these valuations are tied to the field itself.

Any intellectual community dictates (to some extent) accepted ways of generating and contributing knowledge, and, even in the absence of a formal "intellectual manifesto" for design research, it would be possible to construct a sense of what these accepted ways knowledge production might be and whether they align with the field's overall aspirations.

In this paper, our ambition is to develop a set of arguments to account for an apparent asymmetry between scientific and non-scientific theories about designing in the design research community. There appears to be fewer scientific theories about designing when compared to non-scientific theories about designing. This could mean, for instance, that researchers in the field are less interested in developing scientific theories about designing.

During the past few years we have been engaged in a research project examining different theories, models, and frameworks purporting to provide an explanation or description of the design process (cf. Dubberly, 2015; Friedman, 2012; Gero & Kannengiesser, 2014; Hatchuel & Weil, 2009). As a part of this project, we have noticed that fewer theories appear to be scientific. We have reached this conclusion by using Karl Popper's criterion of falsification ([1935] 2002, p. 66) to distinguish scientific theories from other kinds and, from a collection of 175 unique theories about designing, we have identified **25 scientific theories** and **150 non-scientific theories**. Confident in the potential validity of this finding, we take it as an assumption that will frame the rest of the paper.

In the balance of this paper, we first examine different kinds of knowledge growth in intellectual communities, and we survey examples of scientific theories of designing. Then, we briefly discuss what non-scientific theories of designing could be. Finally, we propose three arguments as to why there seem to be fewer attempts to develop scientific theories about designing. These include: (1) Scientific theories about designing are not useful to practitioners, (2) design research is building its own intellectual culture, and (3) different ways of understanding scientific theories may yield different results.

Our hope is that these three arguments might inspire other researchers to reflect on the utility and value of scientific theorizing with regard to designing. However, to be clear, we are not arguing that scientific theories are better or stronger than other kinds of theory. It is obvious that different approaches to studying the design process are able to generate abstract knowledge about designing without leading to scientific theories. This means that scientific theorizing could thus be framed as one relevant approach among others.

2 Cumulative and Additive Knowledge Growth

Our primary purpose in this paper is to generate explanations about why there seem to be fewer scientific theories of the design process relative to other kinds. In the design research community, there has been some interest in knowledge production and intellectual growth (Beck & Stolterman, 2017; Carvalho, Dong, & Maton, 2009; Dong, Maton, & Carvalho, 2014). These studies pose interesting and important questions about how design research measures intellectual progress and whether it is characterized by cumulative or additive knowledge growth. For our purposes, if design is characterized primarily by *additive* knowledge growth, then perhaps researchers should expect to see fewer scientific theories about designing than other kinds. But we must first clarify what we mean when we refer to cumulative and additive knowledge growth.

2.1 Cumulative Knowledge Growth

In a cumulative growth model, new knowledge is "ranked higher" than existing knowledge because of its *greater* explanatory power. This is part of what Basil Bernstein meant when he described hierarchical knowledge growth as "motivated towards building an apex of greater integrating propositions [with fewer and fewer axioms]" (Maton & Muller, 2006). An "apex of greater

integrating propositions" describes propositions that explain more than their predecessors *without the need for axioms*. For example, when Einstein was developing his theory of general relativity, he had full knowledge of Newtonian mechanics. Einstein's theory retained the explanatory power held by mechanics, but, importantly, it explained things that Newton's theory cannot without the need for particular axioms. Relativity accounted for everything that scientists knew about the world and more. In this way, it can be seen as better and more powerful.

A hierarchical structure has important implications for knowledge building. For instance, there is probably an agreed upon, core set of problems or questions. It would seem difficult if not impossible to converge on particular truths if all the knowledge work being done in a field addressed disparate problems or questions. At the very least, progress would be much more incremental. In fact, quite a few scientific disciplines have established or proposed common questions, problems, or challenges around which to organize their intellectual resources (Beck & Stolterman, 2017). In Physics, for example, this is apparent in a document like the 'Oxford Questions' (Briggs, Butterfield, & Zeilinger, 2013), which lists the "big questions" about the world that quantum physicists are trying to answer.

A hierarchical structure may also imply an agreed upon methodology for knowledge building. There must be some consensus regarding what constitutes a novel contribution and this presumably requires an agreed upon means of evaluating validity and relevance. But do agreed upon measures of validity, relevance, and rigor require an agreed upon methodology of knowledge building? And would these same requirements be in place for fields characterized by additive knowledge growth?

2.2 Additive Knowledge Growth

Additive growth is also called horizontal. In horizontal models, new knowledge is not necessarily judged to be *better* or *more powerful*. Horizontal fields embrace a plurality of perspectives, which may emphasize diversity and divergence of knowledge production as opposed to unity and convergence. New knowledge in a horizontal field may provide a different perspective on a well-known topic or it might introduce a new topic to a field. This means that, where new theories are concerned, there is no need to address existing phenomena or even to work from common ontological and epistemological assumptions about the world.

In a horizontal field, a researcher may have more flexibility in their choice of topic since they may not have to demonstrate how new knowledge builds on or extends existing knowledge. In addition, researchers working in horizontal fields may be less likely to adhere to common knowledge production techniques. It is also possible that scholars working in horizontal fields have more freedom to *import* and experiment with practices and procedures for generating knowledge, that is, research methodology.

In distinguishing between horizontal and hierarchical knowledge growth we are not suggesting that a given academic field *exclusively* adheres to one of the other. For example, while the primary concerns in the natural sciences are universal laws, principles, and facts about natural phenomena in the world and, thus, primarily aimed at hierarchical knowledge growth, there are aspects of it that could rightly be interpreted as horizontal. Proposing a theory to explain some new aspects of reality not previously known would be one example of horizontal growth in the natural sciences. And as we discussed, there are examples of hierarchical growth in primarily horizontal fields (Chakrabarti & Blessing, 2014).

In this paper, we take the position that knowledge growth in the design research community is *primarily* horizontal. If our position is accurate, then it may account why we do not see *more* scientific theories of designing. While there are design researchers working from a scientific perspective, there are many others doing philosophical, humanistic, and designerly research.

Even if the design research community *as a whole* is primarily horizontal, different "neighbourhoods" within the community could vary. For example, the "creativity neighbourhood" might study creativity in design in terms of biological bases (scientific), discourse and power

(humanistic), or conceptually (philosophical). In our experience working on the question of what constitutes a design theory we have encountered (1) few theories about designing that seem to claim scientific status and (2) few theories that aspire to scientific status. It would thus appear that the "design process neighbourhood" is *less interested* in theorizing its core object in scientific ways.

3 Scientific Theories about Designing

Some design research literature (Chakrabarti & Blessing, 2014) seemingly assumes that models and theories developed about designing are testable and refutable but we found that there had not been much inquiry into this assumption.

Vermaas (2014) explores this idea in depth in a text on the scientific status of design research, and, in our previous work, (Beck & Stolterman, 2015) we analyse four theories about the design process to determine whether they could be construed as scientific in terms of Karl Popper's famous criterion of falsification. The theories we examine include: CK theory (Hatchuel & Weil, 2002, 2009), the FBS framework (Gero & Kannengiesser, 2014), Figural Complexity (Schön, 1990), and Bounded Rationality (Simon, 1969). Our aim was to use falsification as an analytical tool to determine whether any or all of these theories could be construed as scientific. And our starting point was a simple question: *What basic statements about designing are possible to extract from C-K theory, the FBS framework, Figural Complexity, and Bounded Rationality?*

Think of a proposition as simple as "all men are mortal." It is unfalsifiable since, according to Popper, everywhere we look we can only find confirming evidence. No factual propositions exist that clash with it. Factual propositions have high truth-values, where truth-values are functions of empirical observations *and* mutual consensus within a community. Newtonian mechanics, for instance, had centuries of empiricism and consensus within the scientific community. So, when Einstein proposed his theory of relativity, it clashed with established factual propositions about the world. Moreover, Einstein's theory could be falsified by empirical observation. This means that it was capable of producing basic statements, which must be "testable, inter-subjectively, by 'observation'" (Popper, 2002). In our previous work, we were concerned with evaluating the falsifiability of a theory, and so we extracted basic statements from each design process theory (Beck & Stolterman, 2015, pp. 5-6).

From this analysis, we synthesize several insights that we find useful for our purposes in this paper. First, we found strong indications that there are some theories about designing that satisfy Popper's criterion for establishing scientific status. Second, we believe that it would be possible to develop each of these theories by adhering to the methodological standards of science. Although we do not spend much time elaborating this possibility, we believe that there is sufficient evidence for this kind of scientific theory development in existing literature (Chakrabarti & Blessing, 2014). Finally, we argue that there are fewer theories about designing developed in scientific ways.

As we have continued this project, we have collected and examined 175 theories about designing in a similar way – using falsification as an analytical framework to extract basic statements. So far, we have categorized 150 non-scientific theories and 25 scientific theories. This leads us to believe that there is some validity in this paper's framing assumption—that there are comparatively fewer scientific theories about designing. How might we go about characterizing these other kinds?

4 Other Kinds of Theories

It may be the case that most theories about the design process are not claimed to be scientific by their originators. Some theories are seemingly taken for granted as *particular* descriptions of one design process without any intention to generalize. It seems to us that very few scholars describe or discuss theories of the design process as though they are (or could be) scientific.

A *claim* to scientific status is not the same thing as scientific status. A theory may be presented as scientific yet lack the qualities of a scientific theory. As Popper makes clear, we *cannot* take the word of the theorist regarding the scientific status of a theory (2002). Similarly, theory may have scientific

qualities even if its originators and presenters do not characterize it as such. For instance, to our knowledge, Schön (1990) never framed figural complexity as a scientific description of the design process. Yet, in our previous study, we analyse it in terms of falsification and argue that it could be considered scientific on the grounds that it is possible to extract basic statements about particular instances of designing.

There are a large number of descriptions and explanations of designing that could be interpreted as theories. For instance, there are collections of models (Dubberly, 2015; Friedman, 2012), frameworks (Halskov & Ebsen, 2013), and theories of designing whose authors *do not* present them as fully developed, scientific explanations or descriptions of the design process.

Dubberly's collection could be understood as *schemas* in the sense that they express a particular way of thinking about designing that may serve the purpose of supporting designers in their daily practice (Nelson & Stolterman, 2014). They have practical utility, but they do not necessarily aim to establish any universal truth about designing.

The fact that these theories are not scientific does not mean that they cannot or should not be engaged with and built upon in a scientific way. Nor does their intended practical utility mean that they are actually useful to designers. Moreover, practical utility and scientific status are not mutually exclusive. It is possible for theories about the design process to be both scientific *and* practically applicable or, conversely, *neither* scientific *nor* practically applicable.

Other practice-oriented disciplines, such as education and management, value and cultivate strong scientific theories that they believe are important and relevant to practitioners. Is design research different? Or does it actually have a latent desire to cultivate a strong, scientific culture? If it does have such a desire, then why are the comparatively fewer scientific theories of the design process? And why does it seem as though there are fewer scholars calling for more scientific theories?

In the next section, we propose three potential arguments for the apparent proportion of scientific theories about designing to other kinds of theories.

5 Three Arguments for the Presence of Scientific Theorizing in Design

So, how might we go about accounting for the presence or absence of different kinds of theories about designing? The answer depends on our intentions. If we see the presence of scientific theories as a problem, then we may wish to generate solutions. And, in alignment with others, our view is that better solutions stem from "a greater number of diverse conjectures," (Weick, 1989, p. 522). Hence, we propose three possible conjectures as to why we observe fewer scientific theories about designing in the design research community:

1. Design research develops theories for multiple stakeholders, and fewer stakeholders value scientific theories.
2. Design research is building its own intellectual culture, which could involve exploring different, culturally unique approaches to theory development.
3. Different understandings of what constitutes a scientific theory may yield different insights about the proportion of scientific theories to other kinds.

5.1 Fewer stakeholders value scientific theories about designing.

Design research has multiple stakeholders that can be categorized into at least two groups: (1) researchers and (2) practitioners. These groups potentially have different desires and needs when it comes to theories about designing.

For example, researchers may be more interested in developing theories that revise or extend established understandings of the design process, and they may also believe that it is possible to achieve some "absolute truth" or "predictive knowledge" about the design process. By contrast, practitioners may be more interested in developing theories about designing that are useful and applicable in practice. Whether a theory is scientifically true may be less important to them. It may

only be important that a theory "works" for their purposes. This means that these two groups have different measures of success (scientific truth versus practical utility) when it comes to evaluating theory.

Distinguishing researchers from practitioners within the design field could help make sense of the *co-presence* of scientific theories and other kinds of theories. If different stakeholders in the same field have different needs and measures of success, then it stands to reason that, in response, the field would produce different kinds of theories. This is a simple illustration of supply and demand. It could be argued that since there are seemingly *fewer* scientific theories, the demand for practical theories applicable in the professions is *greater* than the demand for scientific theories.

As we have already claimed, "useful and applicable" and "scientific" are not mutually exclusive categories when it comes to theory. A particular theory about designing may be useful, applicable, *and* scientific, which is arguably the case with CK theory.

CK theory has been presented both as an ontological theory about the design process and as a more prescriptive, applicable theory that designers might use as a framework for designing. Its originators, Hatchuel and Weil, may have *intended* to develop a theory that was both useful/applicable *and* scientific. However, this may be an exceptional case rather than the norm.

It could also be the case that the demand for useful/applicable theories has grown over time as practitioners have refined their sense of what they need from a theory about designing. It is possible that the early days of design research intended to produce more scientific theories about designing because researchers and practitioners thought that this kind of theory would be useful. This sort of thinking may be reflected in early attempts (e.g. during 'the design methods movement' of the 1960's, which has been called the 'design science decade') to discover "the underlying logic" of designing and to use this discovery to generate a universal "design method" in the style of the scientific method. Researchers and practitioners sought, as Nigel Cross writes, "to base design processes (as well as the products of design) on objectivity and rationality" (2001).

But it is apparent that soon after these efforts began, practitioners and researchers realized that scientific approaches—both to designing and to *studying* designing—might not yield the kind of useful results that they previously thought. Christopher Alexander famously disavowed the design methods movement saying, "…There is so little in what is called 'design methods' that has anything useful to say about how to design buildings…" (Cross, 2001).

Saying something true about designing does not necessarily mean that what is said is also useful or applicable to practitioners. And if design is a practice-oriented discipline, then saying something useful or applicable to practitioners is important. It makes up part of the core of the discipline—though not the *whole* core. This is in contrast to a discipline like theoretical physics where the question of "practical" utility and applicability may not make sense.

But a "practice orientation" alone does not explain the preponderance of useful, applicable theories compared to scientific ones. There are other practice-oriented disciplines where this does not seem to be the case. For instance, management studies has been described as practice oriented, yet its researchers are "pushed to produce insight for both the professional and academic realms" (Corley & Gioia, 2011). Their disciplinary norms could be said to promote and support the production of theories that are both scientific and useful *and* applicable to managers and organizational practitioners.

Moreover, Corley and Gioia (2011) have argued that management studies skews toward producing theories—including theories about managing—that primarily aspire to scientific truth and utility. Does design research move in a different direction? And if so, why?

5.2 Design research is developing culturally unique approaches to theory development.

An interesting and important theme for inquiry in the design research community has to do with building a unique intellectual culture (Cross, 2001; Nelson & Stolterman, 2014). This initiative is predicated on the notion that there are ways of knowing (and generating knowledge for and about design) that are unique to design and designing.

Building this intellectual culture, which Cross has called "design as a discipline," (2001) could therefore be understood as an effort to cultivate "designerly" ways of knowing and theorizing rather than importing and relying primarily on scientific ways of knowing and theorizing. This effort may seem similar to previous attempts to develop the design version of the scientific method. But whereas the design version of the scientific method was built around scientific values, including objectivity and testability, the attempt to build a unique intellectual culture for design aims to identify and cultivate designerly values.

This may complicate our previous division of the multiple stakeholders of design research. We divided them into two groups: researchers and practitioners. And we discussed how shifting needs and desires of practitioners may account for the proportion of scientific theories to other kinds of theories about designing. But now it becomes possible to speculate about researchers themselves experiencing a shift in needs and/or desires when it comes to theories about designing. For example, there are a growing number of researchers in the field conducting *research through design* — an approach that utilizes design methods and processes as a legitimate means of inquiry (Zimmerman, Stolterman, & Forlizzi, 2010).

Theories with strong scientific utility can be seen as (1) advancing knowledge and (2) guiding its production; that is, helping researchers identify what to study as well as how to study it. But if a researcher does not intend to study something in a scientific way, or if they complement scientific research with research through design, then perhaps other kinds of theory are necessary. A scientific theory may not be the appropriate tool for guiding concept generation or for judging whether a concept is a good fit (or not) for a given design brief.

Researchers using design methods and processes may find—as some practitioners did—that scientific theories about designing are useful or applicable in some ways but not others. They may therefore share in the demand for other kinds of theories. And it would thus make some sense that researchers using design methods and processes would intend or present their theories about designing *not* as scientific or having scientific aspirations but as practical and useful. While these kinds of theories have the potential to contribute to a general understanding of designing, their purpose is not to present a "true," scientific account of it. Rather, their purpose can be understood as strengthening researchers' ability to design and conduct research through design.

It is also possible that research through design can produce theories about designing in the form of frameworks and methods that are useful and applicable. This illustrates a relationship between a particular research approach and its theoretical output. Simply put, the way researchers think about theory affects the theory they produce (Galle, 2011) and there are many ways to think about theory. But while this explanation may account for the presence of non-scientific theories about designing, by itself it might not account for the ratio of scientific theories to other kinds. There are *some* researchers using design methods and practices in their work, but research through design still seems to be a peripheral approach in the design disciplines despite strong arguments for its legitimacy (Gaver, 2012; Zimmerman, Stolterman, & Forlizzi, 2010).

The potentially evolving needs and desires of researchers in concert with a broader effort to build a unique intellectual culture for design may contribute to the proliferation of other kinds of theories and theoretical knowledge objects such as annotated portfolios (Bowers, 2012; Löwgren, 2013), strong concepts (Höök & Löwgren, 2012), bridging concepts (Dalsgaard & Dindler, 2014), and generic

design thinking (Wiberg & Stolterman, 2014). Taken together, these phenomena may contribute to a decline in the development of scientific theories about designing.

5.3 There are different ways to distinguish scientific theories from other kinds

Our third argument is based on the premise that what is understood as scientific is more complex than any single framework implies. For example, in our ongoing work, we have primarily used Karl Popper's influential concept of falsification to distinguish scientific theories from other kinds, but there are other ways that we could go about doing this.

When a researcher articulates a particular conceptual framework, then that framework shapes their analysis and findings. Frameworks are like lenses that can be changed out to reveal different aspects of the world. Using Popper's criterion of falsifiability as an analytical framework to distinguish scientific theories from other kinds thus becomes *one way* of seeing the interplay between different kinds of theories in the design research community. It appears there are fewer scientific theories about designing, but from a different perspective this appearance may change.

The question is not whether one of these perspectives is the "one true" perspective. Rather, the question(s) are how these different perspectives might complement one another and how they enrich each other in the service of deepening our understanding of designing. This means that we need to ask ourselves: *What does falsifiability reveal that other analytical frameworks do not?* How do *other* frameworks challenge and strengthen the way we understand design theories vis-a-vis falsifiability? And would a change of framework change our perception that there are fewer scientific theories?

Since there are multiple perspectives on the nature of scientific theories, it becomes important to develop a rationale for choosing falsifiability. What are our reasons for choosing falsifiability? Are they good?

Falsifiability strikes us as a rational way to enter the conversation on the possibility of scientific design theories given that other scholars in the field appear to view falsifiability as a valid, useful framework (Vermaas, 2014). Moreover, when we began our research, we had not yet encountered other scholarship using falsifiability to analyse different theories about designing. This means that existing interest in the field *combined with* a novel application of Popper's framework motivated the early stages of our work.

It is also possible to interpret falsifiability and critique, which is a crucial aspect of design culture, as neighbouring concepts. Scientists attempt to falsify scientific theories (in order to test their strength), which is similar to the way designers convene juries to critique (test the strength of) design work. Hence, another possible reason to choose falsifiability as an analytical framework is its resonance with design culture.

However, as we have continued our research, we have realized that, if our goal is to contribute deeper understandings of design to the research community, then there is a need to consider different ways of understanding scientific theories. For instance, the received view (Suppe, 1998) and semantic view (Halvorson, 2011) of scientific theories have been widely discussed and debated. It would be possible to build on our previous work and use these ways of interpreting scientific theories to assess different design theories. It would also be possible to replicate our approach in *this* paper and examine a large collection of theories to see whether the proportion of scientific theories about designing remains the same.

6 Conclusion

If design research is primarily characterized by horizontal knowledge growth, then it stands to reason that there will be scientific theories about designing alongside other kinds of theories about designing. However, the horizontal structure does not account for the proportion of scientific

theories to these other kinds. Nor does it present a clear picture of the epistemological values held by researchers in the field.

Our starting assumption – grounded in on-going empirical work – in this paper is that there are fewer scientific theories that explain or describe the design process than other kinds. We discussed one way to distinguish scientific theories by drawing on a discourse from the philosophy of science, and we contribute three possible explanations regarding why there seem to be fewer scientific theories about designing in design research when compared to other kinds:

1. Scientific theories about designing are not useful to practitioners,
2. Design research is building its own intellectual culture, and
3. Different ways of understanding scientific theories may yield different results

For each of these explanations, we also describe possible consequences for the field, including: (1) a decreasing ratio of scientific theories to other kinds, (2) developing more designerly ways of understanding of theories and theorizing, and (3) reflecting on the philosophical views that one adopts when building and studying theories about designing.

Theory construction and theory use have been addressed in the field in different ways (Friedman, 2003; Gregor & Jones, 2007; Redström, 2017). And there is a growing discourse around the possibility of scientific theories about designing (Beck & Stolterman, 2015; Vermaas, 2014). In this paper, we assume that scientific theories about designing are possible and in existence today and that there are fewer scientific theories about designing relative to other kinds in the design research community.

We offer our three arguments as steps towards a more robust picture of the intellectual culture within design research. Individually, each explanation points toward future questions for inquiry, such as: How do design researchers account for or address multiple stakeholders in their publications and presentations? What is the current state of the effort to build a unique intellectual culture for design research? How and why do design researchers choose between different, potentially competing philosophical views to inform their work?

As we have stated, this paper is not necessarily a call for more scientific theorizing of the design process. It is an examination of the presence and proportion of scientific theories in relation to other kinds. Based on our conclusions, we argue that design research would benefit from a more focused debate about the overall need for design process theories. *Is there is a need for scientific theories? Or is there more interest in developing designerly theories?* When a field produces multiple theories of different kinds about the same phenomenon, an examination of the presence and proportion of different kinds of theory can lead to insights about what kinds of theories the field values, how these values have changed over time, and potential directions in which these values are moving.

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Designerly Activity Theory: toward a new ontology for design research

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This paper is based on empirical data obtained from two case studies whereby collaborative design of teams composed of four recent graduates with different backgrounds were studied. In both cases, the collected data is related to the interactions of team members toward the development of a design solution in response to a brief. Although the study of the collaborative design process is an essential part of this work, the focus of the paper is on the potential of an expanded Activity Theory as a methodological framework that allows detailed analysis of collaboration. A five-step data processing approach contributed to the emergence of a new theoretical model. The model, an expanded version of Activity Theory, takes into account creative and contextual processes of collaborative design, allowing for thorough data analysis and the production of systemic interpretation of design activity in context. Titled Designerly Activity Theory, we present our reasoning and supporting references as the contribution of this paper having potential to offer a situated framework for the ontology of design research.

design team; activity theory; collaborative design; design research

1 Introduction

In projects involving design thinking, it is very common that researchers collect data from dialogues between designers and clients. These conversations occur between designers as teams involving other designers or professionals from various disciplines. In these instances, transcripts form the main document for data analysis. Transcripts are produced, coded and analysed with different criteria and in different ways. For example, we refer to the works of Cross and Cross (1995), Valkenburg and Dorst (1998), Valkenburg (2000), Dong (2005), Oak (2011), McDonnell (2016) and many others, where various frameworks are used for reasoning, evaluating, understanding, discovering and bringing new insights to the design community. In sum, as mentioned by Matthews & Heinemann (2012, p. 649): “Since the ‘empirical turn’ in design studies, many methods drawn from the social and human sciences have been applied to the study of designers’ activities.”

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Looking closer at collaborative design, we examined Activity Theory as an alternative basis on which data from transcripts can be meaningfully and consistently understood. More precisely, we ask ourselves the following question: Can Activity Theory framework offer an underlying structure for coding and data analysis, and help us to better understand interactions and contradictions between team members as well as the design process of multi-disciplinary teams? This article proposes to build on the acknowledged research framework of Activity Theory to test its application and propose a theoretical expansion emerging from our empirical data analysis.
Due to the early stage of this research project, the present article only focuses on the research methodology, more precisely, to find an answer to the above question. The promising *Designerly Activity Theory* that is discussed later in this paper is going to be used, in a near future, as a framework to analyse and interpret data of five case studies that share a unique controlled condition. Those case studies will focus on the design process of collaborating teams to enrich the knowledge surrounding team-related dynamics and team contradictions —which is a strong feature of Activity Theory. Ultimately, we seek that the proposed model, will allow for deep data analysis and the production of in-depth and systemic interpretation of design activities. The model emerged from the data retrieved from two case studies, and after many cycles of data coding, trial and error, and hours of negotiations. The micro-analysis of these empirical observations, with the help of Activity Theory, guided us towards the development of a situated methodological approach, which we value for its potential, reliability and validity. The structure of the article will follow Leplat's most characteristic phases of scientific research: data gathering, data processing and generalization, including comparing conclusions with existing knowledge (Leplat, 2002). Before detailing these phases of our research project, we will introduce the purpose and initial theoretical framework of our study.

2 Purpose of the study and planning

Before providing other details, we would like to specify that our research project is guided by two leading objectives. The first, being the main focus of this article, is to elaborate an innovative methodological approach based on Activity Theory. At the same time, we wish to contribute to the refinement of design research methods. Two case studies out of five constitute the context for this objective. The second objective is to develop and communicate our understanding of the interactions and processes put in practice by interdisciplinary teams. This objective is not represented in this article, but will culminate in future contributions that will delve into this challenge. Although our search for the refinement of knowledge on collaborative design is continuous in our research project, the remaining of this article will strictly focus on the methodological features of the expanded activity theory framework we seek to present.

In order to plan a coherent research program, we conducted a total of five case studies, which will be introduced later. Each case study combined the expertise of a multidisciplinary team of graduates. The first case study has been analyzed and discussed in a previous article (Zahedi, Tessier & Hawey, 2017). The methodological approach that we present here is built on the enriched understanding of the first case study and the analysis of a second case study.

3 Activity Theory

Activity Theory (AT) is a theoretical framework based on the works of Lev Vygotsky, Alexei Leont'ev and others. AT was developed further and adapted to our complex collective reality by Yrjö Engeström. The theory uses the systemic investigation of contradictions to solve problematic situations. AT is used in concordance with a triangular model composed of seven interacting components (Figure 1): subject, object, tools, rules, community, division of labor and outcome.

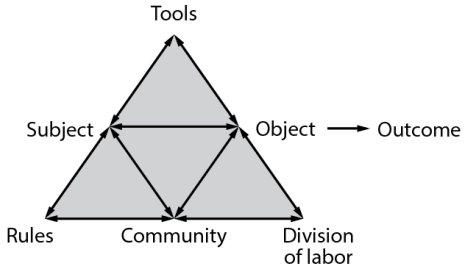

Figure 1 Activity Theory triangle

A number of reasons motivate us to explore AT and suggest it as a promising framework for research on collaborative design. First of all, activity theoretical research explores collaborative systems, including all related members of the community, actors and stakeholders (Engeström, 2001). Adopting a 'multi-voiced' perspective is particularly relevant to context-based and user-centered design projects. Secondly, the theory sees contradictions in a system as drivers for change and development (Engeström, Miettinen, & Punamäki, 1999). Contradictions are difficult to perceive, but "manifest themselves through disturbances, ruptures and small unremarkable innovations" (Engeström, 1999, p. 68). Finally, AT adopts a systemic vision that seeks to find pertinent solutions that are also adapted to neighbouring systems. In short, multi-voiced perspective, contradictions allowing changes, and systemic vision are crucial when designing collaboratively.

3.1 Why Activity Theory?

For more than two decades now, Activity Theory is being recognized as an effective tool to frame the design process by organizing opinions and needs of all stakeholders involved. As mentioned by Nardi (1996), AT is a means of studying practice: it is object-oriented and can be used for designing of human-computer interactions. Heaton (1998) comments that AT "offers a framework for describing how changes in consciousness are directly related to the material and social conditions" and "provide a shared vocabulary for designers".

Still, we note an important difference between the most common way to use AT to frame design projects, and what we are seeking with the present contribution. We consider that the theory has strong potential to be used as a powerful framework to decrypt and interpret the design activity of a team within an activity system. The theory is a powerful approach "to analyse development within practice through the social and contextual activities in which people develop their skills, personalities and consciousness" (Chatzakis et al., 2016, p. 1893 referring to Sannino et al., 2009). It is with this systemic and contextualized perspective of the model that its strong correspondence with design activity becomes clear.

Activity Theory provides a simple but strong visual model that allows for general understanding and interpretation of a situation and its evolution in time (Chatzakis et al., 2016, p. 1893). Also, as mentioned by Engeström, Miettinen and Punamäki in *Perspectives on Activity Theory* (1999), we see AT as fit for today's complex and open-ended challenges: "Activity theory should not be regarded as a narrowly psychological theory but rather as a broad approach that takes a new perspective on and develops novel conceptual tools for tackling many of the theoretical and methodological questions that cut across the social sciences today" (Engeström et al. 1999, p. 8).

4 Case studies and data gathering

The phase of data gathering was executed through the completion of five case studies. According to Creswell, "a case study is an in-depth exploration of a bounded system based on extensive data collection" (Creswell, 2012, p. 464). The author specifies that *bounded* signifies isolated in time and place for in-depth observations. More specifically, we opted for *researcher-provoked data,* as this type of data is created in controlled setting for all cases and considered reliable (Silverman, 2006). The case studies proposed to team up four graduate students from different disciplines: for example, one designer, one engineer, one marketer and one student from a social science field –

both male and female. Teams met on one occasion for 2.5 hours. They had access to a 'live' environment (CollaborationLab) allowing for easy collaboration and the use of different materials (computers, whiteboard, sketching material). Inspired from Dorst and Cross' 2001 article *Creativity in the design process: co-evolution of problem-solution,* teams were asked to design a litter-disposal system for trains. Each team had to provide a realistic solution and respond to the deliverables: sketch of form and function, dimensions, materials, cost estimate. Available to them were documents such as technical plans of the train, client's design criteria and other contextual information. Participants could at any time ask questions to the researchers or use the Internet to gather information.
The case studies were recorded with audio and video materials and participants were asked to think aloud. According to Someren et al. (1994, p. 1), the think aloud protocol "is a very direct method to gain insight in the knowledge and methods of human problem-solving". It allows to connect the participant's actions with a "concurrent verbal report of what they are thinking" (Valkenburg, 2000, p. 85). Three non-participant researchers observed the teams' actions and were each asked to take objective notes on one aspect: use of tools, verbal interactions or team dynamics.

5 Data Processing – Global methodological approach

Our exploratory approach combining the context of collaborative design projects and the AT framework was developed in four subsequent stages. Stage 1 sought to demonstrate the use of the theory and communicate its potential to the design community. To do so, the first case study was coded and analyzed. Stage 2 was guided by the need for more validity and reliability. It sought to extend and confirm the first results in a second case study. Stage 3 pursued the objective of developing a more precise and reliable methodological and analytical approach, specific to the study of collaborative design. Finally, Stage 4 is ongoing and seeks to identify emerging patterns from the data across the five case studies completed to this date. Each stage will be detailed in the remaining of the present section.
Inspired from Engeström's fundamental question "How does one do concrete research on the basis of Activity Theory?" (Engeström, 1993,p. 65), our research project is guided by this overarching question: How does one do concrete research 'on the collective activity of a design team' on the basis of Activity Theory? Each stage seeks to answer a specific question breaking this major inquiry into smaller achievements.

5.1 Stage 1: Demonstration of the use of AT

The first stage of our methodological exploration was developed around a first case study (Team A). It was centered on the exploration of the following question: Can AT be used to support the analysis of collaborative design? If so, how can it be implemented? As this question anticipated preliminary findings, we set our objective to be the demonstration of AT as a complementary analytical tool for the design research community.
In order to answer our research question and respond to this first objective, we developed an approach for analyzing qualitative data, obtained from talk amongst design team. The data processing is composed of five steps:

1. Verbatim transcription
2. Transcription coding
3. Identification of episodes and related main contradictions
4. Interpretation of each episode and its related contradiction into AT models
5. Representation of AT models on a timeline

Step 1 consists in the verbatim transcription of all interactions from the recorded material. Team A's transcription is composed of 1073 lines in total, which corresponds to the equal amount of exchanges between members of the design team.

Step 2 involves the coding of more or less every turn of talk according to one or more component of the activity triangle (i.e.: subject, object, tools, rules, community, division of labor or outcome). Figure 2 shows an example of the typical grid that was used during the coding. In order to allow for greater validity and reliability, the data was coded individually by two researchers (Ph.D. students). A third researcher was solicited later on to guide the arbitration of the two coded files. This intervention was for those lines of talks where the two first researchers had different coding.

Time	Transcription	Subject	Tools	Object	Rules	Community	Div of Labor	Outcome
00:31:54	[H3] Mais là, il faudrait passer à nos besoins...Qu'on tri.						■	
	[F1] Mais pour trier, il faut nos besoins!						■	
	[H3] Bon, déterminer les besoins...						■	
	[F1] Oooh, j'ai pris toute la place sur le tableau... On va le faire sur la... Est-ce qu'il y a d'autres couleurs?		■				■	
	[H2] Je vais le prendre en photo et l'effacer ensuite.	■	■				■	
	[F1] Ah bin on va le garder je pense.	■					■	
	[H1] Fac là c'est déterminer les besoins?						■	
	[F] Oui! Alors! Les acteurs impliqués là-dedans… Je me sens dans mon rapport de ressources humaines maintenant! Il y a les utilisateurs, les gens qui font l'entretien, puis nous dans le sens les besoins qu'on a à respecter, les si, les ça.					■		
	[H2] Ceux qui convoicent.					■		
	[F1] On est secondaires.	■				■		
	[H3] Absolument.	■				■		
	[F1] Il y a les gens, en fait, les usagers.					■		
	[H1] Très important.					■		
	[F1] Après ça, il y a ceux qui vont dire si ça passe au conseil ou pas, alors Via Rail. Ou on met juste les employés de ménage ?					■		

Figure 2 Coding grid with component from activity triangle
Black code represents assertive talks, whereas grey code represents secondary components.

Data coding allowed the emergence of distinct clusters of components that seemed more solicited during certain stages of the case study. Therefore, Step 3 of the data processing served for the identification of episodes and their related main contradictions. Episodes refer to distinct stages of the development of the collaborative design project and are associated to specific discussions and negotiations on a more focused theme. In the first case study, 7 episodes were identified. As shown in Table 1, these episodes create a unique sequence of 19 occurrences.

Table 1 Team A's episode sequence

Team A	1	3	1	2	3	5	2	4	5	1	4/4/4	5	4	5	4	6	7

Step 4 combined the use of talk analysis and of the data coding. Linking together these two data interpretations led us to depict the main contradiction of the episode into an AT model. In order to do so, we analyzed the dominating clusters of components and concentrated on common attributes of the participant's discourses. We adopted Oak's viewpoint "by focusing on the everyday, taken-for-granted features of talk within the settings of design practice, we can see how participants in practice achieve the comprehension and negotiation that allow designed objects to be constructed as both personally and socially meaningful" (Oak, 2010, p. 211).
Step 5 concerns the representation of these depicted episodes in a visual analysis tool organized as a timeline (Figure 3). The timeline provides quick visual reference on the evolution of the project, movements of the main contradictions and team-specific dynamics.

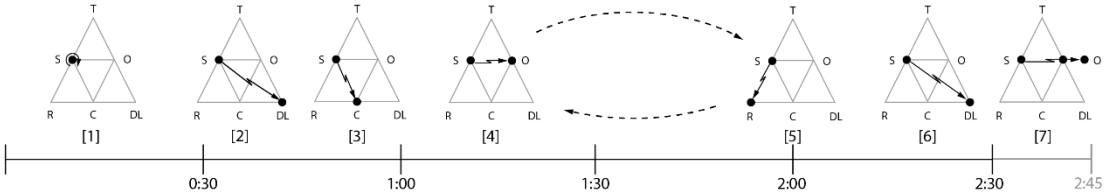

Figure 3 Team A's timeline with activity triangles

The timeline description is as follows: Approximately, the first half-hour (Episode [1]) was a period for expressing team's way of tackling the project. During the next half-hour (Episode [2]), the team showed a strong interest in developing management tools (schedule, tasks listing, etc.). Then, in Episode [3], participants concentrated on the identification of users and stakeholders to consider for developing their concept. Between hours 1:00 and 2:00, corresponding to Episodes [4] and [5], the participants discussed the clients demands and project regulations and translated their decisions into criteria for the final product. We address these episodes simultaneously because the participants alternated from one to the other. During Episode [6], they divided the workload strategically in-between the participants according to their expertise (based on the transcript, this division was for efficiency concerns). Finally, Episode [7] consisted of a recap of the client's requests, project objectives and design criteria.

Representation of the episodes on the timeline granted for a consistent description and interpretation of the team in-context. Compared to the timeline, more episodes are shown on Table 1. In fact, only episodes that happened in a chunk of significant time (more than 15-20 minutes) are shown on the timeline. Results and findings from this first case study were reported in a paper presented at a conference and later published in a scientific journal (Zahedi et al., 2017).

Strong similarities between our findings and important scientific publications allow us to answer positively to our first research question stated earlier. We relied on findings from many design thinkers who have highlighted the iterative aspect of the design process (Nelson & Stolterman, 2003; Schön, 1983; Valkenburg, 2000) and, particularly, on Dorst and Cross' article on co-evolution of problem-solution spaces (2001) to validate the iterative loops identified (see recurring episodes [4] and [5] in Table 1). In addition, the observed dynamics bring to light Vygotsky's zone of proximal development (1978) to account for collaborative learning. In conclusion of this first research stage, we argue that AT can be used for the sustained analysis of collaborative design and should be explored further by design researchers in order to help them discover its potential.

5.2 Stage 2: Validity and reliability

The second stage involved a second case study (Team B) and focused on the same question as Stage 1. Additionally, we sought to answer a new research question: Can the results of the first case study be extended and confirmed with the analysis of a second case study? We wanted to confirm the validity and reliability of the implementation of AT in a collaborative design context. Overall, the second stage was led by the ambition to generalize our findings to show, eventually, a greater legitimacy of our results.

To do so, we used the same methodological process introduced in the first stage. The same five data processing steps were completed on Team B and led to similar findings as in Team A. We were able to identify the same episodes in a similar sequence for both teams. However, we observed different timeframes (see Figure 4) and different sequences for smaller chunk of time (see Table 2).

Table 2 Team B's episode sequence

Team B	1	2	4	5	3	5	4	5	4	5	6	4	6	5	7

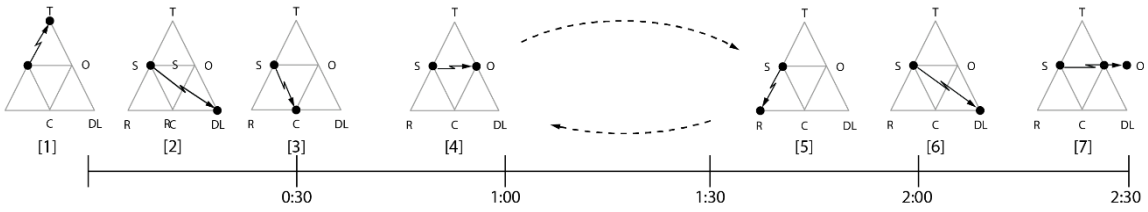

Figure 4 Team B's timeline with activity triangles

The identification of similar episodes in the two case studies encouraged us to define more precisely their nature. Table 3 presents the definition and outcome of each episode.

Table 3 Episode definitions and outcomes. Based on co-reflective practice model (Zahedi & Heaton, 2017).

Episode ID	Definition	Outcome
[1]	Episode expresses the team's way of tackling the project. Corresponds to the "fuzzy front end".	Gain a better understanding of the project brief.
[2]	Episode of "constraining" by the development of management tools such as schedules, tasks and objective listings.	Gain a general sense of the work session's flow.
[3]	Identification of potential users, project stakeholders and needs through "naming".	Gain a team's shared vision of the future design. Foster shared understanding.
[4]	Discuss the design options, stimulate ideation, "framing" according to specific themes or aspects.	Gain inspiration and stimulate ideas. Foster knowledge co-creation.
[5]	Episode of collective "deciding" through the creation of new design criteria. Gives a clear direction to the design development.	Agree on collective decisions to use in the design. Bring new questions for discussion - back to [4].
[6]	Strategic workload division according to participants' expertise, skills and knowledge.	Gain strategic efficiency for the project's development.
[7]	Recap of the client's requests, project objectives and design criteria to validate the final design.	Agreement that all aspects of the project and deliverables have been covered. Refine the outcome.

So far, the answer to our research inquiries is also positive. Highly consistent results emerged from the coding and analysis of the two teams. We link our findings to those of Langan-Fox (2004 cited in Kleinsmann, 2006) who developed a model for describing shared understanding of a team. The model is based on the following phases: (1) team's formation and initial developments, (2) development of team's understanding about causal relationships, and (3) team's high level performance as team members are more accustomed to each other. Thus, Langan-Fox et al. (2004) call this finding a team mental model in three phases. We see similarities between our seven episodes and these three, less detailed, phases. We can link phase 1 to Episodes [1] and [2], phase 2 to [3], [4] and [5] and phase 3 to [6] and [7]. What is more, by comparing the results of both case studies and by drawing preliminary conclusions from our experience, we felt a need to refine our coding, which led to the exploratory stage 3.

5.3 Stage 3: Development of the methodological and analytical approach

The third stage of our methodological process was initiated by an insight on the nature of tools in relation to the observed design process. Through multiple codings and readings of the transcriptions, coders involved in the processing had noted that participants tended to work with different types of tools. At some point, a participant was using 'material tools', such as a pencil for sketching or a computer for searching information. In other instances, the same participant could use 'tools for thinking' when asking questions or drawing attention to encourage ideation and exploration. In relation to this possible distribution of the *tools* component we asked ourselves the following research question: Can AT be refined in order to fit a more precise and detailed analysis of collaborative design? In answering this question we sought to refine the coding and allow the emergence of new interpretations. Moreover, we also sought to test the pertinence of a second dimension specific to collaborative design reasoning in the activity triangle.

Through the exploration of the coding of both teams and of each researcher's notes, we identified four initial components that could potentially be distributed on two complementary dimensions. The first dimension is the original activity triangle, while the second dimension would be associated to designerly thinking and behaviors (Cross, 2001, 2006; Cross, Christiaans, & Dorst, 1997). Through rigorous recoding of Team A's case study new clarity emerged from the data. The first four

components identified are the following (justifications and related references will be introduced in the next section):

- Tools distributed with *signs*
- Rules distributed with *design criteria*
- Division of labor distributed with *process*
- Object distributed with *object in context*

To confirm the potential of this new dimension, Team B was also recoded with these new components in mind. A new researcher was teamed with an already involved researcher to recode the data and provide a fresher viewpoint on Team B's dynamics. They were asked to code the transcription using a new grid integrating the distributed components mentioned above. Their codings were revised by a more experienced researcher and challenged when necessary. This comparison of coding results allowed for greater inner validity and resulted in the adoption of one shared coding grid. During this revision process, the distribution of the two other components became clearer:

- Subject distributed with *collective subject*
- Community distributed with *imagined community*

Time	Transcription	Subject	*Collective subject*	Tools	*Signs*	Object	*Object in context*	Rules	*Design criteria*	Comm.	*Imagined comm.*	Div. of Labor	*Process*	Outcome
00:46:10	[H3] Aussi, ça pourrait être… Non mais ton système de truc, ça pourrait être juste un fil, pas un fil mais un espèce de rubber band aimanté. Ça pourrait se fermer qui ça va comme un peu sceller un peu la chose.					■								
	[H2] Faudrait regarder un peu qu'est-ce qui se fait.			■										
	[H2] Juste faire quelque chose qui est étanche pour ne pas que les odeurs sortent.					■								
	[H1] Mais là, toi tu parles, si c'est comme quelque chose que toi tu ouvres de même.					■								
	[H3] Ouais.					■								
	[H1] Mais si tu ouvres quelque chose comme ça, tu peux pas…					■								
	[H2] Le papier à mon avis a pas besoin de… Du journal, ça ne sent pas tant mauvais.					■								
	[H1] Moi je le verrais plus comme quelque chose qui ouvre genre de même.					■								
	[H3] Mais ça ouvres-tu pour l'usager ou ça ouvre pour le gars de ménage?		■											
	[F] Moi, ça ouvrait pour le gars de ménage seulement.		■											
	[H2] Moi aussi.		■											
	[H1] Ah ok.		■											
	[H2] Parce que tsé penses-y les poubelles à Montréal dans le métro, tu garoches tes trucs dedans pis après ça les trucs tombent.	■												
	[H3] Si ça ouvre pas pour l'usager, il faut que se soit un trou.								■					
	[F1] Ouais.								■					

Figure 5 Complete grid with expanded designerly triangle components

Once again, both transcripts were recoded in order to test and confirm the applicability of these new components. This time, we were testing the complete expanded version of the *designerly activity triangle* (Figure 5). Building on this refined version, we applied the same processing steps described before: identification of episodes, identification of contradictions and timeline representation. Overall, we achieved similar episode divisions in both teams, but the timelines revealed interesting information specific to both teams (Figures 6 and 7).

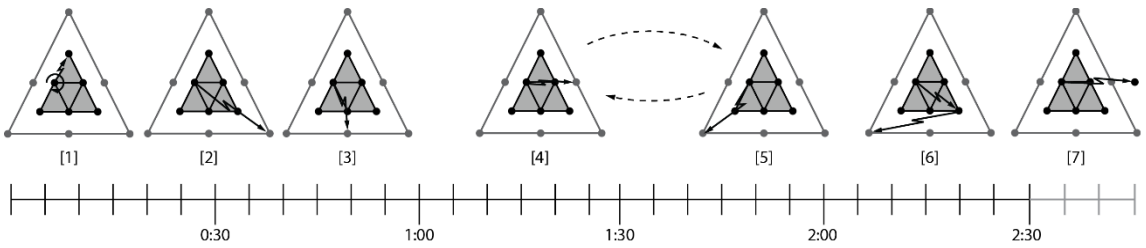

Figure 6 Team A's timeline with expanded triangle

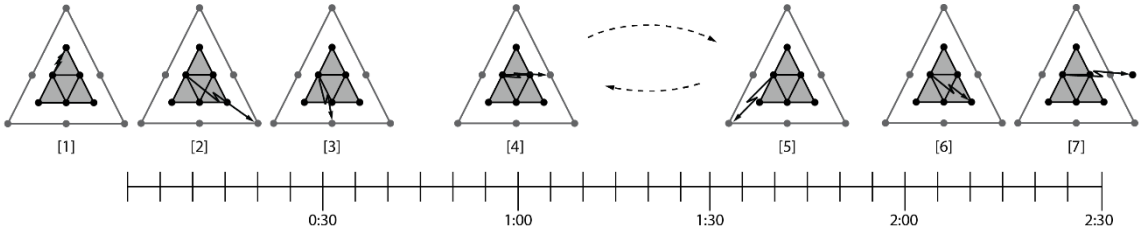

Figure 7 Team B's timeline with expanded triangle

Figures 6 and 7 illustrate that while both teams have achieved in their own way to propose a realistic solution to the design problem, they adopted two different pathways and work pace. Our answer to our third research question was also positive: the coding led to a more refined interpretation of the actions and dynamics of both teams.

Using an iterative methodology, our article Understanding Collaborative Design Through Activity Theory (Zahedi et al., 2017) attests that by using the activity triangle and by focusing our attention on the global contradictions emerging from the team's dynamics we could reach interesting results. We were able to describe the evolution of a team's co-constructed understanding and follow in detail the development of a design project despite the many back and forth, negotiations and decision-making. This process led to the emergence of the Expanded Activity Theory. In the next section, we will present and argument the proposed designerly activity triangle. By using references to authors and published scientific works, we will attempt to offer thorough justifications for each component of the expanded activity triangle that we call Designerly Activity Theory.

6 Generalization – Discussion

Design projects are motivated by innovative discoveries, explorations and unexpected surprises (Dorst & Cross, 2001; Schön, 1983). Similarly, Engeström introduced the concept of transformative agency, which "may be defined as breaking away from the given frame of action and taking initiative to transform it" (Engeström, 2015, p. xxiii). The second dimension that emerged from our data coding is motivated by this transformative agency –unique to design reasoning. In order to gain greater knowledge on these dynamics, exclusive to ill-defined problems, we feel that the addition of a second dimension to the activity triangle is of notable support. We will introduce and justify each pair of components forming the expanded triangle (Figure 8), by starting by the three upper components (subject, object and tools), and conclude with the three social mediators (rules, community and division of labor).

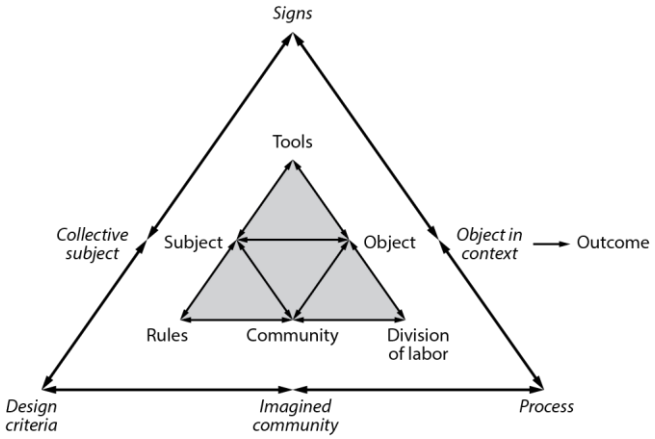

Figure 8 Expanded activity triangle or Designerly Activity Triangle

6.1 Subject and Collective subject

As in the initial activity triangle, the *subject* refers to an individual or team of individuals involved in the activity system. Subject interventions are associated to expert knowledge, disciplinary vocabulary and personal experiences and interests. Design being a social process (Bucciarelli, 1988; Cross & Cross, 1995; Valkenburg & Dorst, 1998), the subject –as a team– goes through many types of communications (i.e. discussions, negotiations, demonstrations, reasoning) and constructs a shared understanding or team mental model. Doing so, the *subject* develops collective meaning and moves to being a *collective subject*. Also, we associate the subject component to Bucciarelli's object-worlds (Bucciarelli, 1988, 2002). In multidisciplinary projects, participants evolve according to their object-worlds –their sets of disciplinary rules. As explained by Kleinsmann, "an object-world contains individual beliefs, interests, knowledge and experiences of an actor, as well as the methods and techniques he is able to use" (Kleinsmann, 2006, p. 44).

The *collective subject* seeks to clarify the existing interpretative gap between the participants' object-worlds. It refers to the co-construction of a team's mental model. *Collective subject* can only be found in activities that engage two or more participants, since it is explicitly a team dynamic. In collective interactions, we see team members working together towards a shared understanding. In design, shared understanding has been explored by many authors including Kleinsmann, Valkenburg and Buijs (2007, p. 61). They defined the concept as "a similarity in the individual perceptions of actors about either how the design content is conceptualized (content) or how the transactive memory system works (process)".

6.2 Object and Object in context

The distribution of *object* and *object in context* is closely linked to Engeström's distinction between the generalized and specific subject. The generalized object is socio-culturally embedded in the historical evolution of a system. On the other hand, the specific object "appears to a particular subject, at a given moment, in a given action" (Engeström & Sannino, 2010, p. 6). The main distinction between the two types of object is the social versus individual sense making process. It is possible that a community shares a general object, but each member also has its own specific understanding of the object. In any case, the object can be either material or conceptual (Jonassen & Rohrer-Murphy, 1999, p. 65). In design, although an object can exist by itself, it finds significant value in its purpose and in the context of use (Krippendorff, 2008).

In summary, the *object* component –as part of the initial activity triangle– allows for an individual perspective of the specific object, while the *object in context* –part of the second dimension– allows for a collective understanding of the generalized object. While the team seeks for the same objective, they foster their shared understanding, but during the entire process, each participant is also embedded in each of their own inquiries due to their different perspectives and individual knowledge.

6.3 Tools and Signs

Along with more traditional physical tools, conversations –as tools of collaborative design– are studied by design researchers (i.e. Cross and Cross, 1995; Dong, 2005; Oak, 2010; McDonnell, 2016; Zahedi et al., 2016). Others have studied boundary objects (Leigh Star, 1954–2010), which are considered as tools to help us understand how team members work together. Literature also contains many other categorizations of tools. However, by focusing on the *tools* component of the activity triangle we notice that it is equally referred to as instruments and artefacts. Wartofsky (1979) distinguished three types of artefacts: primary, secondary, and tertiary. Still, so far, all three types are gathered under the *Tools* component of the AT model. Our data made it visible that, in collaborative design, there is a distinction between material tools and talks that make team members reflect in a different way.

According to Kuutti (1996, p. 28), "a 'tool' can be anything which is used in the transformation process, including both material tools and tools for thinking". Based on this premise, we explored Vygotsky's distinction between the concepts of tools and signs. For Vygotsky, tools and signs always

mediate human interactions with their environment. Tools and signs have intrinsically different mediated functions (Vygotsky, 1978). Tools assist human behaviour, just like a stick helps an individual in reaching something, and signs are cultural productions created according to the time and place under an individual's influence. The following quote explains clearly the difference between the two:

> *The tool's function is to serve as the conductor of human influence on the object of activity; it is externally oriented; it must lead to a change in objects […] The sign, on the other hand, changes nothing in the object of a psychological operation. It is a means of internal activity aimed at mastering oneself; the sign is internally oriented. (Vygotsky, 1978, p. 55)*

In a design project, the *Tools* are material: they can take the form of pencils, whiteboards, computers, sketching materials, prototypes, etc. They allow externalizing ideas, fostering understanding between participants and achieving concrete operations (Engeström, 2015). In design, material tools are seen as "a form of thinking with their hands that allows [designers] to experience the perceptual, emotional, and aesthetic feel of the building [or artefact] as they are thinking their way through the designing of it" (Boland et al., 2008, p. 19). On the other hand, signs are self-mediated and associated to the expertise and experiences of participants. Through the use of signs, participants generate ideas and propositions unique to what they know, understand and imagine in the current context of a design project. Engeström states that "only psychological tools imply and require reflective mediation" (Engeström, 2015, p. 48). Additionally, both tools and signs support the designer in the construction of his mental model. As Kolko puts it, "the externalization of the research data allows for a progressive escape from the mess of content that has been gathered" (Kolko, 2010, p. 19).

This differentiation between tools and signs is closely related to the internalization and externalization process. While the participants integrate new knowledge from others and from the situation, they produce new concepts as they evolve in the system. These learning dynamics are labelled as 'internalization' and 'externalization' (Engeström, 2010). Internalization refers to Vygotsky's knowledge acquisition process. It is a form of individual appropriation or integration of concepts and ideas supported by social interactions with others. Externalization corresponds to the creative effort for collaborative solutions and "discrete individual innovations" (Engeström, 1999, p. 33). Externalization is linked to the solution-space of fuzzy or ill-defined projects. It asks for team members to generate ideas and to have an integrated understanding and shared vision of the problem. To quote Kolko (2010, p. 18) on externalization: "Once externalized, the ideas become "real"—they become something that can be discussed, defined, embraced, or rejected by any number of people, and the ideas become part of a larger process of synthesis".

6.4 Rules and Design criteria

The distinction between *rules* and *design criteria* lies behind the team's external and internal constrains. *Rules* are closely linked to Krippendorff's statement that "objects are always seen in a context (of other things, situations, and users, including the observing self)" (Krippendorff, 1989, p. 12). The *rules* as presented here come from the project's exterior boundaries –context– and are interpreted as guiding directives. These directives are given to the designers as part of the project brief or regulations associated to the design situation –time, place, etc. For example, *rules* can be related to restrictions in regards to ethics, technology or politics, such national laws or norms. They exist before the entry of the designers in the project and designers have either to navigate around them or challenge them.

Rosson and Carroll argued that "designers need constraints" (Rosson & Carroll, 2002, p. 4). Constraints or *design criteria* contribute to the framing of a design project: it is its "semantic perspective" (Kolko, 2010, p. 23). They are collaborative decisions emerging within the team allowing the project to take form. Frank Gehry said that "constraints are what make a design problem unique and worthy of *their* best efforts" (Boland et al., 2008, p. 21). Project perspectives

are researched, analysed and reviewed by the designers in order to reconsider the initial problem or question. This exploration leads to the iterative reframing of the project.
According to Schön, framing is a sense-making activity based on previous experiences and occurs through the process of reflection-in-action (1994). Frames are understood as tentative ways of regarding a problem combining "a few salient features and relations from what would otherwise be an overwhelmingly complex reality" (Takeda et al., 1999 cited in Kolko, 2010, p. 22; Bucciarelli, 1988; Dorst, 2015). Design criteria contribute to the progressive settlement and refinement of the project frame. At best, in collaborative settings, frames lead to shared understanding among the participants and allow common ground for discussions.

6.5 Community and Imagined community

In the past decades, designers have attributed increasing importance to the end users. As discussed by Kuutti, user-centered approaches can be either active or passive. Some approaches tend to actively include potential users as "full partners" in the design process while others "treat users just as passive objects of 'requirements elicitation'" (Kuutti, 2009, p. 67). The distribution between the *community* and the *imagined community* stands on the differences between these two approaches to the designer's sense-making. Still, both components refer to "an action-oriented process that people automatically go through in order to integrate experiences into their understanding of the world around them" (Kolko, 2010, p. 18).
Our data analysis allowed the identification of the *community* component in real, verified information, such as ethnography, but also statistics, interviews, surveys or test bench experiments. In these instances, verified data deals with the habits, needs and behaviours of future users emerging from empirical research. Moreover, stakeholders have come to have an important place in the community as they offer another type of tangible knowledge. Stakeholders are reliable sources since they are often specialists in a certain area of the project. As stated by Krippendorff, the inclusion of stakeholders, as collaborators and opponents, has changed the design process from the problem solving to a "social process that relies on stakeholders with different and potentially conflicting interests" (Krippendorff, 2008 , p. 65). In brief, *community* is an amalgam of knowledgeable sources of information and data feeding the design decisions.
However, often due to efficiency, time or money concerns or to allow for more creative opportunities, designers also rely on *imagined communities.* This component is inspired from Krippendorff's concept of object context, which he says is "cognitively constructed, whether recognized, anticipated, or wholly imaginary" (Krippendorff, 1989, p. 12). We note that *imagined communities* emerge from past experiences, interpretations and deductions through which designers conceptualize the potential use of the artefact to be designed –"how users might or should be using an artefact" (Krippendorff, 2008, p. 134).

We observed the use of scenarios, personas and other human-centered approaches in our case studies. As Krippendorff's puts it, designers consider "maps of possibilities" (Krippendorff, 2008, p. 134). These creative methods are used to provide alternative opportunities to keep the designers moving and reflecting. Some compare the efficiency of sketches to communicate physical features to the efficiency of user scenarios to rapidly depict the core of a situation (Rosson & Carroll, 2002). Scenarios are popular in design projects as they create a common ground for discussion (Krippendorff, 2008), are low-tech, quick to use and easily accessible. They often evoke empathy for the users, raise questions and stimulate reflection. According to Rosson and Carroll, scenarios are detailed propositions "that a designer can evaluate and refine, but it is also rough, so that it can be easily altered, and many details can be deferred" (Rosson & Carroll, 2002, p. 4). Such methods bring those that are not around the table into the solution-search process by sharing possible experience with them.

6.6 Division of labor and Process

The last component is distributed between *division of labor* and *process.* The first refers to the separation of tasks according to expertise and skills. It was noted that such division of labor tended to happen towards the end of the case studies –more precisely during episode [6]– because, as observed by Langan-Fox et al. (2004), team members are more comfortable with one another and

understand themselves better. We interpreted this division of labor as a transition from close collaboration to cooperation between the team members. Consequently, we feel appropriate to refer to Peng's definition of cooperation according to which "participants of different technical specializations communicate and co-ordinate with each other to achieve, or, to cope with, design unity in final products" (Peng, 1994, p. 21).
The *process* component considers 'design' in its verb form (Boland et al., 2008), inviting to a series of design actions. Kleinsmann's definition of collaborative design includes both to achieve agreement on the outcome of the project, as well as the team's design process (Kleinsmann, 2006). Therefore, *Process* identifies the adoption of a "design attitude" centered on the open search for potential solutions and new ideas (Boland et al., 2008, p. 13). Such an attitude is closely related to project framing, as introduced earlier. In this instance, we regard framing in its iterative development. Schön proposed that framing is the result of a reflexive process occurring in action (Schön, 1983). Formed of subsequent cycles of refinement, framing contributes to the definition of the problem and solution. Framing contributes to the settlement of ill-defined problems by using abduction as a cognitive process. According to Cross, abduction is the only cognitive process that allows the creation of new knowledge (Cross, 2006). Dorst explains abduction as "how to think from consequences back to causes and working principles" (Dorst, 2015, p. 24) and Kolko cites Roger Martin explaining that abduction is the "logic of what might be" (Kolko, 2010, p. 20). The design attitude, framing and abduction are bounded together for the search of creative opportunities and iterative problem-solving.

7 Conclusion

The present paper focused on the methodological approach that emerged from using Activity Theory as a framework to analyze collaborative design. Following a designerly research practice, we allowed for unpredicted connections to emerge, which lead to the progressive construction of a second dimension to the activity triangle. This exploratory investigation leads us to believe that we have some elements of answer to the research questions of this study. Activity Theory, as a framework, can offer a concrete and solid basis for understanding the collective activity of the design teams. Ultimately, we seek to propose a new ontology for design research allowing us to meaningfully report the fundamental characteristics of a multidisciplinary team's journey to framing, proposing ideas and decision-making in a design project.

Looking more closely at the evolution of both teams led to the observation of recurring data patterns. These patterns are the focus of Stage 4 (still ongoing), which will result in the publication of another article to answer this last research question: What recurring patterns emerge from the data coded with the expanded activity triangle? Answering this question will lead us to verify the emerging patterns and findings across a total of five case studies. It will also allow us to refine our methodological approach and validate the Designerly Activity Theory. The expanded model will maybe allow identifying successful collaborative patterns in a more objective manner. Finally, we will be able to contrast and compare the five design situations using our Designerly Activity Theory to, potentially, refine our knowledge on collaborative design.

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An Examination of Scholarly Critique in DRS Publications and Its Role as Catalyst for Community Building

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The design research community has been interested in its identity as an intellectual community for some time, and, as with design itself, critique is central to good scholarship. Building on recent citation analyses in the field, in this paper we examine two cases of critique in design research scholarship. We aim to contribute to the theory of scholarly critique by providing a richer picture of critical citations than has previously been available. In addition, we identify the need for a crucial methodological development in the field; namely, design researchers need a way to examine and assess critical citations *from within*. Analytical (citation) frameworks that have been imported from other fields are limited in what they can tell us about the nature and quality of critical citations in the design research community. We argue for the DRS community to examine and reflect on its use of scholarly critique.

scholarly critique; community building; critical citations; citation analysis

1 On Intellectual Communities and Critique

> *"A group can be a society simply by virtue of belonging to a common association. This, however, does not guarantee that the members share anything other than their membership in the association. Societies such as the DRS organize conferences, give prizes, disseminate articles through a journal, and establish standards of achievement without having to deal with how the thematic substance of a scholar's research relates to a larger field. Likewise, we can speak of a design research network but there is no guarantee that those in the network will produce any valuable discourse" (Margolin, 2016, p. 6).*

Victor Margolin has critiqued the design research community and, in particular, the Design Research Society (DRS). Indeed, a grouping of people does not necessarily form a community. Tönnies ([1887] 2001) has stressed the value of a community as distinct from a society. A community includes members who have a common goal and shared values and who achieve something together. In a

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society, groups are *instruments* for people to achieve their distinct and sometimes contradictory goals. Community building is challenging, and it requires understanding (and attempting to influence) a number of dynamic elements.

We propose *scholarly critique* as one such parameter for an academic community. In this paper we are interested in exploring how the presence or absence of scholarly critique plays a role in the intellectual growth of the design research community.

Critique is a crucial aspect of community life. In his famous text, *Ethics* (1904), John Dewey demonstrates the necessity of critiquing human affairs (using social philosophy) to nurture a community. In addition, Richard Sennett has argued that an erosion of social mores originally designed to maintain and cultivate spaces for critical, civic engagement, has resulted in a decline in public life (1978). He elaborates this line of thinking in his more recent book, *Together* (2012), exposing how everyday diplomacy paradoxically hinders group discussion and prevents criticism, both of which are crucial activities for cooperation and community-building.

Critique is also central to designing. Designers regularly critique their work, and many design schools include juried critiques as core components of the design curriculum (Oh, Y., Ishizaki, S., Gross, M. D., & Do, E. Y-L., 2013; Dannels, D. P., & Martin, K. N., 2008; Uluoğlu, B., 2000). In the design research community, as in other intellectual communities, scholarly critique also plays a role in knowledge production (Jacques, 1992; Lakatos & Musgrave, 1970).

Considering the potential importance of critique for building a research community and given the centrality of critique to the design field, we were interested in examining an outcome of our previous citation analysis of DRS publications (Beck & Chiapello, 2016). In an examination of two years' worth of DRS conference proceedings, we found only four instances of scholars citing Donald Schön in order to criticize his work. Schön is one of the most highly cited scholars in the design field. His work thus appears to be highly influential, and yet critical citations, which, following Harwood (2009), we refer to as "engaging citations" were rare. Is this scarcity a cause for concern? How is a key author like Schön criticized? Where should we go from here?

2 Studying Citations in DRS Conference Proceedings

In order to assess the role of critique in the DRS community, we gathered proceedings from the last four DRS conferences (2010, 2012, 2014, 2016). These papers can be seen as privileged sites for scholarly criticism. Margolin (2016) stresses the importance of publications in a research community in part because they can provide a comprehensive view of its accepted knowledge. At the launch of *Design Issues* in 1982, Margolin described the journal as a step towards establishing "new forums for research" where critique could thrive. "We characterized the journal as a forum for design history, theory, **and criticism**" (Margolin, 2016, p.3, our emphasis). Other forums include the *Design Journal*, which is the official publication of the European Academy of Design (EAD), and *Design Studies*, established in 1979 by the DRS. Conference proceedings augment these journal publications, thus forming a vast network of what can be seen as the scholarly writings of the academic field of design.

At the 50th anniversary DRS conference, we published the results of a qualitative citation analysis of all citations of Donald Schön's work in two years' worth of DRS conference proceedings (2012, 2014). In this paper, we build on this study in two ways: (1) we expand the corpus to include two additional years' of DRS conference proceedings (2010, 2016), and (2) we focus our analytical efforts on critical citations only. The former decision contributes to any validity claims we might make about our findings. The latter enriches our understanding of the role of scholarly critique in DRS conference proceedings, which are part of the intellectual output of the design field.

In our previous DRS publication, we examined 194 citations collected from 63 papers using an existing framework that distinguishes 11 different citation functions (Harwood, 2009, pp. 501-510). We found that most in-text citations of Schön's work serve one of two purposes: (1) crediting Schön for his ideas or concepts and (2) justifying their own research topics, arguments, methodologies, and

so forth. We found only *four* citations critiquing Schön's work. We were intrigued by this finding. Since critique is considered a crucial aspect of the design professions *and* the design discipline, we would have expected more scholars to be critical of Schön's work.

Moreover, we were surprised to find that all four critical citations come from the same paper: *Researching the One-on-one from a Learning and Teaching Perspective* (Wallis & Williams, 2012). This means that no other *referenced* critique of Schön's work appears in our first corpus. Working with the same corpus (plus two more sets of conference proceedings) we developed a stronger sense for how to distinguish between the different citation functions. When we analyzed four years' worth of DRS conference proceedings (2010, 2012, 2014, 2016) we found one additional paper critiquing Schön with in-text citations: *The Value of Stimulated Dissatisfaction* (Spencer & Hilton, 2010).

Thus, our findings in this study suggest that only two out of the 120 papers citing Schön published at the past four DRS conferences critique his work**.** This would seem to constitute a peculiar case of absence. Critique is central to designing, and it has been characterized as a crucial aspect of intellectual community life. Yet in four sets of DRS proceedings, critique of one of its most highly cited scholars is notably absent. The few critical citations become quite interesting. Siggelkow calls cases like these "talking pigs" (2007, p.20), which captures their surprising, unusual qualities.

3 Critical Citations are Complex and Nuanced

Citations have been widely studied in research communities, such as: information science, English for academic purposes, applied linguistics, and natural language processing. Scholars in these fields propose different rationales for studying citations. For example, some suggest that studying citations can give insight into the relationship *between* scholarly publications and, thus, the transfer and interplay of academic knowledge (Teufel, Siddharthan, & Tidhar, 2006, pp. 80-81). Jörg argues that citation counts "have matured towards a serious means of assessing impact of scholarship" (2008 p. 31). In our own previous work, we have argued that insight into citation function might tell us something about knowledge production in design research (Beck & Chiapello, 2016, p. 26-27; in press). Citations would thus appear to be complex and meaningful knowledge objects.

In some cases, citations perform the typical function of crediting sources for concepts or text. However, they may be *intended* as demonstrations of researcher fluency in a discourse or topic (Harwood, 2009). Similar to Ziman (1968), Harwood frames citers' *motivations* as multifaceted: there are many reasons to cite a given source and those reasons can be context-dependent.

Hyland has studied "the contextual variability of citations" in order to investigate "the [distinct] ways knowledge is typically negotiated and confirmed within different academic communities" (Hyland, 1999, p. 341). With regard to our previous findings (2016), we became curious about how scholars in the DRS community negotiate knowledge. More specifically, how do they critique and (potentially) engage with or build upon existing scholarship?

A challenge we face in studying critical citations is that, although existing citation frameworks (cf. Harwood, 2009; Small, 1982) distinguish critical citations from other kinds, they do not necessarily account for the complex nature of critique.

One reason for this could be a general deficit of critical citations in published scholarship. Howard White's (2004) summary of citation classification studies describes a thread of research on "negative" and "refutational" citations, which we refer to in this paper as critical citations. From the earliest study (Small, 1982) through more recent studies at the time (e.g., Vinkler, 1998), White summarizes a pattern of "low percentages of negative citations… [the] great majority of citations are thus confirmative" (2004, p. 101).

In addition to a possible overall lack of critical citations, White points out that it can be challenging to distinguish critical citations from other kinds. "The coding of `negativity' in some studies may have

conflated real attacks and refutations with mere assertion that the citee's work has not solved the problem the citer wants to address" (White, 2004, pp.101-102). We agree with the notion that coding critical citations is complicated and problematic. However, we disagree with White's distinguishing "real" negative citations from "mere assertions" about limitations or problems. In our view, both ought to be interpreted as critical citations separated by degrees.

Understanding this difference has practical value for authors as they prepare manuscripts and review submissions for publication, but there seem to be more questions than answers when it comes to the differences between critical citations. For example, "Cronin (1994) observed… that a citation can refer to the citee's work at different levels of granularity to an entire oeuvre, a cross-textual motif, a document, a passage, a single sentence, a phrase, a number); any one of these levels can be criticized, and existing schemes do not take this adequately into account" (White, 2004, p.102).

In our previous work, we imported a citation function framework that describes 11 different citation functions (Harwood, 2009). None of the 11 functions are characterized as "critical" per se. However, Harwood explains that "[engaging] citations appear when authors are in critical dialogue with their sources. This criticality can be more or less marked" (2009, p. 506).

It is important that Harwood's framework is an applied linguistic framework. It is not from design research. The framework is a product of Harwood's rhetorical analysis. The idea that a critique could be designated as more or less intense derives from the language choices an author makes and not the object (i.e. concept, theory) of critique. For example, Harwood cites Hyland's influential study of hedged language in critical citations (1999). Hyland found that strong refutational verbs like "fail," which signify sharp, direct criticism, are increasingly used *primarily* in humanities and social science disciplines while scholarly publications in other disciplines show an overall *softening* of their critical rhetoric. Harwood's framework is conducive for this sort of linguistic analysis, does impose some limits on its capacity to account for the nuanced kinds of critiques that scholars might make against Schön's work in the DRS community.

Harwood's framework amplifies two, broad categories of critical citations. The first consists of "praising but identifying problems with the source "(2009, pp. 506-507). Problems with a source could refer to weak arguments, logical fallacies (e.g. special pleading), faulty assumptions, and so forth. But these problems appear alongside general praise for a text. Harwood includes the following example quote. "Although [this paper] acknowledges that [reference's] synthesis. . . **remains the most sophisticated discussion of x, it identifies a number of difficulties** in their influential work" (2009, p. 506, our emphasis).

The second category of critical citation in Harwood's paper emphasizes "inconsistencies in the source's position" (2009, p. 507). As an example, Harwood describes a citation in which a source is attacked for what one critic saw as an inconsistency between a source's stated theoretical framework (Marxism) and a lack of attention paid to "property" in a particular analysis.

Harwood's framework appears to be a useful way to take first steps towards understanding critical citations in DRS publications and, more broadly, towards developing a tool or method for analyzing critical citations in a designerly way. That is, we can apply Harwood's framework to critical citations and frame our application of it as a kind of usability study. What works well and where can it be iterated, improved, and made more designerly? In the next section, we model our analysis of critical citations of Schön's work on Harwood's approach.

4 A Linguistic Analysis of Critical Citations

In this section, we present two cases of authors engaging critically with Schön's work. First, we examine Spencer & Hilton's 2010 Montreal DRS conference paper. Second, we examine Wallis & Williams' paper from 2012 Bangkok DRS conference. Both papers demonstrate hedged, indirect

critique of Schön's work -- illustrating some of the rhetorical nuances we discussed in the previous section.

4.1 The Value of Stimulated Dissatisfaction (Spencer & Hilton, 2010)

Spencer & Hilton aim to discuss and enhance Schön's model of the reflective practitioner. Specifically, the authors argue that "the reflective practitioner model of the designer must address the stimulation of dissatisfaction as a condition of creative and explorative design practice" (2010, p. 1384). Although Schön's model *appears to be* at the core of this paper, citations of Schön's work are scarce. In the text, we found only four citations. Three of these referenced *The Reflective Practitioner* (Schön, 1983) and one referenced *Educating the Reflective Practitioner* (Schön, 1987).

Of these four citations, only two address a precise flaw in Schön's work. This means that only two are critical citations:

> *Schön describes the good reflective practitioner as being willing to enter into new confusions and uncertainties, but does not provide a good account of states of confusion or the experience of uncertainty and how these affect reflective inquiries. The conversations that Schön presents (1983 & 1987), focus upon illustrating how naming, framing, making moves toward solutions and evaluating through reflection develop through dialogue, focusing upon design content and action (descriptions of solutions and frames; and explanations of moves and reflective behaviour). Schön does not highlight what it is like, experientially, to be in a reflection-in-action moment. Nor does Schön focus upon the affect a practitioner's mental and emotional state has upon their ability to have effective conversations* (2010, p. 1386-87, emphasis ours).

The other citations tend to praise Schön's work, thus using the rhetorical formula (praise + critique) Harwood describes in his text. For example, the authors recognize Schön's model as the "the last paradigmatic shift in support of Design Thinking" (Spencer & Hilton, 2010, p. 1385).

While the paper seemingly aspires to be a general critique of Schön's work, it contains few critical citations, which provides an interesting insight relative to our finding (2016) that scholars publishing at the DRS conference tend to use Schön's work uncritically. It may be true that there are fewer critical citations of Schön's work, but critique can still be present.

Indeed, it seems possible to criticize a concept or an idea outside the boundaries of a given citation. For example, it would be possible to cite one of Schön's concepts (e.g. the reflective practitioner) at the beginning of one paragraph and then criticize him in the next paragraph *without citing again*. We probably would not have counted an example like this as a critical citation simply because the critique did not appear in close enough proximity to the citation. Thus, it may only *appear* that scholars primarily use Schön's work in uncritical ways.

Our intention is not to exonerate authors who critique Schön but do not include citations in proximity to their critiques. In fact, citations are even more crucial in the context of critique. Critics must be held accountable for their critiques, but they must enable readers to hold them accountable by pointing towards the problematic source material. Only by pointing to the source material can the substance of their critique be judged. Is it a good critique or a bad one? Do the authors draw attention to a major flaw? Or a minor one?

These latter two questions are challenging to answer. Harwood uses rhetorical analysis to gauge the severity of the flaw. So, for example, Harwood might point out how Spencer & Hilton use phrases like "does not provide," "does not highlight," or "does not focus" when they refer to Schön and/or his work. Their rhetorical choices do not appear to contradict or refute Schön outright. Instead, they appear to delimit an area that Schön left unexplored. But what is the significance of this unexplored area for the design research community? Just because an area is unexplored does not mean that it is worth exploring.

So, we are left to ask ourselves whether Spencer & Hilton are critiquing something central to Schön's work and important for design research? What would be the value of expanding what Spencer & Hilton see as the apparent limitations Schön's model? Moreover, how do Spencer & Hilton intend to critique the limitations of the model without engaging its foundational theory, such as pragmatism (Dewey) or tacit knowledge (Polanyi)?

4.2 Researching the One-on-one from a Learning and Teaching Perspective (Wallis & Williams, 2012)

Similar to Spencer & Hilton, Wallis & Williams (2012) examine an alleged weakness in Schön's model for educating the reflective practitioner. The studio, the authors suggest, may very well be useless nowadays.

> *"Webster amongst others states that the tradition of the 'studio', in particular Schön's portrayal, may be unhelpful and outdated yet, enduring, lauded, well known and convenient" (2012, p.1972).*

Crucially, Wallis & Williams do not critique Schön themselves. They cite Webster's critique of Schön. In our view, this *secondary critique*, by which we mean citing another author's critique of a source, reaffirms the importance of making strong, cogent arguments for the strengths and weaknesses of a given scholarly source. If we read Wallis & Williams' text *only*, then we do not know whether Webster authors a more cogent critique of Schön. We rely on Wallis & Williams' characterization of it, which could be problematic.

Is it sufficient to quote Webster's published work to demonstrate that Schön's conception of the studio may be unhelpful and outdated? While publication certainly does lend credibility to an argument, absent deeper engagement with the source text we cannot assess whether Webster's point about the studio is a cogent argument or a secondary (or tertiary) point made in the context of a broader discussion of Schön. Read Webster's text becomes a crucial step toward assessing Wallis & William's argument. However, in this scenario, our interpretation of Webster's argument will be independent of any frame Wallis & Williams could have provided.

We maintain that, given page and word count limitations imposed on scholarly publications, it is unreasonable to expect authors to engage in depth with all of their sources (2016, p. 26). However, Webster's position, or, perhaps more accurately, Wallis & William's interpretation of Webster's position, is a crucial component of their project. In other words, if Webster is *in*correct and Schön's portrayal of the studio is helpful and current, then the grounds on which their project rests erode. For this reason, it seems important (if not necessary) to discuss Webster's text in more depth. Consider Wallis & Williams statement that:

> *"In Webster's opinion (2004b) the lack of learning and teaching theory in the 'studio' means that tutors rely on their own experiences and mentoring but are unlikely to engage in critical reflection" (p.1978-1979).*

Here, the authors characterize Webster's position as an "opinion" rather than an argument. This is troubling since opinions, by definition, do not have to be based on facts. Why would Wallis & Williams describe the source of crucial grounds for their own project as an opinion rather than an "argument" or "findings" or some other term designed to enhance rather than detract from the credibility of the source? Paradoxically, it seems as though they frame the source material, which bolsters their claim that Schön's concepts are problematic, as problematic itself. It is based in opinion rather than rigorously developed scholarly knowledge.

Our point is not that Webster's conclusions are *truly* weak or specious. Rather, it is that Wallis & Williams have not necessarily done enough to convince readers that Webster is a substantive, reliable source. They could have accomplished this by dissecting Webster's argument in more depth, exploring *its* strengths and limitations, in the service of motivating their own project. Why does

Webster argue that Schön might be unhelpful and outdated? Why should readers value Webster's opinion on the implications of theory's role (or lack thereof) in design studios?

5 Towards Designerly Citation Analyses

Our analysis illustrates some of the ways in which scholarly critiques can be mellow and amicable. Some scholars have implied that "real" critical citations are supposed to be apparently "negative" or "refutational" (White, 2004, p. 100), and one might expect critique to directly reject the work of a particular author. However, as White further suggests, direct rejection is rare. Indeed, Spencer & Hilton's critiques serve as ways to build on Schön's model, which requires maintaining some of its integrity. On the other hand, Wallis & Williams' critiques are secondary, and although their secondary source questions Schön's, Wallis & Williams do not undertake a substantive analysis of his work. Following Sennett's argument, in a society where "everyday diplomacy reigns," it may be the case that sharp and direct critique is becoming scarce.

In our view, at least one thing is clear: it may be necessary to develop a more robust citation framework capable of describing nuanced kinds of critical citations. Despite what we see as Harwood's genuine attempt to capture scholarly efforts to expose a source text's weaknesses, his categories lack the kind of nuance we may need in order to assess the current state of scholarly critique. Harwood distinguishes two types of critical engagement. These are: (1) praising but noticing problems, and (2) identifying inconsistencies.

These types of critical engagement may inspire readers to explore and iterate on the different ways that a given source text might be problematic *and* the possible way(s) a text might be inconsistent. For example, there could be an inconsistency between an author's stated theoretical framework and the nature of their analysis, and this would seem to be a valid critique. However, we wonder whether there are broader implications.

Where does an inconsistency between a theoretical framework and an analysis fall on the spectrum of scholarly critique in design research publications? Is it substantive or perfunctory? Is it a real critique (White, 2004) or not? Does the stated inconsistency point towards deeper issues with an overall argument or analysis? Is it a substantial critique to identify a missed analytic opportunity as opposed to, say, inaccurate analysis or poor synthesis?

Moreover, the analyses we present in the previous section motivates questions that cannot be fully answered with a rhetorical approach. *What is the significance of a given critique for the design research community? What, if anything, makes a given scholarly critique designerly?* We believe that these questions can only be answered by design researchers after analysing critical citations from a standpoint that gives primacy to design as opposed to linguistics or rhetoric, both of which are useful and valuable for different reasons. Harwood's framework is designed to be used across disciplines, but we may need a citation framework developed for and by design research. And, if we do, then we believe a valuable place to start would be developing a richer account of critical citations.

Harwood did not focus on critical citations. His goal was/is to develop a framework that could explain multiple, overlapping citation functions. In doing so, he enriches our overall understanding of just how meaningful and intricate individual citations can be. On the other hand, since none of the individual functions are developed in detail, we walk away inspired to work towards a deeper understanding of each one. Critical citations, which Harwood calls "engaging" citations seem like a reasonable place to start for design research.

5.1 The importance of a designerly framework for citation analysis

Developing a more detailed vision of critical citation practices appears crucial for understanding how to expand and enrich scholarly critique in design research publications. In our view, following arguments by both Sennett (1978; 2012) and Margolin (2016), enriching critical citation practices is

one way that design researchers might turn existing citation practices in the field into preferred ones. Moreover, we reaffirm the importance of practicing fine-grained citations (Friedman, 2015, p. 21) in the context of scholarly critique. For example, we missed an opportunity to learn about Webster's critique of Schön when we read Wallis & William's (2012) paper. A crucial question for this trajectory is: what next steps could we take to establish a designerly framework for critical citation analysis?

One way forward could be to look for inspiration and guidance in the design research literature. It would be possible, for example, to draw on Anthony's classic work, *Design Juries on Trial* ([1999] 2012, p. 108) and to propose that the three types of design jury criticism (normative criticism, interpretive criticism, and descriptive criticism) provide a useful preliminary framework for analysing critical citations in design research publications. Such an approach could be seen to reframe peer review as a design jury and papers as design proposals, which strikes us as an interesting and potentially valuable approach for the design research community.

5.2 The importance of critique in design education

Both Spencer & Hilton and Wallis & Williams denounce a lack of training in critique in design education. The former argue that Schön did not explain how designers can be (or become) critical of their own work. They stress that, "It is expected that experienced practitioners may generally have **become more critical, more dissatisfied"** (2010, p. 1392, emphasis ours). But, they argue, Schön does not explain how this happens. Similarly, Wallis and Williams stress that critique is not necessarily explicit when a mentor corrects a project in the studio model. "Tutors rely on their own experiences and mentoring but are unlikely to engage in critical reflection" (2012, p. 1979). Hence, design students might not be able to critique their own work as they don't know how to proceed.

This lack of training in critique might be a methodological problem (e.g. how to articulate a critique) or a theoretical one (e.g. which theories one should know in order to be able to critique in design). Returning to Margolin, this might be tied to PhD training in design. "Within the realm of design doctorates, there is no consensus on what foundational texts to read, what methods to master, or whose work one would need to know about" (Margolin, 2016, p.7). This becomes even more problematic in the design community as it educates more and more researchers without any comprehensive, unifying research vision. "This has vastly increased the number of researchers with doctorates but it has not contributed to the coherence of a field and certainly not to the formation of a discipline." (Margolin, 2016, p.1).

In order to transform the DRS *from a society to a community*, we strongly advocate for the role of critique in design research scholarship to be valued and explored in more depth, which involves engaging with and building on current studies (Oh, Y., Ishizaki, S., Gross, M. D., & Do, E. Y.-L. , 2013; Dannels, D. P., & Martin, K. N. , 2008 ; Uluoğlu, B. ,2000).

6 Conclusion

Given the strong culture of critique in design, it is interesting that we find so few critical citations in DRS scholarship. Building on our previous work (Beck & Chiapello, 2016; in press), in this paper we examine four years' worth of DRS conference proceedings (2010, 2012, 2014, 2016) to determine how many publications criticize the work of Donald Schön and how they go about structuring their critiques. We identified only two papers containing a combined total of four critical citations of Donald Schön's work. Is this good? Should there be more scholarly critique?

We make no claims about the generalizability of our findings to design research. For instance, it may be the case that other kinds of publications, such as book chapters and journal articles, contain more examples of critical citations. An important trajectory for future work would be to examine different kinds of publications to see whether this might be the case. On the other hand, it may also be true that, in accordance with White's (2004) argument, there are fewer critical citations in general in academic communities.

In this paper, we presented two cases of critical citations of Schön's work. Because there were so few examples of critical citations, we became interested in capturing the nature of these criticisms. Were they sharp and direct? Or mellow and amicable? Moreover, we wanted to understand how such critiques work. What rhetorical techniques (e.g. hedging, and so forth) did they employ? To conduct our analysis, we started from Harwood's (2009) applied linguistic framework. However, in this paper, we complemented Harwood's framework with additional insights about critical citations from White (2004).

We found that the handful of critiques of Schön were balanced (and thus softened) with praise (Harwood, 2009). In one case, the critique was secondary rather than primary. Wallis & Williams (2012) cited a critique of Schön but did not elaborate its substance in any depth. These findings interested us since we had expected to find more direct refutations and/or stronger intellectual arguments against Schön's work. Instead, we found vague indications of unexplored territory, descriptions of possible limitations, and reliance on others' critiques.

Citation function framework from applied linguistic like Harwood's (2009) seem to be useful. Linguistic analyses can reveal the general perspective on a source or concept. However, such analyses may be limited in their capacity to establish the overall quality of a particular critique. That is, it cannot expose whether a critique is robust or thin, good or bad, and so forth. It may only be possible to make judgments like these with the support of an analytical framework developed from within the design research community. Relying on applied linguistics seems insufficient for the broader purpose of establishing a unique intellectual culture for design (Cross, 2001).

Following Margolin (2016), we argue that members of the DRS ought to be more attentive to the state of their community, and, in particular, to the role of critical citation practices in its scholarship. If we continue citing key scholars like Schön uncritically, we potentially do a disservice to their contribution and legacy in our community as well as others. We hope that this paper might serve as a catalyst for developing a richer culture of critique in scholarly writing in the design field which, we hope, could also be seen as a step in the direction from a society toward a well-rounded academic community.

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The Critical Design Exhibition: an epistemic space

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The overall objective of this paper is to position the critical design exhibition as a context of discovery – a material space for thinking – distancing itself from the more didactic forms of exhibitions that still dominate practice today, and to pose ways to establish a far more dynamic and open relation between critical design and its staging. What will follow will be an examination of critical design as a form of research which seeks not so much to make explicit knowledge production but rather to provide a space for thinking. Consequently critical design is an open undertaking centred on thinking in, through, and with design. I propose the exhibition as epistemic environment for critical design, an environment that secures and creates conditions to support the thinking dimension of critical design practice while unlocking an active agency in the audience. It is a space where research and knowledge production is evoked *in situ* and *in action, reflecting the search for an exhibition practice which moves beyond simple communication to a form of embodiment that embraces collaboration, and experimentation.*

critical design; exhibition; embodied criticality; epistemic space

1 The Exhibition as research for Critical Design

When British educationalist and writer Christopher Frayling (1994) examined the stereotypes of design research he described three types of research (with reference to Herbert Read) which could grow out of design: 1) Research into design, in terms of historical research, aesthetic or perceptual research, and research into a variety of theoretical perspectives on design; 2) Research through design, in terms of materials research, development work, and action research; 3) Research for design, in terms of the expressive tradition, where thinking is embodied in the artefact, in the sense of visual or imagistic communication. Frayling (1994) considered the latter as research with a small 'r' which he earlier defined as "the act of searching closely or carefully" (p.1) He states,

> *So research with a little r has been used, in the last four hundred years, of art practice, of personal quests, and of clues and evidence which a detective must decode. The point, says the OED, is that the search involves care . . . it isn't about professionalism, or rules and guidelines, or laboratories. It is about searching. (p.1)*

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What interests me in Frayling's account of design research with 'r' is the emphasis he places on comprehending the possibilities of design research outside of its instrumental roles. He describes Research for design as an expressive idiom rather than a cognitive one– steeped in autobiography rather than understanding. What this implies is that research with 'r' emphasises self-reflexivity over a communicable knowledge.

2 Critical Design as Research 'r'

The same criteria that Frayling identifies as defining Research 'r' could be said to hold for critical design practice, whose raison-d'etre is to insight questions, challenge and enable action. A form of discursive design (B.Tharp & S.Tharp, 2015), critical design uses artifacts to prompt self-reflection, contemplation, and discussion – to make users think. Therefore, building upon Frayling's typology, critical design calls forth something of a new category of design research - using research with 'r' – one defined by Swiss educators Simon Grand and Martin Wiedmer (2010) as *Research as Design*. In their article '*Design Fiction: A Method Toolbox for Design Research in a Complex World*' (2010) they argue that design research as a practice is fundamentally a way of understanding and creating experimental systems, which our societies need to deal with their most controversial, essential and complex questions and challenges. (p.8) They argue further that this very idea bears close resemblance to an understanding of design fiction, which systematically questions and deconstructs the self-evident by materialising, visualising and embodying controversies and perspectives in the form of objects, scenarios, installations and performances. (Grand & Wiedmer, 2010, p.5; see also Bleeker, 2009) In a more recent article Grand (2012) further argues for both design fiction and critical design as distinct ways to approach design research, both of which he states focus on the world as it could be: What if? as the actual starting point for conducting, positioning, reflecting on, and practicing design research. (p.171) Here the designed outcome is not viewed as an end point in the search for a solution to a problem, but instead assumes an 'experimental value' which acts as an "entrance point for critical thinking about the self evident, not only as the world could be, but rather to find a new, distant perspective on reality as it is". (Grand & Wiedmer, 2010, p.5) Consequently, the work seeks to enhance our experiences not just with what we 'know' and 'understand' but with 'who' we are and 'where' we stand. In this instance what comes to the fore is that critical design becomes a method to reframe what is taken as 'self-evident' in our world, while distributing the agency of research between the designer and its audience.

In this sense critical design could be understood as a device, as theorised by sociologists Celia Lury and Nina Wakeford (2012) Drawing on Foucault's notion of the apparatus, they propose the 'device' as a term, which can be understood as a complex ensemble of practices that are organised in response to urgent needs. (Lury & Wakeford, 2012, p.8) Importantly, they assert, devices act or make others act. (p.9) They are not static forms of representation of issues, but instead active measures which interfere in the worlds in which they are positioned.

Situating the principles of 'device' in relation to that of critical design helps us to conceptualise works of critical design as assemblages (practices, objects and concepts) of experimental activity that are always in relation to particular situations, problems and/or needs. This analogy further positions critical design as both inventive and adaptable, reliant on movement whereby reflexivity becomes its primary tool. Any critical design could therefore not be considered a static fact but more so a performative act in the here and now. It is precisely here where one sees the transition from design characterised as praxis (a will that produces a concrete effect) towards a design that inhabits the space of possible becoming.

The design theorist Clive Dilnot (2014) has referred to this strategy as the 'science of possibility', or what he has elsewhere called the 'science of uncertainty'. It is that which translates the given into uncertainty and therefore opens as question its possibility. Dilnot's point is important for drawing

attention to the work of critical design as a device which allows us to see how we negotiate the limits of what we understand, at any moment, as the 'actual'.

This way of thinking, I argue, contributes to an understanding of critical design as a form of criticality in curator Irit Rogoff's (2006) terms. Criticality, Rogoff (2006) observes, offers an opportunity "to explore that which we do not yet know or that which is not yet a subject in the world."(p.3) It exists in the operations of revealing possibility and potentiality with an emphasis on modes of embodiment – a 'living through' the very problem we are trying to analyse and apprehend. The emphasis here is on the creation of conditions for both thinking and doing, whereby works of critical design privilege a criticality within which users are asked to question their knowledge and modes of inhabiting the world. This emphasis on possibility and potentiality, in which works can be approached as subjective not absolute truths, offers a space for multiple viewpoints and experiences, which together create a collective endeavour that remains forever open to contestation and adjustment. (Rogoff, 2006) Broadly speaking, what Rogoff's theory of criticality brings into perspective is a deeper understanding that critical design is necessarily embodied through the user.

From the present point of view then, critical designers are not experts in solving problems, but more so in arranging situations in which thinking and action become possible. In fact one could go as far as to say that in the context of critical design the whole notion of the expert can be replaced with what Bruno Latour (2004) defines – building on Callon, Lascoumes and Barthe – as the *co-researcher.*He states:

> *We are all engaged . . . into the collective experiments on matters as different as climate, food, landscape, health, urban design, technical communication, and so on. As consumers, militants, citizens, we are all now co-researchers. There is a difference to be sure, between all of us, but not the difference between knowledge producers and those who are bombarded by their applications. (p.16)*

Forming part of his argument on the collective experiment Latour (2004) summarises all of the rules of method under the slogan "No innovation without representation". (p.17) It is time, according to Latour (2004; Latour & Weibel, 2005) that we have a collective say on the innovations in our world, and decide for ourselves what is good for us.

Not only does Latour's notion of the co-researcher represent a particularly influential way of conceiving of the user in critical design, it also introduces the need for critical design to change its terms of engagement. Or to paraphrase Latour: No critical design without presentation.

In what follows, I elaborate critical design as both an object of research and an entity in which and through which research takes place. Through this process of research the audience, as co-researchers, are invited to partake – they are invited to think – in a situated and embodied way.

The intention is not to resolve all the challenges that critical design faces (see Mazé, 2009; Moline, 2006; Prado, 2014) but rather to recognise the importance of its situatedness and modes of engagement. The methods of analysis I apply, which have been gathered from a variety of movements across and between cultural studies, feminist theory and social studies of science and technology (STS), variously make it possible to address the complex relations between critical design and its audience.

I propose the exhibition as epistemic space for critical design, a space where both research and thinking is evoked *in situ* and *in action*. (Knorr Cetina, 2001; Suchman, 2007) I offer three examples of critical design exhibitions, that, while not done through the trope of *Research as Design*, suggest the possibility for the critical design exhibition as an open undertaking centred on thinking in, through and with design.

3 Risk Centre – Onkar Kular with Inigo Minns

To some degree, it can be argued, critical design practice has concentrated its efforts on the development of methods and practices focused on the creation of spaces for thinking, without inviting the thinking to take place. It hasn't really considered or addressed how to actually engage a user in thinking. Which begs the question: Where do the co-researchers figure into the equation?

As mentioned previously, the aim of critical design is to allow its users to think so as to engage with past, present and future worlds, both critically and differently (Rosenberg, 2007, p.6). Complicating matters further, when outcomes are neither knowable in advance nor necessarily bound up in material form, and when co-researchers play an integral role in the process of design, it becomes necessary to question how does the approach take form? And how are co-researchers invited into the overall process? (Kerridge, 2015) Onkar Kular and Inigo Minns' *Risk Centre (2013) (Figure 1)* is emblematic in this context: Using the museum exhibition as the medium of their work their outcome worked towards reframing the concept of Risk (from financial to physical, from civic to legislative, from personal to digital) in unexpected ways. Through a series of performative gestures ranging from playing out scenarios (The guidance script) to participating in workshops (Slow Motion Accidents) to observing others engaging with the space, the work invited the audience to question their personal understanding and relationship to risk while pondering risk as a force that shapes our environments, behaviours and interactions. *Risk Centre* did not function like a standard exhibition whereby objects are put on display for a viewing public. Instead it acted as an open platform, which actively engaged with the subject of risk through both experimentation and reflexivity. In a similar spirit, through 'Risk Centre tours', 'First Aid Training classes', and the 'Painting and Drawing Risk workshop', run by sociologist Erika Wall, *Risk Centre* employed the education department as a more performative, participatory actor in the exhibition context. The education department in turn was figured as an integral part of the work.

Figure 1 A scenario from Onkar Kular's Risk Centre, in which the dangers of an unidentified black bag were explored. Source: onkarkular.com

Importantly, then, through both staging and performance, the project offered a moment to encounter the exhibition; not as a medium for representing a work, but for explicitly inventing it. It embraced elements of chance and unpredictability into its working order, collapsing boundaries between the work of design and its exhibition, while being reflexively critical and disruptive of the institutions expert-driven systems of power. As sociologist Ulrich Beck (1992) reminds us, Risks can only become 'visible' when socially defined. In this sense Risk Centre acted as a prime site for the social definition of risk, while simultaneously emphasising the work as dependant on a plurality of actions and voices.

The project as a whole declared that its desired function to address and transform our relationship to risk could not be secured in advance. Instead the exhibition was restricted to a matrix of possibilities dependent on an audience to activate the outcomes. Here, there is a move away from an exhibition about critical design towards a process of criticality. Indeed the work amounts to questions rather than answers, and it is these questions that take the work elsewhere, through the audience (co-researchers). As Kular (2013) describes it,

> *This approach does not aim to be problem solving, rather it forms an open question or situation that the audience can interpret and respond to. In doing so the traditional relationship between the user and the design is transformed so that the design becomes a tool and the user is elevated to co-author. (p.32)*

This repositioning of the exhibition as a space for experimentation signifies a move whereby the very act of exhibiting critical design is made available as an entity for speculation and reflexivity, which privileges an active engagement with co-researchers directed towards perception rather than understanding. It is in this staging where the exhibition moves from an ascribed space of objective knowledge and learning to a potential space for exploration and discovery. By creating these objects or situations with multiple potentialities, designers and audiences (co-researchers) are invited to 'think', in a situated and embodied way. This ties in with sociologist Karin Knorr Cetina's (2001) notion of 'epistemic objects', which she characterises as knowledge objects defined through "an incompleteness of being and the capacity to unfold indefinitely". (p.180-181) These fluid objects she contends, have an 'ontological openness'. (Knorr Cetina, 2001, p.182) They are objects of investigation that enable the emergence of the new and the unforseen, while acting as signs for further searching and unfinished thinking. (Knorr Cetina, 2001; Rheinberger, 2007; Borgdorff, 2012). Equally, by emphasising the inherently constructivist, critical, experimental and imaginative nature of D*esign as Research*, as understood in the above, we can interpret a direct correlation to the unconventional perspectives in science and technology studies (STS) and their recent preoccupation with the important role of experimentation and the experimental system, which carries the reflexive and affective aspects of epistemic practice. (Latour, 1993; Knorr Cetina, 1999, 2001; Rheinberger, 2007)

4 Epistemic Practices in Science and Beyond

When we speak of scientific research we often think of a laboratory filled with experts wearing white coats working towards proving or disproving specialised theories through a series of experiments, repeatable at will, whose results, if justified, would at some point in the distant future be presented to a public. Such a view, if taken seriously, elicits two different yet inseparable elements. The first is what Latour (2004) defines as the "trickling down' theory of scientific influence whereby knowledge transfer is one-directional, "The public could choose to learn the results of the laboratory sciences or remain indifferent to them, but it could certainly not add to them, dispute them, and even less contribute to their elaboration."(p.18) As an expert driven system, it presents itself as 'truth' tested by scientific researchers, and taught to a listening public. The second is the portrayal of scientific research as method-driven, repeatable, systematic, rational, objective and universalisable. In this classical formulation experiments are seen as singular, well-defined empirical instances embedded in a context of justification dependent on explicit instructions which reveal the methods of one's logic while justifying one's conclusions. (Frayling, 1995). This understanding of science, however, runs

counter to the more recent 'practice turn in the philosophy of science' (Rheinberger, 2007 ; Knorr Cetina, 1999, 2001; Latour, 1993) which seeks to liberate the context of discovery from the context of justification, shifting the focus to experimental systems framed through subjectivity in place of experimentation as a theory-driven activity centred on objective knowledge. (Borgdorff, 2012) Sociologists like Knorr-Cetina and historians like Rheinberger have in fact argued for an understanding of the experimental system as the centre and motor of scientific research, which inherently situates scientific research as far less method-based and far more focused on dynamic, creative, constructive and normative actions. (Knorr-Cetina, 2001, p.187; Rheinberger, 2007) According to Rheinberger (2015) experimental systems offer unknown answers to questions we are not yet able to ask. Such systems, he contends, quoting French biologist François Jacob are: 'Machines for making the future' (2015). They are designed to allow for unprecedented events to occur. They do not seek to augment knowledge, and are in fact not meant to generate answers, but rather to materialise questions. (Rheinberger, 2015; 2013 (1997), p. 220) In an essay entitled '*Artistic Practices and Epistemic Things*', art theorist Henk Borgdorff (2012) makes the comparison between research in both art and science through an understanding of the experimental system. Referencing Rheinberger he maintains that,

> *Experiments are not merely methodological vehicles to test (confirm or reject) knowledge that has already been theoretically grounded or hypothetically postulated, as classical philosophy of science would have it. Experiments are the actual generators of that knowledge – knowledge of which we previously had no knowledge at all. (p.189)*

The reality of an experimental system, characterised through the realisation of epistemic objects, thus resides in its fundamentally open perspective on *what is* or *could be*. (Borgdorff, 2012) Similarly in critical design practice, critical works are the epistemic objects, they are the generators of that which we do not yet know. They create room for that which is *unthought* and *unseen*. Critical design practice, like experimental systems, is thus centred on opening new perspectives and unfolding new realities.

This fuzzy epistemology of critical design practice, where thinking and things intertwine, is what enables us to see things differently. "As long as epistemic objects and their concepts remain blurred", writes Rheinberger (2012) (and I argue the same applies for works of critical design) "they generate a productive tension: they reach out into the unknown and as a result they become research tools" (p.156) This emphasis on unpredictability while being open and attentive to the unknown, is what makes works of critical design vehicles for materialising questions.

But as Borgdorff (2012) reminds us, it is imperative to consider that the specific contribution that practices like critical design make to our understanding, insight, thinking and experience lies in the manner in which the works are articulated, expressed, and communicated. (p.186) Borgdorff (2012) proposes that the component of dissemination that accompanies material research may go in three directions (p.168):

1. A rational reconstruction of the research process;
2. Interpretive access to the findings;
3. A verbalisation or conceptual mimesis of the artistic outcome.

The third possibility, in his eyes "involves an emulation or imitation of, or an allusion to, the non-conceptual content embodied in the art" (Borgdorff, 2012, p.168)) He asserts that traditional research in the sciences and humanities are essentially concerned with the first two forms of dissemination (the context of justification) while establishing an argument for this third possibility (the context of discovery) as being integral to the specificity in how art research is articulated and communicated. Fundamentally for Borgdorff, it is the non-conceptual nature of art that sets our thinking in motion inviting us to reflection. As Borgdorff (2012) states:

> *Art invites us and allows us to linger at the frontier of what there is, and it gives us an outlook on what might be. Artistic research is the deliberate articulation of these contingent perspectives. (p.173)*

Borgdorff was speaking about art. But the concept applies no less to critical design.

5 The Critical Design Exhibition as the 'context of discovery'

The specificity of critical design lies in this third possibility of dissemination, as outlined by Borgdorff. Critical design hinges on collective experiments, which are in themselves acts of communication and dissemination. Celebrated here is the experience of critical design, the conditioning of perception and the construction of the relationship and dramaturgy allowed to be developed through situated and embodied engagement with the audience. Suggested in this understanding is not so much the importance of creating spaces for discourse and debate *about* design, but how to create a space for an engagement *through* design.

This is the 'context of discovery' in critical design practice, which assumes a performative dimension for both the work and co-researchers. Dissemination in this case would seem to take on a completely different set of meanings and suggest a different set of questions, then what is typically considered for design. For example, how can we create works of critical design in a way that situates the audience/activator/co-researcher in a role that blends the production of design and its mediation? How can we conceive of critical design in a way that accommodates this blend while including within it the potential to bring thinking into being? At the core of this understanding of a 'context of discovery' lies the very spaces in which critical design is created and explored. While much of critical design practice is currently found in graduation shows, written up in academic journals, or reported on in mainstream media (blogs, magazines, websites) I want to focus specifically on the critical design exhibition, which I discussed at the beginning of this paper.

Critical design exhibitions, I argue, have the potential to situate themselves as entities *in which* and *through which* critical design can take place. By critical design exhibition, I am not referring to exhibitions of critical design – which put works of critical design on display for a viewing public to consume – but instead to critical design works who use exhibitions as part of their medium of practice (which can themselves be found in critical design exhibitions). Here the emphasis is on how exhibitions might be understood as an alternative model of critical design practice, not as spaces that speak conclusively, authoritatively and absolutely about design, but as other forms of coming together focused on directions over concrete outcomes.

These works, I maintain, subscribe to a movement in curatorial practice whereby exhibitions are increasingly approached as sites where both research and thinking are evoked *in situ.* As curator Christel Vesters (2016) states:

> *They are not merely the outcome of a curatorial research done by a dedicated expert, but in and of themselves sites where various modes of research and various modes of thinking are enacted. (p.1)*

She goes on to distinguish ways in which exhibitions can be understood as thinking spaces arguing that in the same way we can think about, with, and through art (I have argued the same for critical design) we can also think about, with, and through exhibitions. (Vesters, 2016) Vesters (2016) writes that this thinking space opens a political agency aimed at changing the way we think while encouraging a different way of relating to the world we inhabit. She proposes that this shift in exhibitions from spaces dedicated to aesthetic contemplation to dynamic sites for thinking things differently is directly influenced by the spatial layout of the exhibition. (p.14) This understanding is built around the notion of embodied criticality, that is, that exhibitions should allow their audiences to inhabit problems or situations rather than offering opportunities to analyse or objectify from the sidelines.

Implicit in this statement is thus the understanding that the exhibition may be more than the representation of an undeniable truth, and instead function as a site of possibility, or as curator Georgina Jackson (2015) suggests, as a site for "the emergence of questions about the world in which we live." She continues: "In this way, exhibitions become spaces in which the suspension between question and answer permits the continued proposition of meaningful ways of thinking and realising the world anew." (p.78)

Out of this perspective it becomes possible to approach the exhibition medium as an unbounded space of not knowing whereby one is free to test what it means to be in the world. (Rogoff, 2008)

Returning to the example of the *Risk Centre*, the critical design exhibition works as a medium in the process of becoming that engages other becomings. From a space where we learn about Risk, to one where we are invited to think about our relationship to risk in the world.

Celebrated here, then, is the exhibition as a site of possibility and potentiality, connected with ideas of flexibility, experimentation, research and thinking.

6 AfterLife - James Auger & Jimmy Loizeau

To take another example, *AfterLife (2008) (Figure 2)* by James Auger and Jimmy Loizeau is a work that questions human relationships with death and the afterlife. The project proposes the design of a coffin capable of harnessing the acids derived from human decomposition. The device uses an electrochemical reaction to convert organic matter into electricity, which is then contained within a conventional dry cell battery, which could be used to power up a machine, or technological device after a persons passing. While this particular case study has been used previously within conversations on the importance of managing the uncanny in works of critical design (see Auger 2013; Gentès and Mollon, 2015) I argue that it offers equal value to a discussion on the exhibition as a context of discovery.

Figure 2 Coffin which includes two microbial fuel cells that would be used to generate electricity from organic matter, The electricity generated would be stored in the accompanying dry cell batteries held in the capacitor bank on the underside of the coffin. Source: auger-loizeau.com

AfterLife was first exhibited in the *Museum of Modern Art's* (*MoMA*) exhibition *Design and the Elastic Mind* (2008). The display included a 3D visual and technical drawing of the coffin, a photograph of a battery with engravings that read: *JOHN ADAMS, 1959 - 2001, SHINE ON DAD;* a text describing the project, and a video produced as a mock commercial emphasising the service provided by the work and its value as 'the only genuine guarantee of life after death'. According to the designers the MoMa exhibition was a complete failure. As Auger (2013) states:

> *Unfortunately the viewers of the exhibition chose mostly to ignore the intellectual aspect of the project to focus on the more unsavoury aspects, namely tampering with the process of death, the passing of a loved one and the material activity of the human body during the operation of the fuel cell. This resulted in simple revulsion as the benefits of the concept were overlooked (p.16)*

The problem was that, in this context, the work was mainly engaged through an aesthetic contemplation, which focused the audiences' attention toward the functionality of the coffin and the processes of decomposition. The staging of the work supported the perception of a consumerist product destined for the market, while offering no potential for criticality (a living out the situation) or for an exchange beyond consumption.

Alternatively in 2009 *AfterLife* was exhibited at *Experimenta 09*, the *Design Biennale* in Lisbon, Portugal. For this iteration the designers reconsidered their approach to exhibiting the work shifting the emphasis from the coffin design and fuel cell to the existence and function of the *AfterLife* battery. (Auger 2013) To produce this shift they invited 15 colleagues to either propose what they would do with a loved one's battery, or what they would imagine a loved one would do with their own battery. So for example one of the respondents wrote (Auger & Loizeau, 2009):

> *If my father passed away, this is how I would use his battery. I would power some kind of electrical bird warbler. To be left in the garden, a unique noise though, formed from bird sounds common to Cheshire and rural Wales. It should not warble constantly, it should be around breakfast. This is because my father – early in the morning – can often be found out in the Garden (having pissed on the compost) in pants and vest, whistling along with various birds, for extended periods. It has to be said, he is pretty good. - Jack Schulze, 2009*

Together the 15 narratives, each displayed with an object representing the desired scenario (Figure 3), formed the focus of the installation in Lisbon. This arrangement introduced an emotional and human perspective into the work that was not present in the *MoMA* exhibition. In this iteration *AfterLife* seemed to create room for what was unthought and unexpected while indicating ways to gain access to the work. Through simply introducing an array of possibility to what *AfterLife* could be, the project offered a fundamental incompleteness.

This condition of contingency, as Borgdorff (2012) contends 'is what invites us, again and again, to see things differently" (p.196) This more personalised approach to *AfterLife* emphasised the open unfinished nature of critical design. It activated the user/audience to experience their own individual response to the work (how would I use the battery of a loved one? or What would I want a loved one to do with my battery?) while contemplating a subject they had perhaps not considered before. Through the use of scripting and storytelling, the designers were able to invite the visitor to carry the work forward, experiencing themselves as relational and constitutive elements of the project. In this sense, the exhibition took on the role of the experimental system that had been absorbed into the work. It acted not merely as a space to display the project produced by the designers (as in the case of the *MoMA* exhibit), but in and of itself was a site where research and thinking were enacted *in situ* and *in action*. (Vesters, 2016) Furthermore the exhibition as a 'context of discovery' offered the visitor an active agency, engaging them in a specific form of 'experimental reflexivity' targeted at perception and not understanding.

Figure 3 The object displayed alongside Schultz's AfterLife narrative. Source: auger-loizeau.com

This approach to the exhibition as an experimental system shifted the focus from the designed object, understood through detached modes of rationality and objectivity towards a socially constructed 'epistemic object', an object associated not with its materiality but with its ability to open new perspectives and unfold new realities. (Knorr Cetina, 2001; Rheingber, 2004; Borgdorf, 2012) In this sense the exhibition played the role of a dynamic site for thinking things differently. It acted not as a space of closure, a last word, but instead as an opening which seeks engagement over agreement. What emerges in this instance is the provocation of a discussion or an imagining of life after death. What the exhibition in this instance afforded was the potential to think about alternative possibilities of everyday life that may not be obvious otherwise.

7 Evidence Dolls - Dunne & Raby

This idea of the exhibition as an experimental system for critical design brings to mind Dunne and Raby's *Evidence dolls* (2005) (Figure 4), which willfully employed a lack of totality in the exhibition as a tactic for engagement. In fact, it was through the very same juxtaposition of objects and narratives, explored in the previous example, that the audience was invited to carry the work forward.

Commissioned by the Pompidou Centre in Paris for the D-Day Modern Design exhibition, the project comprises a series of 100 custom dolls made of white plastic and available in three penis sizes (S, M, L). Each doll was designed as a customisable storage device able to safeguard material from a male lover (hair, saliva, nails). The work, which explored the impact that genetic technology might have on ideas of love, romance and dating, was presented as an installation consisting of 25 dolls (with illustrated surfaces) displayed on a large table, 4 DVD players showing edited interviews with single women discussing how they might use the dolls in their lives, and 55 blank dolls resting on shelves.

Figure 4 Evidence Doll with illustration by Åbäke Source: dunneandraby.co.uk

Here too, the exhibition acted as a space where research and thinking took place *in situ* and in action. The recordings of the 4 interviews, placed amongst the objects, offered personal stories while operating as a catalyst to enter into a dialogue with the work. From statements of concern: Lady 01, "A genetic future seems so far away, even though it may not be. I'm scared of it, if we start to allow things like developing humans outside of nature, what do we become?" to imaginings around living with the dolls: Lady 02, "If I had one for every single relationship there would be lots of them. A cupboard full. It would be difficult having memories around, sometimes that's uncomfortable. If it was a bad relationship you would probably destroy it. Cut it up into little bits, run over it with a steamroller, flatten it. You could have funerals… that would be cathartic." (Dunne & Raby, 2009) the narrative montage evoked a specific kind of thinking space which worked to unlock an active agency in the visitor (co-researcher) aimed at facilitating different ways of thinking while enhancing their experiences with who they are and where they stand. Like Auger and Loizeau's second iteration of *AfterLife*, Dunne & Raby positioned the exhibition as an experimental system through a staging that invited embodied, situated and enacted forms of cognition. At the same time it invited the visitor (co-researcher) to think through their own position in relation to the social, cultural and ethical impacts of genetic engineering.

8 Conclusion

What these examples point to is how critical design can function as a space for thinking within the parameters of the exhibition context. To return to *AfterLife* for a moment, Auger and Loizeau's engagement with challenging the public's perception of notions of life after death extends beyond merely presenting the work within a clearly defined narrative or knowledge structure. By manipulating the staging and mediation of the work to include personal narratives that left room for uncertainty, the designers shifted the exhibition from a space of aesthetic contemplation to a dynamic site for thinking things differently. Echoing Borgdorff's contingency approach, the designers invited the audience to linger at the frontier of what there is, while offering insight on what might be – ultimately appealing to the audiences imagination to carry the work forward. Each of the preceding examples illustrate a consciousness of research with 'r'. It is the search that they are inviting the audience to participate in, whereby the exhibition assumes an experimental value which acts as an entrance point for critical thinking about what we 'know' and 'understand' as well as 'who' we are and 'where' we stand.

Opening up the theme of the exhibition as an experimental system for critical design allows for a different field of action that positions the exhibition as a context of discovery that seeks not so much

to produce knowledge but rather to provide a space for thinking *in situ* and *in action*. What is implied here is the exhibition as a specific system of critical design, which treats its subjects as uncertainties, and itself as proposition. In this sense, the exhibition acts not only as a form of dissemination for critical design practice, but more importantly as a site for enacted research. But it can only do so by remaining flexible, unpredictable, and open to the unknown, allowing the audience to inhabit problems or situations rather than offering opportunities to analyse or objectify from the sidelines. This repositioning of the exhibition as a modality of lived experience signifies a move whereby the very act of exhibiting critical design is made available as an entity where embodied criticality takes place, privileging an active engagement with audiences directed towards perception rather than understanding.

Through this paper I set out to demonstrate that the work of critical design is tied to the shift from critique to criticality as defined by Rogoff (2006) which sets it beyond the cognitivist preoccupation of Frankfurt School critical theory. The focus here set up one of the main arguments of this paper. That critical design seeks participatory, democratic engagement, which points towards the importance of the very parameters of how the public understand and are invited to engage with the work. The central aim of this paper has been to find a means for disseminating critical design that focuses on engaging *through* the work not *about* it. This mediation, I have argued, is the necessary link between critical design and its audience. The museum exhibition is not the only medium for this way of working. If we want critical design to become a more accepted practice, its modes of dissemination, and relation to its audience, must be further explored.

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Research-Through-Design: Exploring a design-based research paradigm through its ontology, epistemology, and methodology

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Design research has risen in prominence over the past 20 years resulting in substantial discussion regarding it's ontological and epistemological foundation, but there has been limited progression towards consolidation of the disparate views into a fundamental design paradigm. Design researchers continue to struggle to find a unified paradigmatic voice and move beyond a pre-paradigm state. Relying on the foundational support created by Sir Christopher Frayling's taxonomy of design-based research, many have proposed the creation of a new research paradigm. This requires critical discussion on how design differs from the existing realms of research, as well as establishing the ontology, epistemology, and methodology appropriate for this new paradigm. Through literature and an established philosophical framework, this paper will look at the foundational arguments that have been generated by scholars within the design disciplines for this new paradigm, synthesizing a proposal for the associated ontology, epistemology, and methodology.

research through design; design research; design paradigm; epistemology

1 Introduction

> *"Once you let go of the idea of a small set of formal criteria for what may count as "real research" you open the doors for a serious and much more interesting discussion about what should be considered good research." (Kjørup, 2012, p. 41)*

Research Through Design (RtD) currently has multiple interpretations within design research. The term is derived from Sir Christopher Frayling's(1993) three categories: *Research for art and design, Research into art and design, and Research through art and design* and is referenced as a paradigm (Zimmerman, Stolterman, & Forlizzi, 2010), a methodology (Findeli, Brouillet, Martin, Moineau, & Tarrago, 2008), a method (Hatleskog, 2014), and at times an ambiguous theoretical process. With the absence of a formal classification, RtD is most often discussed in the context of a proposed

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methodology. These discussions do not, however, directly acknowledge the ontology and epistemology that this would-be methodology is founded in. It is therefore difficult to justify it without these paradigmatic foundations. For the purpose of this paper, RtD will be discussed at the philosophical level as an emerging paradigm addressing the position of Zimmerman et al(2010) in which, while including discussion of RtD as a methodology, also critiques it as a research approach that does not currently enjoy "the status of a well-defined research paradigm" (p. 316).

The multiple interpretations of RtD, and furthermore the lack of a unified paradigmatic voice, within design research is related to the relatively young age of the discipline. Clemente et al.(2017) credit the beginning of academic research in design with the conversion of The Design Research Department at the Royal College of Art to a postgraduate teaching department in 1976. This was a precursor to the larger movement in design research that started in the late 1990's with the first PhD Design Conference at Ohio State University. The youthfulness of this movement has resulted in researchers adopting methodologies from established research paradigms as a means to validate their diverse research. These methods can often be inadequate for the design fields and as such demonstrate the necessity for the establishment of specific methodologies that contribute directly to design research. (Clemente et al., 2017)

This current state within design research demonstrates Kuhn's(1996) discussion with regards to emerging paradigms. (Gaver, 2012; Kjørup, 2012) Until a research community has widespread adoption of an agreed upon paradigm, practitioners will draw upon different philosophical foundations that are oriented towards the field in varying ways. This borrowing of philosophy requires researchers to establish the rationale behind their approach every time they seek to make a contribution. This need to continuously justify methods would be greatly reduced with the establishment of a paradigm. Currently within design research, there are concerns that design does not have a theoretical tradition and that design research pertaining to the process and creation of objects currently does not have a shared paradigm. (Gaver, 2012; Koskinen, Zimmerman, Binder, Redstrom, & Wensveen, 2011)

As the design field begins to embrace academic research, there is a need to "build the epistemological and methodological foundations of a discipline that can be recognized and legitimated by other disciplines in the academic community" (Clemente et al., 2017, p. S792). The recognition of this need for a more defined and consistent methodology is the motive behind the discussion of the establishment of a new paradigm, but this is not possible without the backing of an epistemology. (Findeli et al., 2008) This epistemology is not agreed upon, however. While there is widespread acceptance that design projects have a place within academic design research, there are currently two fields of thought regarding the basis of the epistemology. (Clemente et al., 2017) The first considers that there is a wide range of current methodologies, and by association epistemologies, within established paradigms in which design research can find a fit for all questions. This is especially true when considering qualitative research.

The second school of thought argues that a new methodology must be established that accepts the process of design as a valid research method. This is the focus of this paper; positing that a new paradigm must be established first. In order for the paradigm to exist it must have an epistemology and ontology with protocols, principles and validating procedures. (Bolt, 2008) The latter of these will be outside of the scope of this discussion but they should still be noted as they are directly influenced by the paradigm's theoretical foundation.

In consideration to this second position, the lack of a unified paradigmatic voice within design research, and Jonas'(2007) and Haseman's(2006) call for the formation of a performance based paradigm, this paper focus on the development of the philosophical foundations of a design paradigm. This will begin with an examination of the historical foundation of RtD. The categories of design research will be reviewed following the work of Frayling(1993), Cross (1999, 2006), and Findeli (2008). Through this review it will be demonstrated, embodying Jonas'(2007) argument that

the foundations for design research cannot be found in the sciences or humanities, that research categorized within Frayling's(1993) R*esearch through design* category does not easily fit within existing paradigms. RtD will then be evaluated through literature as an emerging paradigm, with a focus on its foundational philosophy. This evaluation will be the basis for the synthesis of a proposed ontology, epistemology, and methodology for RtD, utilizing a framework based on discussions by Groat and Wang(2013) and Guba and Lincoln(1998). Finally, while it is not the intent of this paper to discuss the implementation of RtD within research, there will be a brief discussion of its implementation and the concerns associated with its current lack of philosophical foundations.

2 Historical Foundation

Discussion of RtD begins with Sir Christopher Frayling's(1993) three categories of design research: *research for art and design*, *research into art and design*, and *research through art and design.* These classification have been refined by others to include the following definitions. (Findeli et al., 2008).

- *Research for design*: highly relevant to the design practice, focusing on various parameters related to the output of design such as technology, ergonomics, and aesthetics. Performed in academics and in practice. Often builds upon previous knowledge, is at times done without rigor, and is not always intended to be published.
- *Research into/about design*: performed with rigor by various disciplines both inside and outside of design. Accepted by the scientific community but at times has a lack of relevance for the practice of design. Can be performed for the advancement of disciplines outside of design and focuses on the significance of the process and products of design for society or culture.
- *Research through design*: relevant to the academic advancement of the design discipline. It is rigorous, produces original knowledge, and has virtues of both research for design and research into design.

These categories do not establish the need for a design paradigm. They formulate the understanding of how research is conducted in design and where a design focused paradigm may be needed. *Research for design,* when conducted in practice, is routinely considered unscientific and is concerned with producing some form of tacit knowledge. (Clemente et al., 2017). When performed with rigor it draws upon several established paradigms. R*esearch into design* is frequently conducted by disciplines outside of the design field, such as the humanities, and uses paradigms associated with those disciplines. This leaves *Research through design* that is concerned with all aspects of the design process and is also concerned with new knowledge and scientific rigor. Therefore, the development of a new paradigm is based upon the third category.

Frayling's categories do not provide the strong foundational theory that is needed to guide design research. (Koskinen et al., 2011) For this reason, other scholars must be consulted to formulate the philosophical foundation of RtD. However, the placement of RtD within the spectrum of other research paradigms must be considered first. Figure 1 demonstrates how RtD, along with the other two categories, fit within academic research. This provides an understanding of how RtD overlaps the other categories, but it does not explain how RtD fits within established research paradigms.

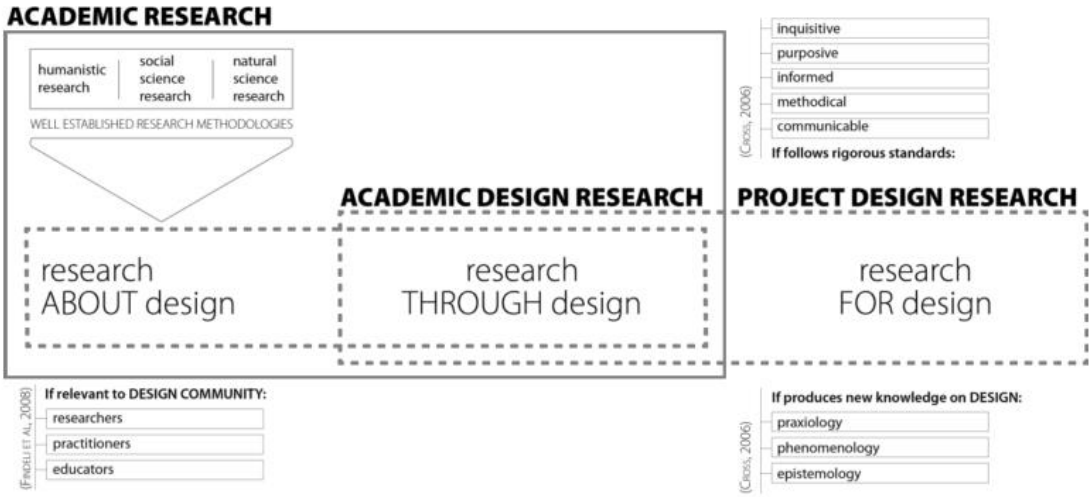

Figure 1: Frayling categories within research. (Clemente et al. 2017, p.S794)

Currently design research is in a pre-paradigm state and has used existing paradigms to justify research with mixed results. This is linked to the fact that design is associated with the divide between the objective and subjective worlds (Hawkins & Wilson, 2017). Figure 2 establishes the current spectrum of objective-subjective research paradigms. This spectrum suggest that scientists discover pre-existing objects embedded within the objective world and artists create artifacts from their subjective imagination (Hawkins & Wilson, 2017). The argument for the formal establishment of RtD outside of these conventional bounds can be made by eroding this spectrum (Cross, 1999, 2006). This process provides the foundation for the ontology and epistemology of the RtD paradigm.

Objective ◄——————————————► **Subjective**

	Positivism/Postpositivism		**Intersubjective**	**Constructivism**	
Epistemology	Knower distinct from object of inquiry	Knowing through distance from object	Knowledge framed by understanding sociocultural engagement	Knowledge co-constructed with participants	Knowledge perpetually provisional
Ontology	Assumes objective reality	External reality revealed probabilistically	Diverse realities situated in sociocultural context	Multiple constructed realities	Infinite realities

Figure 2: Continuum of research paradigms (Groat & Wang, 2013, p.76)

The objective and subjective spectrum applies to the current thought of artist and scientist. It can, however, be considered that there are "...forms of knowledge peculiar to the awareness and ability of a designer, just as the other intellectual cultures in the sciences and the arts concentrate on the forms of knowledge peculiar to the scientist or the artist" (Cross, 1999, p. 5). This ascertains that designers have a form of knowledge that does not easily fit within the objective-subjective bounds. This breaks from C.P. Snow's (1959) "two cultures" view of Western intellectual tradition in which there is a division between two factions, art and science. Therefore, there must be consideration for at least one other faction, design, as it can be articulated through comparison of the other two (Cross, 1999).

Within design Cross's (1999, 2006) classifies three areas of study: people, process, and product. These three areas form the foundation for Cross's taxonomies of design research.

- Design epistemology: study of designerly ways of knowing

- Design praxeology: study of the practices and processes of design
- Design phenomenology: study of the form and configuration of artifacts

These categories do not reclassify Frayling's (1993) categories but further refine research conducted within RtD and its overlap of *Research into design* and *Research for design*.

The expression of a thought process outside of the objective-subjective spectrum and the conventional thought of scientist and artist provides argument for the development of a design paradigm. When this is coupled with the design research taxonomies, the foundation for RtD is established. Using this framework, a set of theoretical assumptions will be used to synthesize the ontology, epistemology, and methodology of RtD.

3 Philosophical Foundations

A theoretical framework is needed to aid in the discussion of the ontology, epistemology, and methodology of RtD. Findeli et al (2008) state that the formation of the philosophical basis for the RtD paradigm is difficult and must determine: 1) the relationship between theory and practice; 2) support the claim of practice is important and necessary for theory building; and 3) explain how this contribution of practice to theory is to be contrived and operationalized. These three items correspond to the organizing questions that Guba and Lincoln (1998, p. 201) used in their discussions of paradigms.

> *What is the form and nature of reality and therefore what is there that can be known about it?*
>
> *What is the nature of the relationship between the knower or would-be knower and what can be known?*
>
> *How can the inquirer go about finding out whatever he or she believes can be known?*

These questions relate respectively to ontology, epistemology, and methodology and frame the remaining discussion regarding the philosophical basis for the RtD paradigm.

This considered, these questions need to be framed within design. This begins with a summary description of current RtD practitioners:

> *… researchers make prototypes, products, and models to codify their own understanding of a particular situation and to provide a concrete framing of the problem and a description of a proposed, preferred state…Designers focus on the creation of artifacts through a process of disciplined imagination, because artifacts they make both reveal and become embodiments of possible futures…Design researchers can explore new materials and actively participate in intentionally constructing the future, in the form of disciplined imagination, instead of limiting their research to an analysis of the present and the past.* (Koskinen et al., 2011, p. 5)

This description provides the underpinning for a design paradigm and can be expanded to provide insight into the qualities of the researchers and process within RtD. 1) Research founded in RtD embodies the qualities of design by building, exploring and creating new things (Jonas, 2007). 2) Ideas originating from the imagination of the researchers are made tangible through the process of design. 3) This process is as equally important to the research as the created artefact. 4) The creation of knowledge is grounded in imagination but keeps a distance from the pure practice of building objects. 5) The design explored within the research should offer alternatives rather than try to alter reality directly. (Koskinen et al., 2011). 6) A successful research design should change the way people think about material and social reality, open possibilities, and prepare for action. 7) This should lead to hypothetical discourse that strives to enrich the imagination and open new ways of seeing and discussing opportunities from those who the research targets (Zimmerman et al., 2010).

This context along with additional resources can be used to create a philosophical foundation. In Figure 3 Groat and Wang's (2013) table of quantitative and qualitative paradigm assumptions has been modified to include a third category, design. The ontology, epistemology, and methodology of RtD has been added and will be explained through the following sections.

Question	Quantitative	Qualitative	Design
Ontology: What is the nature of reality?	Reality is objective and singular, apart from the researcher.	Reality is subjective and multiple as seen by particpants in a study.	Reality is practical and imaginative as seen by the designer through the process, and from the objects created
Epistemology: What is the relationship of the researcher to that being researched?	Researcher is independent from that being reserached.	Researcher interacts with that being researched	Researcher and the objects created are entwined and cannot be seperated, the process of inquiry is as important if not more important than the final product
Methodology: What is the process of research?	Deductive process: cause and effect.	Inductive process: Mutual simultaneous shaping of factors.	Design process: reflective synthesis of the creation of material objects

Figure 3: Paradigm Assumption, based on (Groat&Wang, 2013, p.71)

4 Ontology

The proposed ontology of RtD is derived from a consolidation of views. This begins with Koskinen et al.'s (2011) description of design researchers,

> *…researchers [within RtD] do not try to analyze the material worlds…, nor do they see designs as an exercise in rational problem solving. Rather, they imagine new realities and build them to see whether they work. (p.42)*

Here, the existence of an imaginary and real world is established. This link is not dissimilar to the perspective of subjectivism, but one must consider that in the case of RtD there is a duality of worlds. This is perceived through the acts of researchers which are

> *…intended to alter reality, pushing it in the direction of order and logic. Instead the project is an act of invention that creates something to be added on to existing reality, increasing its depth and multiplying the number of choices available* (Koskinen et al., 2011, p. 44).

In such, the dual nature of reality is established thorough the design process. One reality is the researcher's imagination. This is where the design originates. The other reality is the physical world in which the design manifests and is interacted with during and after the design process. By acknowledging that design objects and their intended function initially exist in the imaginary form, researchers in RtD recognize that the design artifacts in both the imaginary and physical state has function; therefore, it exists in two realities. Founded in this concept, RtD in its most basic form can be viewing reality as the real that "will be" (Godin & Zahedi, 2014).

The nature of this reality can be further derived from Cross' (1999) three fields of knowledge: the natural world, the human experience, and the artificial world . These are directly linked to science, the arts and humanities, and design respectively. Their 'ways of knowing', while also tied to epistemology, can be used to refine the ontology of RtD. The 'ways of knowing' are as follows:

- Science: rational and objective
- Humanities: reflection and subjective
- Design: imagination and practicality.

Through this, the reality that "will be" is bound to a plane of practicality. As such the ontology for RtD is not only concerned with the reality associated with the imagination but it must also maintain some form of perceived practicality.

The creation of the proposed ontology is a synthesis of the discussed concepts. 1) The recognition of dual realities, the imaginative and the physical. 2) The understanding that these realities manifest

themselves through the design process. 3) The realities may only be perceivable in some instances by the researcher. 4) The physical reality is tied to practicality. Therefore, the ontology is stated as: Reality is practical and imaginative as seen by the designer through the process, and from the objects created.

5 Epistemology

The epistemology of RtD is easier to derive than the ontology as it is found in an array of discussions either directly or indirectly. Within RtD, the researcher and the objects created are entwined and cannot be separated, establishing knowledge through this relationship. This is in part due to the inherent nature of design but also lies within the assumption, like those listed under qualitative paradigms in Figure 3, that knowledge established through research is influenced by the researcher. In the case of RtD, this relationship goes further and is only fully perceivable when looking at the design process and objects created in unison. For this reason, the process of inquiry is perceived as important, and by some more important, than the final product. This is most simply derived from Kozel (2012),

> *I practice, and I reflect upon practice in infinitesimal loops. This is the nature of my perception and my embeddedness in the world. It is not that the doing is the practice, and the mode of reflection is the theory. Both are reflective practice and, taken together, both make up research. (p.208)*

Cross's (2006) 'desingerly way of knowing' provides a framework to this concept. Designerly knowledge is unique and not simply 'a ragbag of all the things that science and humanities leave out' (Cross, 2006, p. 6). Similar to science and humanities, it has its own inner coherence. Demonstrated through the 'ways of knowing', designerly knowledge differs from the sciences and humanities through the perception of how it is gained. This way of knowing is in part associated with a relationship with artifacts and is associated with the constant realignment of artifacts based on trial and error to learn about design problems (Godin & Zahedi, 2014).

Jonas (2007) and Koskinen et al. (2011) agree that designerly knowledge is generated through the process of creation and the "…functional and symbolic fit of artefacts and their human, social and natural contexts of use" (Jonas, 2007, p. 1363). Learning occurs through the process where the "aim cannot be a final "true" represenation of some external reality, but rather a process of (re-) construction for the purpose of appropriate (re-)action" (Jonas, 2007, p. 1368). This emphazies the link between the process, artifacts, and unique knowledge associated with the design discipline.

There is a systematic relationship between the designer, process and product (Hatleskog, 2014). Knowledge is created through the designer and the process of creation. This relationship between the designer and process is indistinguishable. There is an "embodied cognition view of knowledge, knowledge is a process of inquiry rather than a final product" (Johnson, 2012, p. 145). This indistinguishable nature is the reason that the role of the designer must be considered and evaluated through the process (Hatleskog, 2014). The process includes the identification of the acts or techniques required to first determine the issues and then solve problems.

This emphasis on the process does not supersede the importance of the final object and its own ability to provide knowledge. Building upon Cross's statement, "Objects are a form of knowledge about how to satisfy certain requirements, about how to perform certain task" (Kimbell, 2009, p. 3), the importance of the created objects is identified through the consideration that

> *someone has designed them a particular way, for some reason. It may not be a good reason, but for designers, objects offer information about the purposes of their designers, manufacturers and users.* (Kimbell, 2009, p. 3) *(p.3)*

Zimmerman et al. (2010) reinforces the concept that the ideas of the design researcher are made tangible through designed objects. Further, the complexity of the process and problems to be resolved can be found embedded within the objects.

The knowledge contained within the objects is not always transferrable through numbers or words (Carless & Douglas, 2013; Haseman, 2006). Carless and Douglas (2013) state that "knowledge or understanding is not always reducible to language…we know more than we can tell" (p. 55) With this acknowledgment, it must be considered that "artefacts other than the written word are considered sufficiently powerful in the their own right to carry the force of the academic argument" (Hawkins & Wilson, 2017, p. 82). Given these perspectives, a RtD epistemology must address that knowledge is imbedded in and created by all aspects of the design process, from the designer to the process to objects; the inseparability of these components drives how knowledge is derived in RtD.

The proposed epistemology is synthesized from understanding; 1) design knowledge is unique to the discipline, 2) knowledge is generated through the design process and its artifacts, 3) the researcher and process are interrelated due to the process of design, 4) the process and the resulting artifacts contain knowledge. As such, the epistemology is proposed as: Researcher and the objects created are entwined and cannot be separated, the process of inquiry is as important if not more important than the final product.

6 Methodology

Referencing the previously outlined epistemology, the methodology associated with RtD must be directly linked to the design process and, with respect to Kozel (2012), Hatslekog (2014), and Cross (2006), embody reflective synthesis of the creation of material objects. This proposal of RtD's methodology, is closely associated with Cross's (2006) "ways of finding out". It draws directly from his classification of appropriate methods for design paradigms, which includes the process of modelling, pattern-formation and synthesis.

This methodology is heavily associated with the process and artifacts of design. The design process will both define and drive the research (Forlizzi, Stolterman, & Zimmerman, 2009; Hatleskog, 2014). The associated methodology leverages the design process of repeated problem reframing to create a scholarly method of inquiry that allows researchers to engage in wicked problems and become active constructors of possible futures. (Forlizzi et al., 2009) Again, the discussion of the methodology connects back to the epistemology and ontology, as it should. In such, it reinforces the concept that the designers are creating knowledge that has the potential for hypothetical discourse that enriches and opens ways of seeing and discussing opportunities (Koskinen et al., 2011). It should be noted, however, that it is this exact concept of using the design process for the creation of academic knowledge that Haseman (2006) attributes to difficulties of design and performance based paradigms being accepted.

A newly defined process-based methodology may not be the only acceptable methodology for a RtD paradigm. If RtD is to be considered a paradigm, multiple methodologies may be associated with it, as long as they align with its ontology and epistemology. Methodologies do not have to be exclusive to RtD and similar to Gioia and Pitre's (1990) discussion of multiparadigm perspectives, it may be found that existing methodologies could be appropriate for use within RtD. In this case, the chosen methodology must reflect the importance of the process in the RtD paradigm.

According to Haseman (2006) and Findeli et al.(2008), the existing methodology must associate with research through practice and can include practice-led research, action research, project-grounded research, studio research, research through practice and others. This listing is heavily associated with intrinsically experiential and iterative practice, but the concept of action research is repeated throughout several discussions. Zimmerman et al.(2010) emphasizes that the methodology should consist of iteratively planning, acting, observing an d reflection.

Summarily, the process and practice of design is a significant component of the any methodology used within a RtD paradigm. This is founded in the significance placed upon process in the outlined ontology and epistemology. The methodology does not have to be solely bound in practice as described by Hatleskog (2014) but should act as a starting point and should be processed based. Through this approach it is critical that any methodology chosen reflects this importance of the process. As such there is a need to potentially refine and develop new methodologies that better reflects this stance.

7 Employing RtD in Design

After discussion of RtD's philosophical foundation, it is beneficial to briefly review the application of RtD within design research and potential concerns. RtD is directly tied to the discipline of design and research questions will be framed solely for the study of design. For that reason alone, it is a strong perspective to use when looking into design questions. It is not, however, the only perspective that can be used in design research. As demonstrated through discussion of Frayling's three categories, design is an expansive discipline with many areas of focus, ranging from social factors to physical sciences. Other perspectives could effectively handle the research question depending on its focus. For example, if the research focuses on architecture's impact on the perception of societal structures, then the research could be conducted under constructivism. Conversely if the study looks to determine the energy reduction associated with parametric optimization, then a positivist or post-positivist approach may be more appropriate.

Therefore, an understanding of the phenomena of focus is necessary for the use of RtD. RtD will typically include questions regarding phenomena in the process, the use or properties of artifacts, or the relationship between the two. It can look at a variety of aspects, ranging from how internal or external phenomena influence the design process to how an artifact's embedded knowledge informs others to its use. Studies under these conditions would potentially look at a variety of scenarios. They would compare results between multiple processes or artifact conditions. This creates extensive possibilities for the use of RtD in design but does not properly relate some of its concerns.

There are still several issues that must be considered prior to RtD being recognized as a valid research paradigm. At its basis the RtD paradigm is not well documented and has not been fully formalized or developed. This is directly seen thorough the discussion of the ontology, epistemology, and methodology. Several sources were required to derive the definitions of the philosophical foundations. This is not due a lack of individuals discussing these concepts, rather there is no consolidated stance on its position within the philosophical framework. This is a critical component of implementing RtD. There is a need for an understanding and agreement on its theoretical platform, its link to design practice, and of utmost important its placement within a paradigm, either its own or existing. It is these concerns that cause issue with its acceptance within the academic community and gives initial concerns as to its ability to effectively be implemented with wider academic acceptance.

Additionally, RtD needs an understanding regarding the ability of the artifact to stand alone and suffice as research output. As stated by Zimmerman et al. (2010), the knowledge gained can be implicit in residing almost entirely within the resulting artifact. The community must decide if this is a valid measure or if the research must follow more traditional standards with a written output. Accepting the artifact as knowledge leads to the potential issue when the transference of knowledge is a research goal. This would require individuals to gain knowledge through usage as proposed by Haseman(2006) or the researcher to disseminate the knowledge gained through the artifact's use via a written paper or presentation. This can create concerns regarding the ability to widely and accurately distribute the knowledge gained from the research. This is part of the ambiguities that the community as a whole must address and define for this paradigm.

Finally, there is concern with regards to the physical ability to conduct research under this paradigm. The research can be cumbersome due to its nature. This resides in the focus of research and the size

of the artifact. This concern does not apply uniformly across all design disciplines. Projects that are conducted primarily within a studio or similar area, pertaining to small scale items or confirmable through scale models, will have very different requirements for space and cost than ones that are fully implemented and consist of large scale human interaction. Therefore, RtD may be more inclined to be used under disciplines such as industrial design rather than architecture.

These concepts result in major reflection regarding the appropriateness of RtD for all design research. It is not the argument of this paper that all design research should use RtD, rather RtD is a paradigm specific to design that can help unify design research. To employ RtD, these issues must be taken into consideration and are part of the larger philosophical discussion of this paper. Implementation of RtD as a research paradigm will be dependent on resolution of these concerns and widespread acceptance of its philosophical foundations within the design community.

8 Conclusion

Zimmerman et al. (2010) summarize the usefulness of RtD through the statement that it "allows researchers to rely on designerly activities as a way of approaching messy situations with unclear or even conflicting agenda; situations that are not well suited to other methods of inquiry." (p.310) This usefulness towards design research can only be fully realized, however, once RtD has been fully established and recognized by the research community at large. Currently RtD is not well established and lacks any agreed upon system or focus (Zimmerman et al., 2010). In order for RtD to progress forward it needs an understanding within the design community about its philosophical foundation.

This exploration used established literature to proposes that these foundations resides in the design process and an understanding of designerly knowledge. This allowed for the synthesis of proposed ontology, epistemology, and methodology. Further exploring these concepts and establishing a unified paradigmatic voice can move the design discipline forward from Kuhn's pre-paradigm state. This cannot occur until there are open discussions regarding the design disciplines philosophy and establishing its ontology, epistemology, and related methodologies. For this reason, the design community must continue to have these discussions and move design research towards an accepted field of rigorous academic research.

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Structuring Roles in Research Through Design Collaboration

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In Research through Design knowledge is generated, but not always captured and shared effectively. When working in a multidisciplinary team of, e.g. designers, design researchers, academic researchers and domain practitioners confusion about roles, processes, and results easily occurs. In a series of three Research through Design cases we developed a set of role descriptions to help structuring the collaboration in such projects, using different configurations of people, roles and documentation tools. We conclude with a structure for assigning roles that enables multidisciplinary teams to make their Research through Design process more explicit, reflect on their activities as part of process data, and propose moments to capture knowledge from all actors involved.

research through design, collaboration, design documentation

1 Introduction

Research through Design (abbreviated in this paper as RtD) covers a range of approaches in which design and research activities inform each other with the aims of generating new insight and new solutions. Most academic discussions of RtD concern work of academic researchers (in PhD positions or beyond, often with a design background). When an RtD project involves multiple actors in a multi-faceted project, collaboration can become rather challenging. Different actors are often strongly motivated and dedicated in willing to improve the current situation, come from very different backgrounds, and bring in a wide variety in expertise knowledge, skills and language.

In the last two decades design is increasingly addressing complex and social issues (Norman, 2010; Kimbell, 2011; Dorst, 2011; Sanders and Stappers, 2014; Sustar and Mattelmäki, 2017). The design discipline has broadened from traditional product design to the domain of social transformations (e.g. transforming healthcare; Jones and van Patter, 2008). In social design and service design the domain is often complex, and projects typically involve multi-disciplinary teams. The complexity of design problems expands and designer's practice is changing, requiring new methods, practices and roles and new networks to collaborate with (Kimbell, 2011). Stakeholders in design processes are no

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longer designers' direct clients, but rather a network of different stakeholders. Rygh (2013) suggests new roles for designers such as connectors between diverse stakeholders, facilitators of co-creation and instigators to get an idea forward towards implementation. Manzini (2015) suggests several structures to organise social innovation with designers and non-designers, e.g., citizens, where non-designers become the change catalysts, and where designers take a more research-oriented attitude and facilitating role. When many actors from practice are involved designers are faced with challenges to orchestrate, facilitate and moderate all their inputs and activities. Raijmakers, Vervloed and Wierda (2015) describe such orchestration activities, e.g. building involvement and steering larger processes, and suggest that these activities continue beyond the classical design process that ends when a solution is produced. In this paper, we focus on RtD projects involving multiple actors with variying expertise in research, in design, and in the domain where the project is conducted. We address the question of how to organise the collaborative RtD process. We describe an RtD project, MyFutures, in which various parties and expertise were involved (see table 1). The project required collaboration of all involved parties, and aimed at both new knowledge generation and pragmatic guidelines for improving the current situation. Participating actors brought different capabilities and skills regarding design research, domain knowledge, and different amounts of time available for the project. The challenge was to integrate all expertise and structure the collaborative case studies in this project. At the start of the project details of collaboration could not be planned, as topics, needs, and opportunities emerged and developed as the project unfolded. In the next section we review literature on RtD methodology and position our project within it.

Table 1 Key data about the MyFutures project.

Aim	To support people in arranging their own older future lives on our changing society
Phenomenon	Thinking about and anticipating on your own personal future lives when getting older, while the societal context is changing from state-driven care to self-organised care
Research questions	1. How do people (not) deal with their own futures in their everyday lives? 2. How can notions of people's own futures be stretched towards seeing plural options and more awareness of own needs and wishes?
Method	Literature studies and design research (in-home interviews) to answer the first research question. Case studies in practice with design interventions to gain insights for both research questions.
Involved parties	6 design researchers from university and design school, all with design and design research expertise (through background or design research practice) 3 design researchers from agencies specialised in design research and designing for care-related societal challenges 10 practitioners from institutes like public services (municipalities), health insurances and care-related institutions
Starting point for collaboration	A 2-year research project funded by national science organisation of the Netherlands. Parties contributed in-kind through participation and some of them received partial funding.

2 Research through Design categories

In RtD research and design activities are closely related, but different. Both are intentional activities with the goal of creating something new (Stappers and Giaccardi, 2017), but where research aims to create new knowledge with general applicability, design aims to create new solutions suitable for a particular situation. The differences and overlaps of research and design are widely discussed in literature (Sanders, 2005; Cross, 2007; Stappers, 2007; Koskinen, Zimmerman, Binder, Redström and Wensveen, 2011). Both Koskinen et al (2011) and Stappers & Giaccardi (2017) reflect on a variety of example RtD projects, and the role of process and outcomes. Still, most authors remark that there is no clearly defined, singular, method by which RtD is conducted (Mattelmäki and Matthews 2009; Wensveen and Matthews 2015). Most authors agree on the definition of research as a 'systematic

inquiry, the goal of which is knowledge' as stated by Archer (1981). However, a review of a wide range of reported RtD projects shows that the 'systematic' aspect is interpreted quite differently. Koskinen et al (2011) categorized RtD approaches in three types: 'lab', 'field' and 'showroom'. In the 'lab' hypotheses are studied, through prototypes in controlled settings. The 'field' approach is conducted in the 'real' world, and involves stakeholders beyond researchers and designers. In the 'showroom' approach instantiations of new prototypes are produced to demonstrate a particular phenomenon or new technology. Stappers and Giaccardi (2017) suggest another categorisation of RtD projects based on outcome orientation:

1. generating collection of examples without an explicit theory or application goal
2. iterative successive prototypes of increasing quality with often an application goal
3. testing hypotheses of concepts under controlled scientific methods
4. pursuing a programme with an inquiry driven approach, in which prototypes are part of experiments meant to explore and open up new design spaces.

Both overviews of categories show how different RtD types can be distinguished, but do not provide guidelines how the systematic inquiry can be organised. Moreover their reviews of RtD projects mostly cover solo research projects, with limited multi-party collaboration. The RtD project we discuss in this paper follows an inquiry driven approach, the fourth type of Stappers and Giaccardi, and the 'field' type of Koskinen et al (2011). In line with Binder and Redström (2006) we structured the project as 'a programme' consisting of a series of questions and experiments. The 'programme' is the organisation of the entire project; the combination of gaining knowledge from literature, field work and design explorations, and a vision on how each of these activities help to answer the main research question. Through 'experiments', in the form of concrete activities, such as co-creation workshops, prototypes and field testing, contributions to theory are developed, consolidated and disseminated.

To conclude we use the term RtD to indicate a study in which knowledge is generated on a phenomenon (inquiry driven) by conducting design activities, drawing in support knowledge from different disciplines, and reflecting on both design activities and evaluations of the design interventions in practice. Our main aim is a general understanding of the phenomenon that drives application beyond the created prototypes in the project. The new knowledge has a theory component and an impact component to improve current practice.

3 Research through Design challenges

Organising an RtD project with multi-party collaboration can be challenging on a number of fronts. We discuss three which are relevant to the collaboration; interplay of research and design, documentation and collaboration.

3.1 Interplay of Research and Design

The very terms research and design can already be problematic within a single discipline, but can be downright confusing for practitioners with different backgrounds. The approach to research in this project is through a process of discovery, bringing in as much relevant different perspectives as possible to study the phenomenon in an integrated setting of current practices in everyday life (Stappers, Sleeswijk Visser and Keller, 2014). Many participants without an academic design research training, have more formal expectations of how research is done. Likewise, their perception of 'design' can be traditional, e.g., the formgiving of an object. But the 'material' to create new solutions for societal problems involve people, mindsets, behaviour and organisational change. Design interventions cover more and more the orchestration of how people interact, for example through scripts, tools and staging (Laurel, 2003) which might be less concrete than a traditional design result and not even recognized as a design result. People in a team can have different ideas about design, let alone the interplay of research and design. In our RtD project we aimed to explicitly define what we regard as research and design outcomes, with the intention to create a shared reference with all parties involved. In a process of various iterations of research and design activities,

loops of reflection in action take place, and the generation of prototypes serves to simultaneously explore the problem space as well as the solution space (Koskinen et al, 2011). Basballe and Halskov (2012) have tried to describe their RtD process at a micro level by addressing the dynamic interplay of research and design as they unfold throughout the process. Through the example of the design of a project installation and its use they reviewed how this interplay happened, which gives an insightful view into their RtD process and helps understanding their interplay of research and design activities. Nevertheless, their activities are rather generally divided in research or design, not emphasizing the variety in design or in research activities.
We needed a structure to frame our method and explain the interplay of research and design in understandable ways to support fruitful involvement of all actors.

3.2 Documentation

Stappers and Giaccardi (2017) suggest that 'the' knowledge that emerges from RtD is not obvious, so communicating what it is what is looked for, how to capture that and frame the result is a challenge. Documentation and communication of insights and findings should support understanding of all involved actors. Moreover recognizing which data is relevant, selecting it during all the activities in a collaborative iterative process is more complicated than when these activities are planned and conducted in controlled lab settings. For example, a practitioner explaining in his own words what a prototype does can be seen as relevant data by trained researchers, but practitioners might not realise this and may not be triggered to record that explanation. Another example of relevant data that goes missing is design decisions made during the design process for creating prototypes. These are often not well documented but capture rich insights about the phenomenon (Stappers, 2007; Höök and Löwgren, 2012).

Reflective Journals are a method used in action research to document each actor's thoughts. For example Sleeswijk Visser (2009) used this method in cases studies of an RtD project in which she took on different roles to record and analyse thoughts and decisions during the process from the perspective of researcher, designer and user researcher. The journal was used as process data to unravel what had happened during the course of the case study, recordings which otherwise afterwards would have been remembered as 'obvious practice' rather than being recognized as new and relevant insights. Van Asseldonk, Scheepers and Raijmakers (2016) used a trail of evidence technique to capture design students' processes and make intermediate actions and decisions explicit, leading to joint reflections. Also Dalsgaard and Halskov (2012) developed a digital tool, 'the Process Reflection Tool', to document reflections of various involved actors to each event and sub-event.

Altogether, in setting up RtD case studies, we need such type of documentation tools, to capture the otherwise hidden insights next to participatory meetings.

3.3 Collaboration

In the areas of social sciences and design research, collaborative ways of conducting research have been reported before, as in action research (Avison, Lau, Myers and Nielsen, 1999), participatory design (Schuler and Namioka, 1993), and co-design (Sanders and Stappers, 2008). However, the way how people collaborate in RtD projects is often less explicitly described, since project settings and aims differ greatly. In participatory settings, Sleeswijk Visser, Stappers, van der Lugt and Sanders (2005) promote to involve everyday people ('end-users') in design processes as 'experts of their experiences' and in that role they contribute to the design process. Again, we take this stance, where not only everyday people are regarded as experts of their everyday experiences, but all involved professionals. This approach helped planning and organising elements of the process, such as co-creation workshops of the programme, but did not provide detail on involving practitioners as producers of shared knowledge generators instead of merely domain information providers. In our project, cases emerged from opportunities in practice, but how the design researchers, designers and practitioners would go from there was a rather intuitive path where expertise and tasks needed to be optimally combined.

We needed insights on how to orchestrate the collaborative process and define roles in this.

To conclude there are various approaches to conducting RtD, but little guidance on how such projects should be conducted, especially if they are built around a multidisciplinary team rather than individual researcher. How can we benefit from all stakeholders on the right moments in the process and seize knowledge together? In what roles can stakeholders contribute, collaborate and generate insights relevant and useable for each party? After the method section, we describe in section five how we dealt with these questions in running our case studies. In section six, we reflect on the observations and interventions of interplay of research and design, documentation and roles.

4 Method

We reviewed the collaboration of three case studies in this project. The author joined collaborative meetings, observed the process of collaboration, the exchange of information (when enough explicit to point at) and the assignment of roles, tasks and expertise that was divided between actors. The author conducted interviews at the end of each case study with each actor on their individual experiences of the interplay of roles and expertise along the process and on how they experienced the RtD approach from their point of view. Two sessions, one halfway and one at the end of each case study, were organised to collaboratively reflect in- and on the actions and output to evaluate the working structure of the team collaborations. Relevant insights were directly implemented to improve the collaboration processes, as is common in Action Research (Avison et al 1999). A documentation tool, the Reporter Kit (see figure 2), served as a backbone for these reflective sessions since it provided insight in each distinct role actors took. The combination of observations, interviews, reporter kit data and collaborative reflections halfway and after each case study helped to triangulate findings (Denzin, 2006).

5 Collaboration in the case studies

Table 2 shows an overview of the case studies under examination. The cases started when there was a match of research focus, design exploration and opportunity in practice to intervene. For each case a main research question and an applied research question were formulated.

The cases evolved through opportunities to intervene in practice and happened in chronological order. While forming teams, we discussed process, output, roles, and relevant deliverables and all felt a need to bring clarification to these issues. To respond to this need the researchers created visuals of what stages and activities an RtD case study compels and proposed that each team needs to have at least one of the roles in figure 1 fulfilled by team members (actors). The initial description of these roles was a first ordering in the process. One actor could take more roles, and multiple actors could take one role.

Table 2 Summary of three case studies in the MyFutures project.

Case	Domain	Research questions	Applied research question	Design interventions	Domain practitioners
1	Care request conversations between care planner and care taker	What do people (not) consider when arranging in-home care? Can we stretch their thinking from next day to next year?	How can people be supported in discussing more holistic matters next to practical planning of in-home care and take this into account in care planning?	Series of co-creation workshops. Redesign of conversation script, three iterations of templates tools to support care request conversations, and a new database tool.	1 care institute acted as problem owner during entire case. Their current conversations with clients about planning care were used to test the design interventions.
2	Family conversations about >10 years ahead	What are needs, motivations and dynamics in and around such family conversations? Can people discuss future issues (>10yrs) that are not urgent now?	How can family members be supported in sharing thoughts and expectations in relation to each other when there is no urgent issue (yet)?	Series of co-creation workshops. Five design iterations of a family discussion tool consisting of script, templates and game elements.	6 parties (municipalities, health insurances, and HR institutions) acted as domain experts. 2 of these parties acted as problem owners and used the last tool version in their practice.
3	Elderly people speculating about the future together	What dynamics play a role when people speculate together about the future if they think they don't have much future left?	How can we challenge people to look ahead together further than tomorrow and see more options towards their own futures?	Series of co-creation workshops. Series of staged social activities in which future is addressed to provoke speculative future thinking.	1 care institute acted as problem owner during entire case. The involved persons are 'social innovators' within their institute.

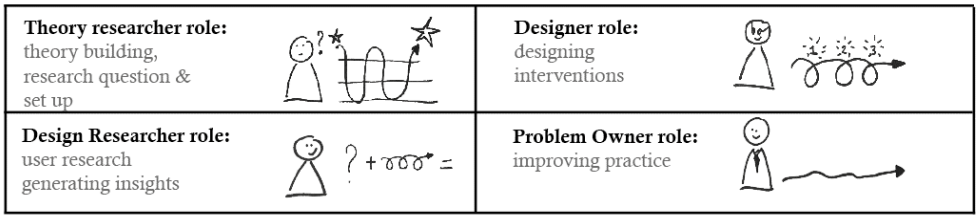

Figure 1 First suggestion of different roles that could exist in an RtD case study in practice (later two other roles were added to the roles template)

Furthermore we developed a tool, the Reporter Kit, based on the work of Sleeswijk Visser (2009), van Asseldonk et al (2016) and Dalsgaard and Halskov (2012), to document reflections and decisions of each team member along the process (see figure 2). We deliberately choose for a simple form, with only three questions; *'What happened?', 'What decisions did I make and why?', and 'Doubts, ideas, expectations, considerations, plans…?'* This reporter kit was also intended to gain insight in how each of the actors experienced the collaboration while conducting the case studies and being able to intervene in roles to optimise a productive process.

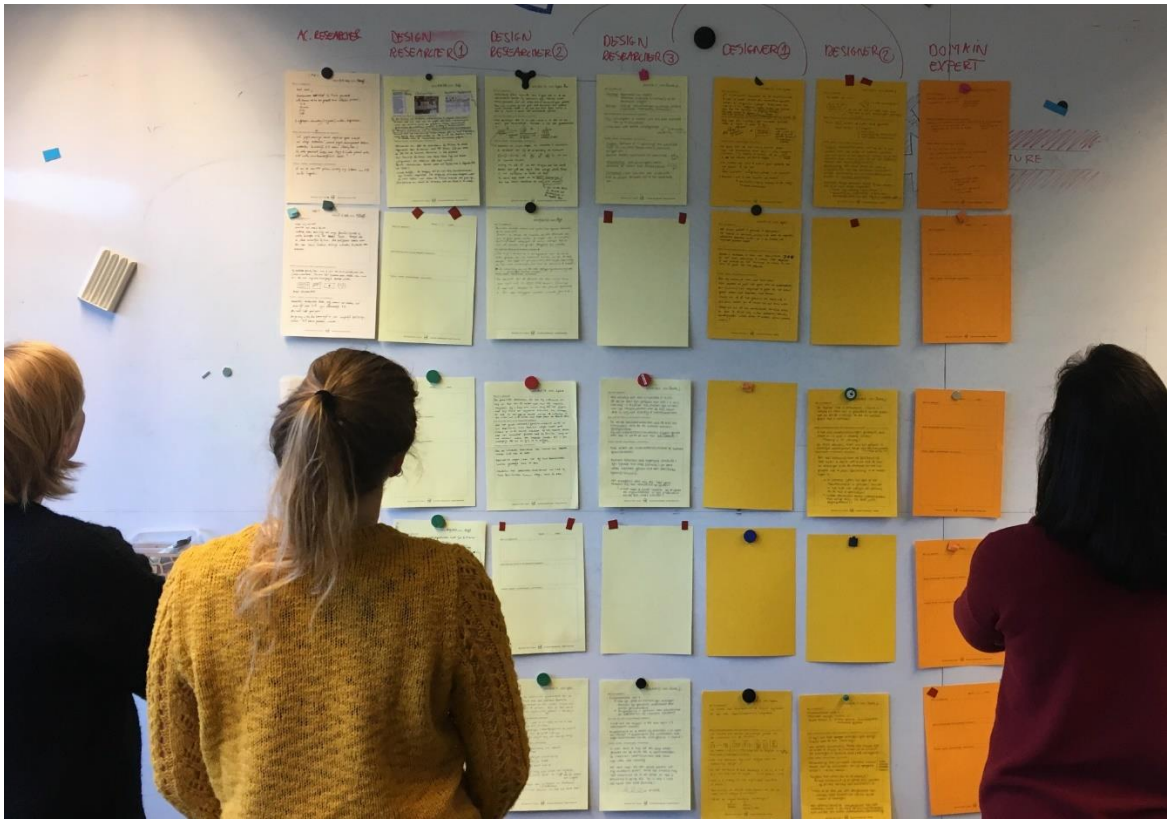

Figure 2 The Reporter Kit is a journaling tool in which each actor reflects on his/her role(s) during the process. Each colour presents one specific role. For example the light yellow represents the designer researchers role and the dark yellow the designer role. This picture shows a reflective session of case two, where some of the actors fulfilled multiple roles.

5.1 Exploring different configurations of roles

Figure 3 shows how the roles were distributed over the three cases as the case studies unfolded. The figure shows that new roles were added to the initial suggestion of roles in figure 1. For each case the teams were differently composed based on the present expertise and availability. Actors A and B represent researchers with design research expertise from academia or design school. Actor C, D, E represent parties from practice, e.g., care institutions or design agencies, of which actors C had most substantial hours to dedicate in each case as part of the funding structure. Over the cases different people were involved as actors A, B, C, D and E.

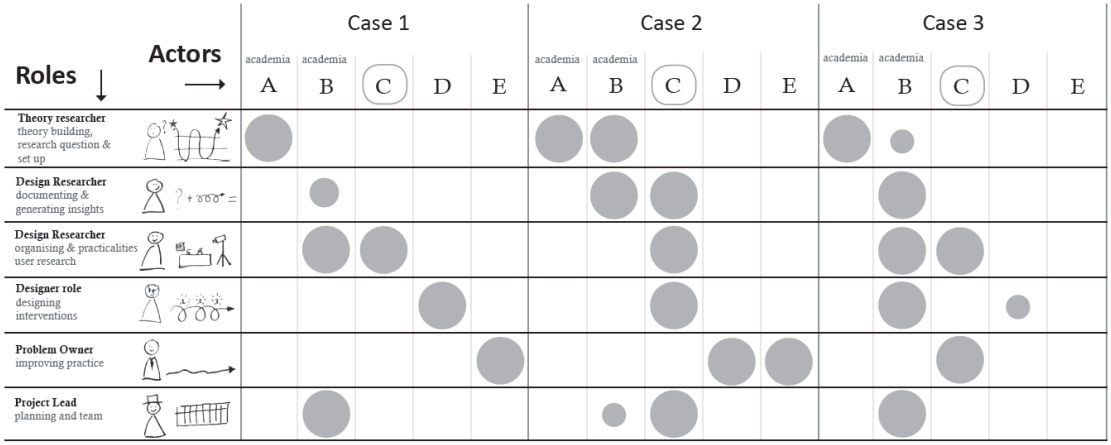

Figure 3 Depending on involved actors, their expertise and starting point for case study, the roles were differently assigned in each case.

In case one it was initially planned that actor C would take the lead, but when setting up the case, this person didn't feel comfortable taking the design researcher' and designer' roles. This actor had extensive experience in conducting fieldwork and was well acquainted with the domain, but didn't have design expertise or overview of the RtD process;

> *'You need to take me on the hand with such methodologies and set up the case, so I can follow you, and I can execute user research activities (recruiting, conducting interviews, observations)'*
>
> *'I am not a designer, I can't facilitate these co-creation workshops or design the interventions'*

The researchers (actors A and B) realised that one of them was needed to take the lead. All three discussed what tasks each of them felt comfortable with, and what was practically possible. The roles template served as a point of reference for needed expertise and they made decisions on collaboration: Actor A took the theory researcher role and would only be involved in collaborative sessions. Actor B took the design research lead role and actor C would assist in organising the fieldwork. Assigning these tasks already yielded for two types of design research roles; one mainly focusing on generating insights and the other one on organising fieldwork. Furthermore they realised that design capacity would be missing, because each of them would be fully taken by more research oriented roles. A design agency (actor D) got involved to explicitly design the series of co-creation workshops and design interventions. Actor E took the role of problem owner (see table 2).

The second case didn't start with a concrete challenge from one problem owner, but with a shared interest in possible outcomes of the case study of six different parties. They were involved as domain experts in a series of insights sharing and co-creation workshops and two of them were involved in testing the last design iteration in their own practices. A design agency (actor C) led the case study as project lead and fulfilled three other roles; the designer role and both design researcher roles. The roles template was used as an instrument for actors A, B and C to define their collaboration at the start of the case (see figure 4). Discussing this made explicit that actors A, B and C had large overlaps in capabilities. Realising these capabilities and expertise helped planning the entire project and their collaboration. For example each took responsibility for facilitating and documenting workshops with domain experts, for different user research activities and planned when joint expertise would be needed. An explicit new role 'project lead' (last row in figure 3) was added to the roles template (already halfway during the first case) to explicitly extract tasks of project management, such as project planning and teamwork. Actor C took the project lead role, and actor B would take this role when actor C would be less available.

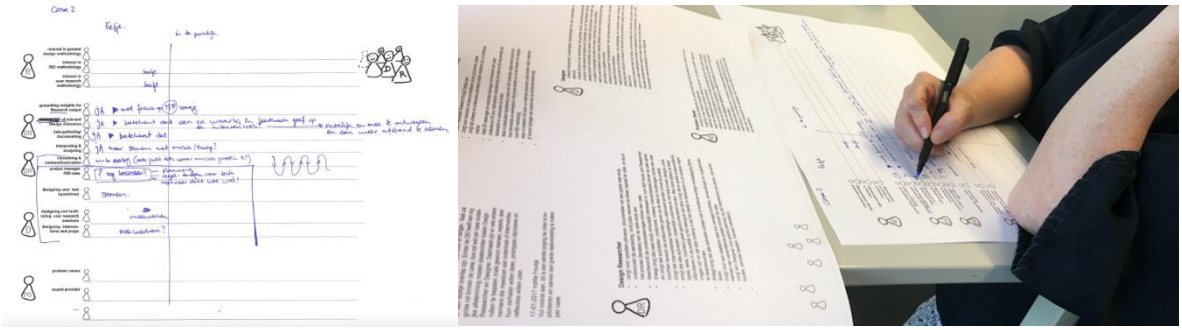

Figure 4 One of the actors reflecting on tasks and responsibilities she would feel comfortable with in relation to the other team members using a roles template.

The team composition of the third case was again very different from the first two cases. Actors C were domain experts but also social innovators within their care institute. All wanted to collaborate but didn't know each others' exact expertise, which made it difficult to directly assign roles. Actor B took the project lead and took multiple roles of design researcher and designer. The roles template helped actor B to discuss with actors C what was expected from conducting an RtD case study together and proposed several options of how actors C could contribute to different types of

research and design activities. This helped in assigning dedicated tasks for actors C, in which they felt comfortable, such as organisational tasks and what to collect as data.

5.2 Use of reporter kit in halfway sessions

The reporter kit was not always consistently filled with annotations of each team member, but enough to gather relevant insights on case content and collaboration. We adapted the reporter kit as soon as when new roles were added. After the first case we also changed its template to give the third question (*Doubts, ideas, expectations, considerations, plans…?)* more space since this question revealed most interesting data.

Splitting roles and documenting thoughts on each role helped in sticking to 'your task'. For example the person in the designer role expressed thoughts as:

> *'Should we really transcribe all these conversations? It is quite some work, I would do this differently with my design agency, I think. But maybe I can also learn from this and see what it brings. For now I focus on producing the next templates design by Friday.'*

The reporter kit of the problem owners documented a lot of insight in their thoughts along the case study process. In contrast to the other roles, people in the problem owner role did hardly reflect on process issues, but shared their thoughts on their everyday work in the reporter kits. For example one problem owner reflected on her own role in her daily work.

> *'Maybe I should propose this […] earlier with client B…. '*
>
> *'I am going to change the evaluation forms, where clients not only evaluate the care provider, but also our role'*

Such reflections provided rich insights on how low hanging fruit ideas were immediately implemented during the case study.

Furthermore we observed that design decisions were not well documented in the reporter kits and concluded that the form (one A4 printed paper with three questions) didn't stimulate this enough. At the end of the first case we decided that we need better documentation of design decisions beyond reporter kit and created an online document to keep a record of design decisions. In the other cases this shared document with design decisions was experienced as very helpful after, but especially during the process, because actors in the designer role had more dedicated conversations together what to document. This made them more aware of the many little decisions they made that eventually had large effects on the actual design that was used in the interventions.

Using the reporter kit annotations as data to evaluate the process of collaboration through the assigned roles halfway the case studies helped in adjusting fruitful collaboration. For example in case one the team noticed that the reporter kit of actor B only showed thoughts on project management level and missed research focus. When observing and discussing this, it became clear that organising the case study as a project was a large task that overruled the task of generating research insights. Even though actor C helped in organising the fieldwork, doing field observations, joining design iterations, analysing, organising sessions, updating everyone and managing all overruled the focus of generating relevant research insights. The team added an explicit new role of project lead in the roles template and in the reporter kit. They also planned more frequent meetings between actors in the theory researcher role and design researcher role to discuss research questions and analysis developments. As a result in case two and three the focus of actors in the design research roles was more evenly balanced between research and application outcome.

6 Insights on collaboration in Research through Design

Through the series of these three case studies we have experienced how assigning roles helped organising the RtD case studies. Finding opportunities in practice for design interventions through an RtD approach is a process which is difficult to plan ahead or control from the start. Being aware of

different roles helps in planning, integrating expertise, dividing responsibilities and collaboration of all involved stakeholders. From the experience of these three case studies and the adaptations we made on the way during the case studies, we have learned insights that might be relevant to other RtD practice that follow a programme approach (Binder & Redström, 2006). Here we share our findings on the interplay of research and design, documentation and taking roles in collaboration.

6.1 On the interplay of Research and Design

Through the case studies we intervened in the phenomenon (people planning their own future lives) with the aims of (1) describing the phenomenon in context and (2) based on this understanding to formulate directions for improvement. In table 3 we summarised five levels of outcomes we identified through this project. From top to bottom, the outcomes range from research oriented to more application oriented. These levels of outcome relate to the different roles, but only in terms of main focus for each role. By discussing these levels generating outcomes has become a shared responsibility for all team members.

The main aim of the project was research driven; generating new knowledge about the phenomenon. However, the societal context of this phenomenon is under change: municipalities, organisations, and citizens in the Netherlands are dealing with a transformation from a welfare state to a local 'participation society'. Therefore describing the phenomenon in this changing context (fourth level in table 3) was more relevant for this project than producing pure theories. Guidelines (system level) and concepts (service level) were further developed as deliverables to impact practitioners and policy makers beyond the participating stakeholders in the assigned project. Small-scale solutions served as demonstrators to illustrate insights on the phenomenon. Several small-scale solutions were also directly infused in practice of involved parties. For example in the first case numerous insights and low hanging fruit improvements were directly implemented by the involved problem owners.

Table 3 Five levels of outcome ranging from research oriented to application oriented we identified in our RtD project, which helped in creating a vocabulary for what is aimed at in a multidisciplinary team.

Outcome of RtD	**What it is**	**Example from first case study that studied care request conversations**
Knowledge	Theory constructs of phenomenon	Theory framework presenting theory variables and how they relate to each other
Contextual knowledge	Better understanding of phenomenon through combining knowledge from various disciplines, trends in political system, future thinking and user research and prototyping in various practices.	Timeline showing moments where people are more receptive to think about personal futures and strategies how to stretch their future thinking.
Guidelines	Directions for innovation strategies for service providers and political institutions beyond the involved parties presented in visualisations such as design documentaries, opportunity maps, and series of workshops etc.	Journey map presenting ideal care conversations in different moments of people's lives.
Concepts	Concept ideas that emphasise an added value for users and providers in the system.	Business model for new service as pre-care planning conversations
Solutions	Directly applicable concepts immediately implemented	Templates and scripts for care planning conversations

Research and design activities were closely interwoven. We experienced that collaboration of all actors in design activities was very fruitful. Through collaboratively framing the problem and solution space, many insights were brought in by domain practitioners, but also were directly fed back to them on different levels. In research activities the collaboration with domain experts was slightly more staged. Domain experts joined in fieldwork and analysis sessions, but design researchers

conducted in-between activities such as preparing, articulating and visualising relevant data categories to facilitate joint production of insights. To conclude, domain experts were involved in various design activities, while their involvement in research activities was more thoughtfully staged.

6.2 On documentation

The Reporter Kit documented process data from the perspective of each role and made visible how things have changed along the case. Using a tool like the reporter kit with only three simple questions on one A4 format did not document all relevant process data, but by jointly sharing each perspective halfway during the case, it helped the team to communicate and discuss aspects which otherwise would have remained tacit. Especially having documented thoughts of the actors in problem owner roles on directly applicable aspects of the designed prototypes was helpful in coining results of a case study on a solutions level. Another positive effect was that it reminded each team member to be aware of their role(s) in the process. Team members who fulfilled multiple roles were supported to deliberately shift between roles and focus within the case studies. It also helped the entire project team to evaluate the methodology and improve the collaboration.

To conclude, the reporter kit is a tool that requires little work for all involved members and tracks enough interesting thoughts to steer joint reflection and to remind each one on their role in relation to the others.

6.3 On collaboration

Defining and assigning roles helped making available expertise and assumed contribution and responsibilities more explicit. Personal traits and expertise vary greatly from person to person, regardless position or title. Through this open way of collaborating but meanwhile framing expertise through roles helped mapping opportunistically each team member's contribution and adjust when needed.

The roles we implemented in this project are not an off-the-shelf, one-size-fits-all solution for RtD projects, but distinguishing roles helped structuring the collaboration, while affording openness to build on personal traits, skills and emerging opportunities in the domain practice. It is a flexible yet systematic approach. We also noticed that the project lead role was always combined with at least one of the other roles and imagine it would be rather difficult to manage an RtD project while not being involved in the complex process through other roles. Each project will form its own team composition, but applying the roles in combination with the reporter kit tool helped structuring the collaboration.

Although each RtD project can have a different set up or be part of another category, and roles may differ, we would like to share our observations about the role of design researcher, because that role included many different capabilities. We identified several components to the design researcher role:

- Organizing skills, getting people on board;
- Shifting between abstraction levels;
- Shifting from knowledge to solution;
- Facilitating all actors in the process, working with people, talking their language;
- Using visuals and aesthetics to pinpoint at intermediate results;
- Making props in collaboration with designer's role;
- Conducting user research, recruitment, field work, observation, interviewing, analysing.

The last one, conducting actual research work, is a large time consuming task that should be made more explicit. We learned that this task easily draws attention from other tasks. Arranging and organising user research activities just absorbs time and focus easily. To highlight this pitfall, we proposed to distinguish two roles of design researcher; one focusing on generating insights and one on practicalities of fieldwork. In the second and third case studies the actors fulfilling these roles also

took the project lead role. By being aware of the different roles they were better able to focus on the activities that were most important and collaborate fruitfully. The assignments of the roles are not distinct, they have large overlaps of expertise, responsibilities, activities and tasks.

To conclude, defining roles helped the team per case to discuss each team member's contribution and being able to flexibly adapt these along the process. Through positioning explicit roles, though they overlap greatly, we were able to organise case studies with the main task of generating knowledge through design interventions. The division of roles provided structure to the process and supported in collaboratively generating insights on the different levels of knowledge, guidelines and solutions.

7 Conclusion

In this paper we explored the process of three case studies in which domain practitioners, designers, design researchers and researchers collaborated in different ways. We illustrated how collaboration in a complex RtD project can be structured through explicitly assigning roles and using tools to integrate perspectives of all involved actors.

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RTD in Landscape Architecture: a first State of the Art

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The discussion regarding the relation of design and research in landscape architecture started somewhat later than in other design disciplines. But the past decade has shown a sharp rise of publications on 'research through/by design(ing)' (RTD). The literature has now reached a level of richness that enables a review of the State of the Art and a differentiation of types of contributions to the discourse. We reviewed more than 200 publications (scientific journal papers, conference papers, PhD theses, MSc theses and others) on RTD in relation to landscape architecture and closely related disciplines. The review shows that a rather small portion of the publications deals with RTD a scholarly sense. The remaining portion of scholarly publications offered a useful base for further scrutiny. We categorised the relevant literature according to types of publications and the epistemological stances taken. Based on this categorisation we identified areas that need further research and thus sketched an agenda for further research on RTD in landscape architecture.

landscape architecture; research through design; research by design; review

1 Introduction

Landscape architecture has developed from a professional discipline into an academic discipline in the past few years (Benson, 1998; Milburn & Brown, 2003; Milburn, Brown, & Paine, 2001; van den Brink & Bruns, 2014). As designing landscapes and urban environments tackles spatial concerns of various scales and a wide spectrum of issues from the natural and social realm, designing is a very complex activity. Therefore, landscape architecture embraces approaches such as 'evidence based' design. These approaches are based on research results from other disciplines (e.g. ecology or environmental psychology) and offer thorough legitimations of design decisions (Brown & Corry, 2011; Deming & Swaffield, 2011) in site-specific designs. 'Evidence based design' formed the major efforts in research related to landscape architecture for a long time. Most of this research would range under 'research on design' and 'research for design' when categorizing it according to Frayling's (1993) terms. This evidence was mainly produced by other disciplines and was of descriptive nature.

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However, descriptive knowledge of a status quo is not sufficient to support design decisions that aim at future conditions of cities and landscapes. There is a need to develop more knowledge about projected new states of cities and landscapes and on how to assess them. Furthermore, more recently it also occurred that there is a need to generate knowledge that goes beyond the support of site-specific design. Designers in practice often find it difficult to translate 'evidence' from other disciplines into practical application, especially when knowledge is very abstract (Eliasson, 2000; Kantrowitz, 1985; Nassauer & Opdam, 2008). Additionally, in practice time constraints or simply the nature of assignments can make it hard for design professionals to find relevant evidence that can inform their designs. As a further consequence, this lack of evidence also makes it hard to assess design results on a reliable basis.

Due to this, designers ask for various kinds of design directives (guidelines, principles, prototypes and recommendations) to bridge this gap and, thus, to make knowledge easily applicable in design practice in different locations. Such design directives differ substantially from the ones developed in other disciplines as the scale and complexity of landscape architectural artefacts are unlike the ones designed in other disciplines such as in industrial design or architecture. These disciplines usually focus on smaller scale designs and more delimited design assignments. Furthermore, many landscape architectural assignments have to respond to a higher degree of unpredictability and thus need other types of design directives.
Plan analysis of existing precedents is a useful way to identify design directives, as results of design (realized plans) are an important source of knowledge and evidence of which planning and design principles function well or not. This type of knowledge can serve as the basis for future designs (Nijhuis & Bobbink, 2012). However to study design directives for entirely new conditions, rigorous research through design is required to explore the breadth of future design possibilities beyond the precedents. Apart from that, designers in practice are increasingly urged to legitimize their design decisions towards a critical public. This requires conscientious designing and rigorous testing of design alternatives.

These developments in the field lead to increased efforts in identifying landscape architecture's methods to combine research and design in common research processes in which the designs form the object of the inquiry. Usually these methods are termed 'Research by design' and 'Research through design(ing)' (RTD). They are research processes actively employing the act of designing. They are research methods 'native' to designers "that places the making of original creative work at the centre of the inquiry" (Carruth, 2015). RTD can help shaping the designing activities of landscape architecture as research methods. As a form of 'evidence based design', in RTD processes "designs are not made intuitively, but based on study (experimental design study), recording, examination and evaluation; an incremental process, where the former informs the latter in an iterative process" (Nijhuis & Bobbink, 2012). The design activities of landscape architecture can have two lines of outputs. One consists of meeting a design-led objective by directly addressing a concrete or site specific assignment. The other contribution can be the development of more generalizable knowledge for landscape architecture for practice. Akin to other design disciplines, designing in landscape architecture can thus produce relevant new knowledge provided it comes up with substantiated general learnings for future designs.

RTD methods developed quite rapidly during the past decade although it seems that often the term 'research' was used in quite random ways. In order to build a sound academic discourse on 'Research through design' in landscape architecture it is now time to take stock of the developments, identify the academically relevant literature and discover the main strands in these developments. Consequently, the main objective of this paper is to explore the State of The Art of RTD in landscape architecture based on the research questions:

1. What are the studies using 'Research by design' or 'Research through design(ing)' methods in landscape architecture and related fields?
2. In how far do these studies qualify as 'Research through design' in a scholarly sense?

What kinds of RTD literature can we differentiate (e.g. epistemological level, design case studies) and to which worldview approaches by Creswell (2011) would they fit?

2 Brief theoretical framework: basic concepts of 'design' and 'research'

As this review aims at developing design research theory in landscape architecture further, a range of terms needs to be defined. These terms will also guide the selection and discussion of relevant studies in our literature review. Many different definitions exist for 'research' and 'design' but, in this context, we will use the terms as introduced by Glanville (2015) since his terminology is widely used in the design research discourse. Glanville concluded that 'research' in the academic sense means a rigorous and in-depth search for answers to research questions and to conclude with new knowledge (which can also be embodied in an artefact). To sketch the wide range of approaches to 'research' we need to specify the concepts behind different ideas of scholarly research.

To define 'research' in a scholarly sense will use the well-established framework of Creswell (Creswell & Plano Clark, 2011). Creswell describes four substantially different worldviews within research: (post)positivist, constructivist, transformative/participatory and pragmatic. These worldviews guide the choice of research methods. The research methods within the (post)positivist paradigm entail mainly quantitative methods that are used to measure an objective reality and are common in the classical sciences. Methods within the constructivist paradigm are of a qualitative nature and support the search for (individual) meanings and interpretations of reality. Transformative/ participatory research methods explore reality together with (members of) society. The latter two worldviews are common in the social sciences, arts and humanities. In the pragmatic approach, the choice of methods is guided by the research questions and consists of a mixture of the first three worldviews. These four approaches to research described by Creswell are transferable to 'research through design' in landscape architecture (Lenzholzer, Duchhart, & Koh, 2013). Lenzholzer, Duchhart, & van den Brink (2017) suggested that most RTD in landscape architecture should belong to the 'pragmatist' approach but it is not clear if this assertion can be supported by the RTD studies conducted in landscape architecture so far.

Glanville (2015) also differentiated 'design' as a noun and as a verb (see also Steinitz, 1995). 'Design' as a noun is the outcome of the design process in which a product, i.e. the design, is projected (and sometimes also implemented). 'Design' as a verb means the active projecting of future environments or objects, for instance through drawings or other representations. In landscape architecture the verb 'design' means giving three-dimensional form and function to urban, peri-urban or rural landscapes. The scale, natural and societal context and the resulting complexity of landscape architectural designs are very different from other design disciplines. Landscape architectural design focuses on creating 'contexts' whereas other disciplines such as industrial/product design or architecture focus on designing single objects.
The 'design' action within research (thus the meaning as a verb) can form part of the research process itself, as opposed to analysing finished designs, in the sense of a noun (post hoc).

3 Methods

To answer our research questions we conducted reviews and analyses of the literature. We gathered the available literature in English language for landscape architecture and the closely related disciplines of urban design and planning.

To answer research question 1 we conducted a literature search in Google Scholar. As the discourse on RTD is rather recent in landscape architecture, we chose this database because it offers a broader selection of literature (including conference papers, MSc and PhD theses or book chapters) that could be relevant for this study. We accessed Google Scholar in March 2017, set out combined search terms and related them with Boolean operation "AND" to find precise matches. The fixed search terms were to be found either in the title, keywords or text body fields, but not in quoted literature or literature descriptions, figure captions, indices, footnotes, as parts of author

descriptions or affiliations. The first combination of terms we studied was “research by design” AND “landscape architecture”. The term “research by design” has been in use for some time and we expected a broad set of results. The yield using this combination of terms was indeed very extensive. A first quick scan of the literature yielded under search term “research by design” revealed that much of the literature would not meet the criteria needed for answering research question 2. Hence, we narrowed the search of terms to “research through design” and “research through designing” in a next stage of literature search in Google Scholar. In turn, we broadened the field to which RTD can be associated (“urban design”, “public design” and “landscape planning”).

To answer research question 2, we analysed the literature found in terms of contents and of how far the addressed studies met the requirements of scholarly quality as indicated in the theoretical framework above. Assessing the scholarly quality of the conducted ‘research’ was based on two sets of criteria. Either the publications had to display a sound embedding in the literature about from other design research fields or they had to follow the classical setup of research in the RTD. This involves: the existence of clearly formulated research questions, a rigorous assessment of different design alternatives or scenarios, and the drawing of conclusions going beyond site-specific learnings. Literature that did not meet these criteria was excluded from further consideration.

To answer research question 3, we further analysed the remaining publications on their contents in order to derive different types of publications dealing with RTD ‘avant la lettre’ in landscape architecture, and to identify the considered worldview according to Creswell (Creswell & Plano Clark, 2011).

4 Results and discussion

Overall, our literature review of RTD studies in landscape architecture and related fields showed the existence of a large array of studies that offered us a wealth of material for further scrutiny. In the following paragraphs we will address and discuss the results from this literature review for each research question.

4.1 Research question 1

The literature search to answer research question 1 (‘What are the studies using ‘Research by design’ or ‘Research through design(ing)’ methods in landscape architecture and related fields?’) yielded 222 publications. This number of publications is far larger than we had expected and it indicates how quickly the Research by/through design terminology has found its way into landscape architecture publications. We noticed that the majority of contributions to the literature come from a rather small amount of countries or regions: Scandinavia, Germany, Netherlands, United Kingdom, USA, Australia and New Zealand. This shows similarities with the RTD discourse in industrial and HCI design (Stappers & Giaccardi, 2017) and might be attributable to a multidisciplinary RTD discourse within the respective regions. We observed that many publications are not from landscape architecture per se but from other somehow related disciplines which might also be influenced by this multidisciplinary RTD discourse. All results of the literature search can be found in appendix (appendix can be obtained via communicating author).

4.2 Research question 2

In general, the different search steps yielded some publications that did not strictly match the combined search terms or they did not occur at all in the suggested links. Even though the search terms were precisely determined, it appeared that some search terms were used in a different context in the literature suggested by Google Scholar. The literature associated to these cases was not taken into consideration for further analysis under research question 3. During the second iteration with new search terms, in many cases the search terms either did not appear in the actual texts or were actually related to a different field (e.g. interior design, architecture, human computer interaction, science philosophy). Also, many texts did not address structure, methods and outcomes of RTD processes. Also these texts were excluded from further analysis under research question 3.

The results from scrutinizing all these publications to answer research question 2 ('In how far do these studies qualify as 'Research through design' in a scholarly sense?') shows an interesting picture (see results of this search in appendix, right column). From the 222 publications, we found actually only 59 publications (about one fourth) dealt with RTD in a strict sense as delineated in the scholarly literature. It did not matter if these studies ranged under the search terms "research by design" or "research through design"- the ratio was about the same in both cases. The approximately three quarters of the publications we found that would not match the scholarly criteria showed some commonalities.

We found many examples of 'research by/through design' for all kind of participatory designs, in which it was not clearly stated what the research question was (e.g. Gutmane & Schreurs 2012, Brand et al 2014, see appendix). Other typical projects that are called 'research by/through design' are evidence based designs (e.g. Zhou & Bonenberg 2016, see appendix) but they did not test artefacts nor generate new insights. Furthermore, we found several reports of designs lacking an evidence basis (e.g. Ware 1999, Waegemaeker 2016, Szakel 2014, Ziemelniece 2013, see appendix) and that are described as 'research by/through design'. Many Master thesis projects can be found amongst projects not explaining what the 'research' entails (e.g. Zhao & Xiaoqing. 2015, Keddeman 2011, see appendix) and it became clear that various Master programmes coined their design thesis projects 'research by/through design' without strictly delimitating the term 'research'. Several publications that used an undefined interpretation of 'research' referred to the contentions of architect Peter Downton: "design is a way of inquiring, a way of producing knowing and knowledge; this means it is a way of researching." (2003, p. 2).
In all these projects, it was either not made explicit what the research questions were, nor which different design options were chosen and why. These studies often did not provide a broader set of new insights going beyond site-related learnings. Generalizable conclusions were therefore mainly meagre or absent. We acknowledge the different merits of many of these 'research by/through design' projects. However, we tend to agree with Janssens (2008) who had already criticized the misuse and inflationary use of the term "research by design", and its devaluation as a truly academic research method. This idea is supported by Schreurs and Martens, who posited: *To label every design as research is not wrong by definition, but it is neither very helpful. 'Research by design' then is on its way to obliterate itself: it tends to become meaningless as an analytical category! Thus, shouldn't we feel uneasy as well when every design becomes research?* (2005). Interestingly, Peter Downton (whose quote mentioned above is often misused) actually also laments the misappropriation of the term 'research': "to speak the speak ... and claim that design is research. Without reflection this means nothing" (2003, p.126). Amongst the publications that did actually meet the criteria to be RTD 'avant la lettre' we observed that a large amount originated from other disciplines than landscape architecture. This indicates the paucity of RTD literature within the discipline itself and points to the need to establish the concepts of RTD more firmly in the methodological discourse of landscape architecture.

4.3 Research question 3

To answer research question 3 'What kinds of RTD literature can we differentiate?' we further analysed the literature. We were able to identify a set of different types of publications. In the first place, an obvious difference exists between publications dealing with RTD on a methodological meta-level and publications describing RTD related to specific cases. The results are summarized in Table 1.

The meta-level of RTD knowledge is represented by studies on a more abstract/general dimension, on the nature of RTD and ways of conducting it. The meta-level publications can be subdivided into two types. One type entails abstracted science philosophical/epistemological reflections on RTD and draws methodological conclusions. These types of studies are denoted in Table 1 by 'meta-level: methodology'. The other type comprises reflections on and abstractions of different implemented RTD cases. These are denoted in Table 1 by 'meta-level: case studies'.

The other types of publications dealt with concrete cases of RTD in which new insights were generated that provided findings of general relevance or validity. Within this set of publications we distinguish three types of studies. The first and quite common type was site-specific RTD, in which various design alternatives are thoroughly tested against several variables. Peleman and colleagues explained it as follows: *a set of options is tested under certain conditions, in a particular terrain or region, before the outcome of these tests are translated into numbers, regulations, plans or recommendations for a policy. They form a kind of catalogue of alternative solutions that meet the expectations of the initial assignment* (Peleman, Pelger, & Braudel, 2015). The results were thus region- or site-specific designs. Also more general learnings were distilled from the region- or site-specific design process and shared with a wider public. These were often textual, general design recommendations. These types of studies are denoted in Table 1 by 'practical RTD: site-specific'.

The second type of practical RTD studies deals with developing generalizable design objects such as prototypes or spatial design guidelines (see Prominski, 2017; Stappers & Giaccardi, 2017): knowledge that becomes 'embodied' in the design artefact (Cross, 1999). These types of studies are denoted in Table 1 by 'practical RTD: generalizable prototype'. The third type of practical RTD studies aim at creating new procedural knowledge about design processes. In these studies, the 'how' prevailed over the 'what'. Such knowledge is often of paramount interest for participatory design processes in which types and moments of communicating designs need to be carefully timed. These types of studies are denoted in Table 1 by 'practical RTD: generalizable procedure'.

We were also able to allocate the worldviews (Creswell & Plano Clark, 2011) used in the different RTD studies. We connected the worldviews to the five different types of studies on RTD (see Table 1) and found remarkable relations.

In the category 'meta-level: methodology' we observed a predominance of pragmatist approaches. This is a necessary choice as many approaches have to be embraced in meta-studies. However, we also noticed that many publications in this category were not explicit about the choice for a pragmatic approach. In the category 'meta-level: case study' we mainly found constructivist and pragmatist worldviews. Interestingly, the (post) positivist view was underrepresented although it usually constitutes the majority of scientific knowledge production.

On closer inspection of the practical RTD studies in relation to the worldview/research approach, some clear relationships can be identified. When examining 'practical RTD: site-specific' we mainly found studies that used a (post) positivist or a pragmatic approach. Constructivist and participatory cases were underrepresented. The underrepresentation of participatory approaches might be attributable to the fact that almost all the studies embracing participatory approaches can be found amongst the studies 'practical RTD: generalizable procedure'. The 'practical RTD: generalizable prototype' studies tended to focus on (post) positivist approaches. The relative absence of other worldviews is surprising, especially in the light of the rise of 'co-creation' processes in which participatory research plays a major role. The studies that range under the 'practical RTD: generalizable procedure' type tend to use a participatory approach more than the other types. The relative absence of constructivist approaches in the practical RTD cases might stem from the academic contexts in which these studies were carried out. The design schools that are embedded in a scientific context devote more attention to methodology. Given the prevalence of (post) positivist approaches used in these environments they tend to follow that tradition of thought.

Table 1 Academically sound literature on RTD in landscape architecture

Author, year, title	**Category of publications**	**Worldview according to Creswell**
Fischer, 2008, Landscape architectural research: Inquiry, strategy	meta-level: methodology	constructivist

Janssens, 2008, Critical Design – The Implementation of 'Designerly' Thinking to Explore the Futurity of Our Physical Environment	meta-level: methodology	constructivist
Coombes, 2011, Unfamiliar terrain: From the paradox of intervention to paradoxical intervention	meta-level: methodology	constructivist
Clark & Widding, 2005, A Student, A Product, A Process: A Fresh Look at Concept Design Games and the Habraken Tradition	meta-level: methodology	constructivist
de Jonge & van der Valk, 2010) Bridging the gap between knowledge and action	meta-level: methodology	constructivist + participatory
Huybrechts & Hendriks, 2016) Counterfactual scripting: acknowledging the past as a resource for PD	meta-level: methodology	constructivist + participatory
Norrie & Abell, 2016, Collaborative Design Research: Linking universities with government policy-makers	meta-level: methodology	participatory
Prominski, 2017) Design guidelines	meta-level: methodology	pragmatist
Schreurs & Martens, 2005, Research by design as quality enhancement	meta-level: methodology	pragmatist
Deming & Swaffield, 2011, Landscape architectural research: Inquiry, strategy, design	meta-level: methodology	pragmatist
Dankl, 2015, The paradox of design methods: Towards alternative functions	meta-level: methodology	pragmatist
Lenzholzer et al., 2013, Research through designing' in landscape architecture	meta-level: methodology	pragmatist
Lenzholzer et al., 2017, The relationship between research and design	meta-level: methodology	pragmatist
Lenzholzer, 2013, 'Science'and'Art'in landscape architecture knowledge production	meta-level: methodology	pragmatist
Duchhart, 2011, An annotated bibliography on 'research-by-design' (ontwerpend onderzoek)	meta-level: methodology	pragmatist
Downton, 2003, Design research	meta-level: methodology	pragmatist
Roggema, 2016, Research by Design: Proposition for a Methodological Approach	meta-level: methodology	pragmatist
Nijhuis & Bobbink, 2012; Design-related research in landscape architecture	meta-level: methodology	(post) positivist
Jonge, 2009, Landscape architecture between politics and science: an integrative perspective on landscape planning and design in the network society	meta-level: case study	constructivist + participatory
Barnett, 2000, Exploration and discovery: a nonlinear approach to research by design	meta-level: case study	constructivist
Lenzholzer & Brown, 2016, Post-positivist microclimatic urban design research: A review	meta-level: case study	(post) positivist
Peleman et al., 2015, When the Mayor Calls the Designe	meta-level: case study	constructivist
de Zwart, 2008) Designing Waterland: Strategies for a Contested Arcadia	meta-level: case study	constructivist
Nijhuis, Stolk, & Hoekstra, 2017, Teaching urbanism: the Delft approach	meta-level: case study	constructivist
Howard & Somerville, 2014, A comparative study of two design charrettes: implications for codesign and participatory action research	meta-level: case study	participatory

Bäckman, Liao, Marttila, & Oguz, 2012, Designing early community engagement for the revitalization of suburbs: Experiences in Kannelmäki	Meta-level: case study	participatory
Meyer & Nijhuis, 2013, Delta urbanism: planning and design in urbanized deltas–comparing the Dutch delta with the Mississippi River delta	meta-level: case study	pragmatist
Montague, 2013, Reflective Practice in Urban Design	Meta-level: case study	pragmatist
Meyer & Nijhuis, 2016, Designing for Different Dynamics: The Search for a New Practice of Planning and Design in the Dutch Delta	meta-level: case study	pragmatist
Felix, Torpus, & Wiedmer, 2009, Negotiating reality	meta-level: case study	pragmatist
Gampfer, 2012, Reality Design and Slow Prototyping as Methods in Sustainability Education	meta-level: case study	pragmatist
Carruth, 2015, Infrastructural urbanism that learns from place	meta-level: case study	pragmatist
DiSalvo, Jenkins, & Lodato, 2016, Designing Speculative Civics	meta-level: case study	pragmatist
Korsgaard, Hansen, Basballe, Dalsgaard, & Halskov, 2012, Odenplan: a media façade design process	meta-level: case study	pragmatist
Kosunen & Hentilä, 2015, Assessing Climatic Impacts through the Lifecycle of an Urban Environment	meta-level: case study	pragmatist
Boekel & Neven, 2008, Landscape and the energy transition	practical RTD: site-specific	constructivist + (post) positivist
Hermens, 2015, Research by Design on a Sustainable Form of Agriculture for the Krimpenerwaard	practical RTD: site-specific	constructivist + (post) positivist
Eriksson & Wideström) The virtual culture house–shaping the identity of a public knowledge institution	practical RTD: site-specific	participatory
Hines, 2014, Submerge: Urban Surface Adaptations	practical RTD: site-specific	pragmatist
Zakariya, 2011, Fleeting feast: mapping and accommodating temporary markets	practical RTD: site-specific	pragmatist
Flanagan, 2011, Addington 2041-a platform for change	practical RTD: site-specific	pragmatist
Wilschut, Theuws, & Duchhart, 2013, Phytoremediative urban design: Transforming a derelict and polluted harbour area into a green and productive neighbourhood	practical RTD: site-specific	pragmatist
Blondia & De Deyn, 2012, Infrastructure Design as a Catalyst for Landscape Transformation: Research by Design on the Structuring Potential of Regional Public Transport	practical RTD: site-specific	(post) positivist
Bobbink, 2009, Design with Water in Dutch Low Land Cities	practical RTD: site-specific	(post) positivist
Marques & de la Fuente, 2012, A sustainable landscape for Arnhem	practical RTD: site-specific	(post) positivist
Rice, 2010, Retrofitting suburbia: is the compact city feasible?	practical RTD: site-specific	(post) positivist
Schork, Burrow, & Minifie, 2009, A Workbench for Emergent Urbanism and Architectural Form	practical RTD: site-specific	(post) positivist
Fischer, Zöllner, Hoffmann, Piatza, & Hornecker, 2013, Beyond information and utility: Transforming public spaces with media facades	practical RTD: generalizable prototype	participatory
Lenzholzer, 2012, Research and design for thermal comfort in Dutch urban squares	practical RTD: generalizable prototype	(post) positivist

Lenzholzer, 2011, An optimized model for a thermally comfortable Dutch urban square	practical RTD: generalizable prototype	(post) positivist
Huijben, Transform Weather for Cycling	practical RTD: generalizable prototype	(post) positivist
Blaauw, 2016, Visualizing energy flows in urban microclimates	practical RTD: generalizable prototype	(post) positivist + participatory
Gregorowicz-Kipszak, 2015, Rethinking Social Impact Assessment through Urban Design: Towards designerly evaluation with a socio-form approach	practical RTD: generalizable procedure	Constructivist
Huang & Xu, 2012, Parametric Urban Design exPloration in a graDUate Design stUDio	practical RTD: generalizable procedure	(post) positivist
Backhaus, Dam, & Jensen, 2012, Stormwater management challenges as revealed through a design experiment with professional landscape architects	practical RTD: generalizable procedure	participatory
Roggema, Martin, & Vos, 2014, Governance of climate adaptation in Australia	practical RTD: generalizable procedure	participatory
Faber, 2014, Landscape architects at the beginning of a participatory process: making use of landscape architect's design skills to start a discussion	practical RTD: generalizable procedure	participatory
Mathew, 2014, Interactive Placemaking: Creativity and User Experience at Urban Installations	practical RTD: generalizable procedure	participatory

5 Conclusion

This first stock-taking of the RTD studies in landscape architecture and related fields has yielded an array of studies presented as RTD. Our review of the State of the Art showed, however, that a large part of the publications found would not fit the academic scope of RTD and that the misuse of the term ‘research’ is rather frequent. Similar inflationary use of terms has been reported in other design disciplines. Research in landscape architecture might end up stepping into the same trap. The young academic discipline of landscape architecture runs the risk of discrediting itself as a proper research discipline. This is a development to be prevented with all means. Assigning landscape architecture an academically sound RTD methodology based on existing research frameworks can take this discipline to the same level of other well-established research disciplines. To build a widely acknowledged basis in landscape architecture RTD, we suggest to found the term ‘research’ on the well-established methodological research framework by Creswell (Creswell & Plano Clark, 2011) and address its underlying epistemology and worldviews ((post) positivist, constructivist, participatory and pragmatist). Yet, we also see a growing body of literature on RTD that displays an encouraging countermovement by fulfilling academic standards.

A large part of this literature is devoted to creating general frameworks of RTD in landscape architecture in a philosophical sense (‘meta-level: methodology’). We noticed that many publications in this category followed a pragmatic approach but that their authors were not explicit about this choice. This phenomenon points towards a lack of embedding studies in the research methodological literature. We suggest that landscape architecture scholars who teach PhD and MSc students make themselves more thoroughly acquainted with research philosophy and methodology to be able to guide young researchers’ methodological choices in an optimal way.
In the category ‘meta-level: case study’ constructivist and pragmatist worldviews prevailed. Interestingly, the (post) positivist view was underrepresented although it constitutes the majority of science production. It might therefore be necessary to enhance studies with a (post) positivist approach to state good or typical examples of such studies.

We detected a lack of literature describing how RTD should be carried out in a more practical sense: what should the methodological strategies be in actual RTD projects? Reporting of practical RTD projects and their specific methodological choices needs enhancement to fill this knowledge gap.

In detail, we noticed that site specific RTD and practical RTD for prototypes tended to focus on post-positivist approaches. Both need an enrichment of constructivist approaches, for instance artistic research in landscape architecture. Such approaches that focus on the creation part rather than the analysis part in design processes can be crucial. They can help to develop entirely new and exploratory research and to formulate novel design hypotheses that can form leaps of design knowledge in landscape architecture.

In general, further research should focus on identifying and describing good examples of RTD practice to support design researchers in academia and design professionals practice with a solid frame of reference. Pragmatist research is generally already well represented in the literature. However, we noticed that most authors did not substantiate their choice for this approach which might be attributable to a lack of knowledge or interest in epistemological issues. But as landscape architecture is embedded in different research traditions it is necessary to take clear stances.

A limitation of our study is that only the available digital literature in English language was taken into account that uses the specific vocabulary as mentioned before. However, there are also useful analogue standard works on the topic available in different languages and/or have similar intentions but use more general wording. These have been excluded for the sake of academic rigour but should be taken into account in further research, too.

RTD in landscape architecture holds the power to move the design professionals' ideas from mere personal musings to consistent visions for the future based on evidence-based knowledge. Without proper RTD it is not possible to develop new artefacts — both in an academic or non-academic context. To put it with Sanders and Stappers (2014), "use making to anticipate the future" is paramount. We need to anticipate future landscape and urban environments able of dealing with great challenges such as climate change or socio-economic shifts. Especially climate change makes RTD necessary — more than ever — in order to find new integrated design and research solutions and to provide design professionals with applicable knowledge as soon as possible.

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Critical Placemaking: towards a more critical engagement for participatory design in the urban environment

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This paper offers a framework for design research that invites civic participation in the construction of place, and aims to reignite the conversation Nigel Cross raised in 1971 as a part of the first proceeding of the Design Research Society, calling on a need for user participation and intentional boundary-crossing. The need for new methods is no more evident than in the field of urban design. As global populations are migrating at unprecedented rates, new and different ideas and cultures are integrating and colliding at a high velocity. Additionally, the digital tools we use to understand and navigate urban environments as physical place, cultural space and social territory offer a new "place" and opportunities to rethink the role of the planner and designer in the process. This paper introduces the basis for novel forms of participatory design research that build on elements of placemaking, participatory design, co-creation and critical action to engage in a mutually critical and evaluative process between designers and users through the mapping process.

critical placemaking, participatory design, mapping, community engagement

1 Introduction

A note about terminology: *We use the term designer generally to include traditional design disciplines as well as architect and/or urban designer. We also use the term policymaker to reference what would generally be thought of as the "client" in a traditional design engagement, which might include governments, institutions, organizations or companies. Likewise, we use the term person to include users, citizens or anyone who is affected by the intervention that the design process might affect. Additionally, we use the term map to mean geospatial representations of place as well as abstract visualizations. The history of the map as a marker of place has informed this choice. Finally, we are reinterpreting the idea of placemaking, and place, to include environments that are not necessarily physical, but might be digital, social, cognitive or otherwise.*

In the 1971 introduction to the Design Research Society Conference Proceedings on Design Participation, "Here Comes Everyman" Nigel Cross made the call for designers to involve users in an

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explicit partnership in the design process. Cross argued for a change in the handing down of policies and designs to users who had little to no say in the plan that subsequently dictated their lives. “Every development” Cross argued, “seems to hold as many threats of harmful side effective as it holds promises for the enhancement of society” (p. 11). Cross, along with most of the contributors to the conference and proceedings, posited a similar view. Since that time, the idea of user-centered and participatory design has been central to much of design research and practice. Yet too many existing practice-based research methods serve to reinforce existing assumptions and cherry-pick answers from the participatory process to support a preordained agenda, rather than using the research process to expose assumptions driving the project and author alternative forms of engagement and design intervention. The concepts in this article are not novel in their fundamental theory, but explore how new contexts might shape alternative interpretations and applications that catalyze designers to challenge their own bias informing design action and engage in a more open-ended and discursive process. We adamantly challenge the idea that participatory design usurps the designer’s pivotal and critical ability to use their perspective as both insider and outsider to balance the needs of many different stakeholders. Additionally, we reject the idea that grassroots participatory design necessitates the abolition of a design expertise. Instead, through critical placemaking, we posit that the design process is essential in navigating and integrating the myriad agendas that drive urban planning decisions. While not neutral, designers occupy a crucial role to include perspectives from people who are not traditionally a part of the urban development conversation and to use their ability for visual translation to mediate debate and negotiations in real and meaningful ways.

2 What is Critical Placemaking?

Historically tied to the physical environment, and seeded by well-known urbanists like William H. Whyte and Jane Jacobs, placemaking focuses on the ways that urban environments manage and shape human experience. In her book, *The Power of Place*, Winnifred Gallagher (2007) argues the impact of place on our human psyche. “Just as the world around us affects our behavior, our thoughts, emotions, and actions affect our surroundings” (p. 19). Gallagher discerns some fundamental components of place including light, climate, energies (both traditional and anomalies) and sacred-ness. Gallagher extends the idea of place to include concepts of people as place (i.e. parenting and emotional connection to others). Today as we fluidly navigate social and physical space through diverse digital platforms that frame or augment our embedded personal experiences, the dimensions of place must expand beyond the physical world and into the virtual one. Therefore, critical placemaking is not solely concerned with our experience of the built and natural environment, but must also necessarily engage the digital environments that mediate them. In extending the idea of the physical manifestation of place—neighborhood, home, community—and the concepts of city that Kevin Lynch (1960) posed in *The Image of the City*—namely, that of edges, nodes, paths and landmarks—into the social and political forces influencing and constructing physical place, we suggest a model for design research and critical discourse that engages designers, users and policymakers in fundamental conversation about the meaning of place and its importance to different people with different experiences. Lynch himself understood the city as a metaphor, stating that “Moving elements in a city, and in particular the people and their activities, are as important as the stationary physical parts. We are not simply observers of this spectacle, but are ourselves a part of it, on the stage with the other participants. Most often, our perception of the city is not sustained, but rather partial, fragmentary, mixed with other concerns. Nearly every sense is in operation, and the image is the composite of them all.“ (p. 2) It is an evolution of this “composite,” which Lynch referred to as the *Image of the City*, that critical placemaking aims to co-create. Building on James Corner’s (1999) call for the agency of the map to “inaugurate new grounds upon the hidden traces of a living context” (p. 214), we seek to leverage the power of visualizations to “emancipate potentials, enrich experiences and diversify worlds” (p. 213). While the map might not be central to all iterations of critical placemaking, we see it as a particularly powerful analytic, synthetic and formative tool in a number of way which we will describe in more detail in the

mediating section of this paper. In essence, the map as a cultural symbol of truth and reality, coupled with its ability to iteratively reframe and redefine that truth, has the potential to activate public discourse in way that other visual or textual mediums cannot.

To expand the voices defining the dimensions of place and composing the composite images of place, it is essential for critical placemaking to author tools which engage a diverse cross section of the community and contextualize of those voices within the complex interplays precipitating place. Traditional concepts of placemaking encourage a community-based approach to urban design and architecture. More recently, creative placemaking has built on these general concepts by advocating for the inclusion of creative practices that help citizens and users feel more connected to their community and environment. While these are valuable for activating urban environments, we believe that there is another facet to placemaking that can encourage ownership and critical questioning of the historical, physical, social, political and economic components that contribute to the contemporary environment. The role of the designer in grounding community engagement within a broader context necessitates illuminating the complexity of the environment. Without this framing and contextualization, placemaking remains an incomplete tool for engagement in the planning process and builds a participatory process reliant on naive assumptions and conclusions. To combat this we argue for a perspective of placemaking that encourages criticality, agency and activism on the part of the designers and the communities with whom they work through visualizing the diverse dimensions of place. Within the tradition of a community-based approach to designing public (physical or digital) spaces, critical placemaking looks beyond shifting demographics and emphasizes *how and why* development of the built environment influences the social fabric of the city and vice versa.

In traditional participatory design practices, people are engaged as a way to figure out how best to address a particular problem, but more often than not citizens are not included in an iterative question seeking and problem definition processes eliminating their ability to question the assumed issue at hand. David Hammond, one of the grassroots organizers of The Highline in New York City, exemplifies this conundrum when reflecting on the process by which the Friends of the Highline engaged communities in the planning process. “Instead of asking what the design should look like, I wish we’d asked, ‘What can we do for you?’ People have bigger problems than design” (Bliss, 2017). Hammond’s response was directly related to the unforeseen success of the public park—which has directly led to over 8 million visitors and $1 billion in tax revenue and indirectly to the potential for gentrification that often follows restoration projects like this one. Alternatively, critical placemaking encourages the evaluation and transparency of needs and wants on the part of both the designer/planner and the community member. By provoking reflection throughout the process, critical placemaking seeks to challenge the assumptions that designers and community members might hold about what is valuable and necessary for successful design and urban development.

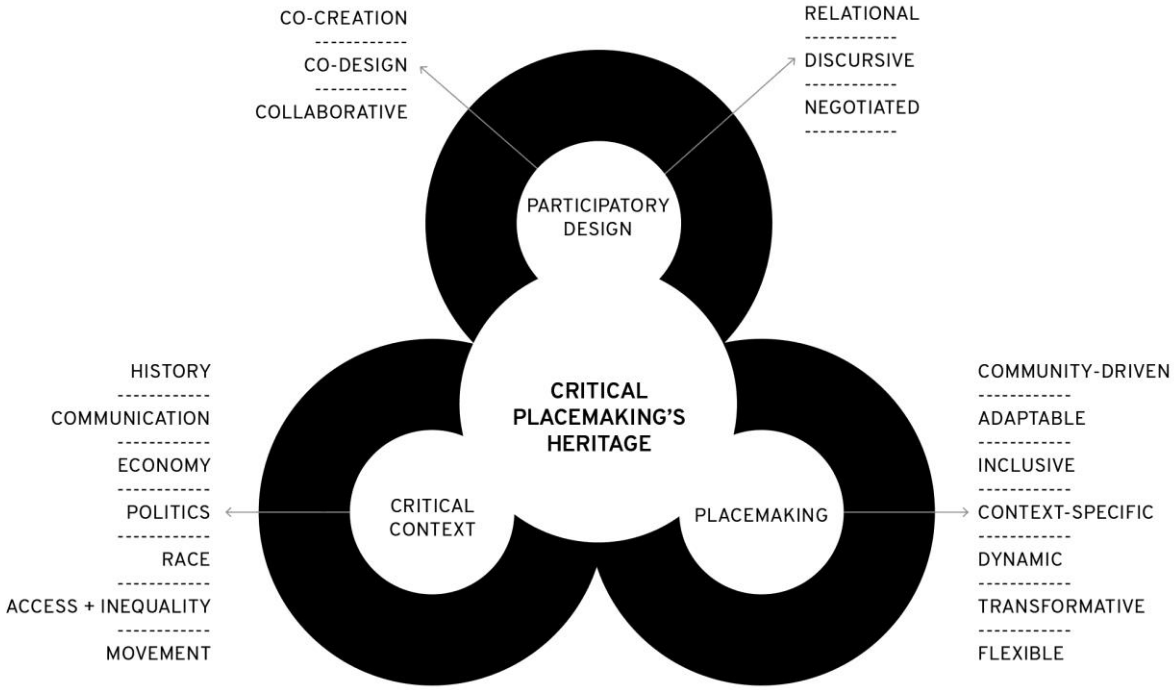

Figure 1 The heritage of critical placemaking builds on a legacy of participatory methodologies in architecture and design.

3 Critical Placemaking as Mediator

Critical placemaking has emerged from its placemaking predecessor(s) through the necessity to not only balance the needs of the citizens, but also to navigate and negotiate those needs as they interface with public policy, special interests and economic barriers. Possibly one of the most important aspects of placemaking is the very acknowledgment that design operates within a larger and incredibly complex system where the stakes and stakeholders are not always aligned. As such, critical placemaking as mediator has three distinct aspects to it: (1) The designer as mediator capitalizes on the the dual roles of the designer as both insider and outsider to help negotiate and spark discourse. (2) The design process as mediator is grounded in an open-ended iterative process where by citizens and designers can actively contribute to the continual negotiation and construction of meaning as well as contextualize decisions within a wider pool of knowledge and experience. (3) Design research tools and artifacts as mediators (such as the map) allow “truths” on which design action might be based to be confronted, challenged, or modified. The potential for mediation at each of these levels is not new, but the designer has not always used the research process as a conditional tool for negotiating, mediating or building up the necessary expertise. By reframing the position of the designer (and their process and tools) as mediator rather than facilitator, we open design research up to inaugurate new possibilities in designed environments, and give equal agency to the role of the designer in the discursive process. Critical placemaking sees opportunities for design as a mediating tool to create bridges between users and the authorities (whether governmental or private interest) who are influencing their everyday lived experience—in many ways controlling, or at least regulating access to needs that enhance daily life. Ultimately, we see it as a tool for connecting and prompting informed and prolonged discussions that provoke reflection and reaction to the social, political and economic forces that underpin conditions for design intervention.

As with other types of placemaking, the concern that critical placemaking might become trivialized and overly simplified on the one hand, or unnecessarily cumbersome on the other, is real. Critical placemaking, as a mediating tool, necessitates a deep and prolonged engagement that regards the design and research development process as iterative, ecological and ever changing. This primes a

sort of anthropological experience whereby the designer is charged with bringing together diverse voices and experts to unpack the complex relationships between our built environment, social territories, governing policies and economic flows. As Laura Gatt and Tim Ingold (2013) argue in *From Description to Correspondence, Design in Real Time* "…design is part and parcel of the very process of dwelling. And it is, by the same token, about the ongoing creation of the kinds of environments in which dwelling can occur. What, then, can it mean to design things in a world that is perpetually under construction by way of the activities of its inhabitants…design is not so much about innovation as it is about improvisation" (p. 145). Gatt and Ingold argue that because design is a future-thinking activity it can never be definite or finished, but must build into its process and proposal a very interactive nature, not just of the process of design, but of the process of living. By the same token, as tools of mediation design research methods must challenge assumptions about what is visible and invisible, and what is fixed and negotiable.

We see visualization—specifically mapping—as an especially powerful tool for this mediation because of the tangible nature of the map, the process of translation embedded within its creation, and its inherent connection to place. We believe that mapping as an analytical, synthetic and formative process is essential in the translation of research and data into critical visualization and propositional tools. These benefits are not just for the viewer of the map, but also for the creator as they engage in a fluctuation between the activity of encoding and decoding; constructing and deconstructing. As James Corner (1999) argues in *The Agency of Mapping*, the map's" agency lies in neither reproduction nor imposition but rather in uncovering realities previously unseen or unimagined, even across seemingly exhausted grounds" (p. 213). As a mediating tool for critical placemaking, we see the process of visualization as an important connector between different perspectives and stakeholders. Through the qualities inherent in the map itself—specifically, scale, orientation and framing the map forces a discussion of inclusion and exclusion that can confront larger issues of value, priorities and impacts (Allen and Queen, 2015). "Tools borrowed from geography are critical assets to advance mapping beyond the analysis of isolated project components and into the synthesis of both process and outcomes for generative research—research that is beyond a verbal activity." (Allen and Queen, 2015, p. 82) In their seminal work, Anuradha Mathur and Dilip da Cunha use the mapping process as an iterative and performative activity to interrogate the relationship between landscape and culture. Studying such seemingly different places as the Mississippi Delta, Bangalore and Mumbai, they use the map as a way to explore the intertwined relationships between environment, behavior, vernacular development patterns, cultural perspective and environmental policy. The outcome of their work—exhibitions and published books like *Mississippi Floods*, *Bangalore Traverse* and *Soak*—challenge the singularity of the map as a record of fact, and instead present them as a series of haptic artifacts which record the negotiations between physical and non-physical elements in the landscape. Their research process through mapping operates to expand the dimensions of place, illuminate change and the cycles fluctuation as inherent to the landscape, and expose how different culture perceptions and values influence our perspective of the landscape and dictate how we inhabit it.

4 The Democracy of Critical Placemaking

Democratic principles inherently rely on open access and participation by those who are directly or indirectly affected by the policies of governance. In urban planning (and design in general) this might mean access to the context and scope of the project, the plans being projected, the underlying analysis that is driving the planning process, the proposals being presented or a host of other pieces of information. Many democratic principles are visible in architecture and design today, informing strategies such as tactical urbanism, everyday urbanism, participatory design, public interest design and even participatory placemaking. All of these variations necessitate what Thomas Ermacora and Lucy Bullivant (2016) characterize as a re-coding of the roles and expectations between people, planners and policymakers. "'Recoding' anchors and stabilises growth, and supports local relationships, respecting and rewarding communities for their creativity and staying power" (p. 10).

Through varying degrees and types of public participation, placemaking and its various offshoots emphasize a design process that is ideologically equalizing, democratic and accessible. Arguments that this grassroots approach has in many ways undermined the value of the designer as an expert able to balance (or at least consider) multiple stakeholder positions and weigh costs and benefits of an issue are real. "Privileging the grassroots over plannerly authority and expertise meant a loss of professional agency. In rejecting the muscular interventionism of the Burnham-Moses sort, planners in the 1960s identified instead with the victims of urban renewal. New mechanisms were devised to empower ordinary citizens to guide the planning process" (Campanella, 2011). As a democratic process, critical placemaking does not try to erase the expertise of the designer or planner, instead it reframes and redefines what expertise means and how it is gathered. In their 2000 article, "Implacing Architecture into the Practice of Placemaking" for *The Journal of Architectural Education*, Linda Schneekloth and Robert Shibley suggest a similar transformation necessary in architectural education and practice. "If we acknowledge the real complexities and contradictions inherent in each site of intervention, seeing differences and similarities, we would be required to continually negotiate meaning and position—including where we as "experts" are located" (p. 131).
In his essay, *The Right to the City*, David Harvey (2003) argues that "The right to the city is…far more than a right of individual access to the resources that the city embodies: it is a right to change ourselves by changing the city more after our heart's desire. It is, moreover, a collective rather than an individual right since changing the city inevitably depends upon the exercise of a collective power over the processes of urbanization" (p. 1). If we consider the city as analogous to many different forms of spaces for community and interaction—which we do—then the argument that Harvey makes can extend beyond the physical space and into all spaces in which we engage in a collective interaction. As a response to Harvey's call, critical placemaking, like its predecessors, advocates for a democratized process whereby users, designers and policymakers act as partners in the discovery and advocacy process. Through critical placemaking, we are particularly interested in a democratization process that is discursive, whereby users can engage more deeply with the social, philosophical, and ideological history that is underpinning the plan for design action. Through articulating this historical knowledge, critical placemaking can expose many of the underlying practice-based assumptions motivating a project and empower informed citizens to actively participate in all levels of a project from project definition to evaluating its long-term success.
Critical Placemaking as a democratic tool also places diversity and access at the center of the research process. Rather than including people in a controlled participatory experience, critical placemaking takes conversations and prompts out into the public sphere to be encountered by people who are not primed or conditioned to respond. The data artist Jer Thorp's *Map Room* emphasizes this democratic process by using the map as a negotiated tool for understanding, explaining and representing the city. Initiated in St. Louis, Missouri the *Map Room* was set up to allow visitors to create a large 10' x 10' map that revealed their everyday experience and perception of the city. These maps were then overlaid through projection with historical maps that showed demographic data, urban planning information and environmental shifts as a comparison. Through this process, visitors could evaluate how their perception evolved from or contradicted the official and historical records of the city.

5 Critical Placemaking as Laboratory

The inclusion of citizens in the creative and planning process is predominant in critical placemaking, but doing so in a meaningful way necessitates a reframing of the type of "information" designers and planners are hoping to retain from these engagements. It also entails (or precludes) a fundamental shift from the objective of participatory design research as a mechanism to develop and refine design interventions towards a more experimental, flexible approach. We see critical placemaking and its powerful methods of mediation as an opportunity to experiment in new forms of participatory design, research and discourse. Traditional motivations for participatory design have argued for engaging in these practices so that "planning decisions by specialists should be made with

the participation of the end-user to minimize uncertainty as far as possible" (Thomas, 2016, p.1). This viewpoint still belies what we would argue is a fundamental fallacy that uncertainty (and resulting instability or change) is the enemy. Rather we wonder what we might gain by embracing uncertainty as a learning tool. By using the critical placemaking process as a sort of laboratory experience whereby different conditions are compared against "controls", we aim to more fully and deeply understand the root causes of issues and to engage in a more open-ended design research process. These types of experiments are core to any participatory process, but are by and large a by-product of the participatory experience, rather than being central to it.

Theories of ecological design and systems thinking offer alternatives to traditional masterplan approaches to urban design. Rather than starting with the goal of a singular, controlled outcome, ecological systems theory embraces the idea of change and evolution as core to its principles of discovery and proposition. In an article for *Places Journal,* the landscape architect Chris Reed (2014) argues that, "The past two decades have witnessed a resurgence of ecological ideas and ecological thinking in discussions of urbanism, society, culture and design…Increasingly these concepts are seen as useful heuristics for decision-making in many fields, and as models or metaphors for cultural production, particularly in the design arts." (Reed and Lester, 2014) In Reed's argument, the Sciences, Humanities and Design have all expanded their understanding of natural and built environments to emphasize growth, change, adaptability and flexibility. Critical placemaking builds on these concepts by also considering the social, economic and political dimensions and implications of design action. In this setting the map lends itself to exploration with the potential to visualizes interconnectedness and change in a very real, tangible way. Through dynamic and speculative interactions, maps have the potential to show the implications of action (design or otherwise) throughout a system. The map then can become a feedback loop within the design process to test ideas with immediate adjustment and flexibility. Digital, open-source platforms provide a particularly rich environment in which to explore some of these ideas. After the earthquake in Haiti in 2010, Open Street Map, the WikiMapping platform, was used to reconstruct the island when no visible markers existed on the ground. This has indirectly led to the Humanitarian OpenStreetmap Team (HOT) that uses collaborative mapping, and open source data sharing to provide maps to aid workers around the world. As an ongoing project, the maps are constantly updated based on experiences of those "on the ground" and so become living documents of human experience as much as traditional denotation.

6 Critical Placemaking Case Study

A project that we are currently working on, entitled *(in)Tangible Boundaries: A People's History Exploring the Political, Social and Physical Forces Shaping Urban Development* seeks to test some of these approaches to critical placemaking. The primary assumption driving this project is that with a deeper understanding of the social and political dimensions manifest in the physical environment, we can facilitate a collective critical placemaking process which has the power to create meaningful dialogue about a city's future. By highlighting the constantly evolving relationship between intangible social, political and economic forces and the tangible physical landscape, this project underscores how urban development both shapes and is shaped.

Too often in design and planning, history is understood as a part of the past—commemorated, preserved or abandoned. Alternatively, *(in)Tangible Boundaries* aims to make historical understanding a working asset that is integrated and used as a transformational tool for imagining and planning for the future. While to some this might seem a semantic difference, we see this differentiation as substantial, with history becoming an integral part of the current urban fabric—having the potential to engage communities in activities of critical reflection and action that move beyond the traditional methods of participatory design and planning that have preceded it. There is also much criticism in the urban renewal application of current concepts of placemaking and participatory design, citing the gentrification and displacement that so often accompanies these revitalization projects. Addressing this critique is a central component to *(in)Tangible Boundaries*, and so motivation lies in sparking debate and discourse on the historical social, political and

economic forces that have contributed to the current landscape, in addition to how that landscape might or should change in the future. To seed, as Rem Koolhaas (1995) has suggested, an approach to urban design that "will no longer be obsessed with the city but with the manipulation of infrastructure for endless intensifications and diversifications, shortcuts and redistributions – the reinvention of psychological space." (p. 969)

Similar issues arise in the development of theories of public history, especially in relation to historic preservation and urban revitalization. In *Beyond Preservation*, Andrew Hurley (2010) suggests that the evolution of public history has moved beyond the preservation of a single building or entire districts, to considering "the entire urban terrain and all of its component parts" which includes "a complex web of social relations that evolved over time" (p. 39). He further argues that "[c]onceptualizing space as a perpetual object of social production and contestation thus provided a powerful antidote to the preservationist flaw of freezing the built environment in time" (p. 40). Dolores Hayden (1995) pointed out in *The Power of Place* more than 20 years ago, "Today, debates about the built environment, history and culture take place in a much more contested terrain of race, gender and class, set against long-term economic and environmental problems…" (p. 6). Hayden further argues that urban space and public history should be reframed not solely as inclusion of differences in race, ethnicity and gender into public history, but aimed at finding common human experiences that have individual and diverse episodes within them. To encourage participation and a genuine connection with these episodes necessitates the development of what Michael Frisch (1990) defined as a "shared authority" with opportunities for community members to actively engage in the collection, dissemination and correlation of historical narratives and contemporary events.

A preliminary exhibit attached to this project used student maps and research posters as prompts to discuss the social, cultural, political and physical implications of urban development in Raleigh, North Carolina. As a Southern U.S. city, issues of economic and racial segregation permeate the its history of its urban development. Mapping issues of education access, for instance, shows a clear and common disadvantage for certain citizens throughout the history of Raleigh's urbanization. Whether explicitly or implicitly realized, the location and value of housing disadvantages some students from attending schools that are better and closer. Once you see that trend as part of a larger continuum of disadvantage, a relationship emerges between policies and actions taken and how different levels of privilege manifest in the physical environment where people live. This preliminary exhibition also indicated the power of the map as a discursive tool. We found that the 'authority' of the map being used to tell alternative stories to the official ones that citizens are usually exposed held powerful, energizing and engaging potential. By making the tacit explicit, the map provided a critical tool in the construction of knowledge. Many people at the exhibit inquired about getting more involved in the project, and especially since many of them were visitors who had "wandered in off the street" we considered that a provocation for continued work.

Through this project, we are considering how these different manifestations of the map can serve as primary interfaces which allow users to navigate communities as complex social and physical terrains composed of collective histories, personal accounts, historic photographs and archival documents situated within the more typical dimensions of space and time to discover meaningful interactions in the current landscape and speculate on their influence for future scenarios. (Figure 2) The map provides the project with a provocative framework through which to explore the "shared authority" of writing a community's history. Through a participatory platform (tangible and digital) that encourages user generated content, the map interface will inherently employ multiple authors, empowering diverse voices to contribute to and interpret the information at hand. In *Design for Information*, Isabella Meirelles (2013) builds on the historical and contemporary research of Jacques Bertin, Donald Norman and others in arguing that "[v]isualizations of information can be considered cognitive artifacts, in that they can complement and strengthen mental abilities" (p. 12). Through the cross-disciplinary work of this project we aim to develop a system which is both interpretive and propositional to solicit visions of *what might be* that is grounded in a deep understanding of *what is* and *what was*.

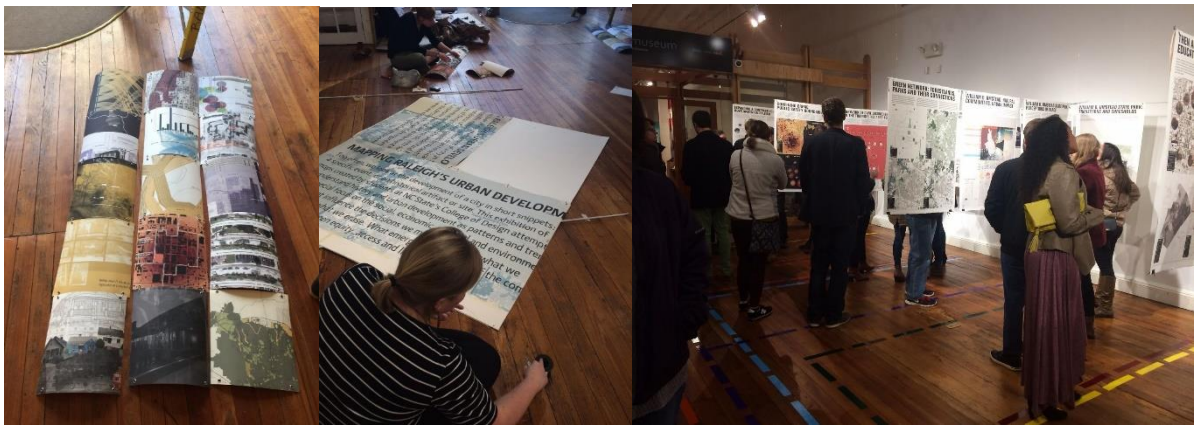

Figure 2 Mapping Raleigh's Urban Development Exhibition, February 2017

Because people do not always have the tools, information or language to participate in the planning process in a similar way—but they do have an individual and collective experience that they can share—a key part of critical placemaking, then, is devising ways to capture that variety of experience, and use the map as a prompt, a mediator, and a data collection tool. The current project, *(in)Tangible Boundaries* also aims to do that through a series of distributed prompts and "sites" for dialogue. The primary goals of the current iteration of this project are three-fold. First, this project aims to augment and overlay current methods for studying patterns of urban development (historic maps, aerial photographs, GIS datasets, infrastructural investment records and zoning policy) with everyday citizen's knowledge and personal narratives to capture and more deeply reflect how the social and physical dimensions of place are intertwined. Second, this project aims to illuminate the legacy of political and economic policy in the built environment by paying special attention to how these tools have had long lasting, often unintended, consequences dividing and segregating our physical and social spaces. Third, this project aims to provoke how policies under consideration today might impact the future form of the city.

7 Conclusion: Critical Placemaking as Cultivator

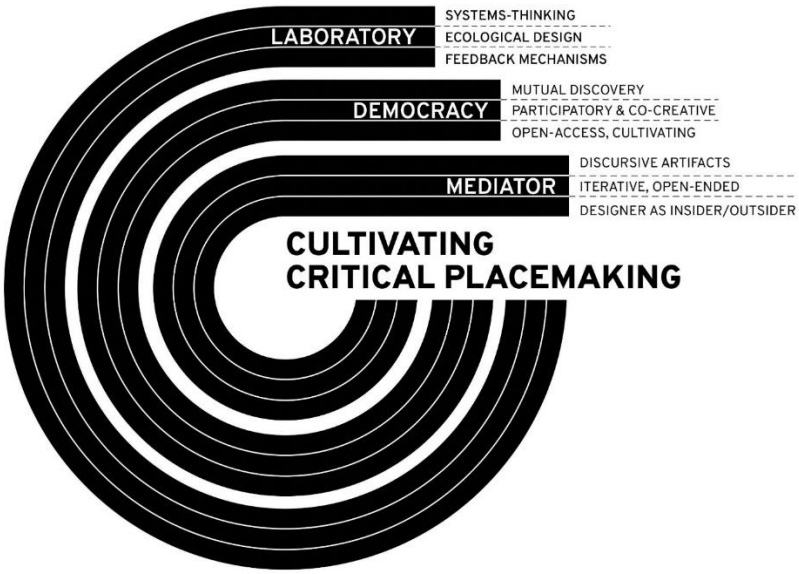

Figure 3 Cultivating Critical Placemaking

Within critical placemaking there is no assumption of physical intervention, and much like in participatory design, the designer, user and policymaker are engaged in mutual discovery and

sharing. Even when physical intervention is involved, critical placemaking proposes moving away from the primary goal of a singular, isolated object (exhibit) or a space (a city park, building) to designing for a civic conversation through platforms, systems and communities that allow co-research and co-creative processes which construct meaningful relationships through a diversity of voices providing agency to all involved. At its core, critical placemaking privileges interaction and conversation through mediated design interactions. This discourse might involve the social, political, economic and historical contexts under which design and change is necessary (or not). In their article, *Co-Creation and the New Landscapes of Design*, Liz Sanders and Pieter Stappers (2008) argue that "participation in the design process, as it is practiced today, is focused more on the exploration and identification of presumably positive future opportunities than it is on the identification and amelioration of adverse consequences" (p. 8). Critical placemaking seeks to prompt discourse focused on these ideas of the consequences of design action. Additionally, critical placemaking seeks to unpack how the activity and outcomes of the act of designing (i.e. what is created) could be used to provoke a deeper, more engaged and interesting discourse. Essential to the sustainability of these engagement platforms is the inclusion of dynamic feedback mechanisms which allow for evolving forms of interaction to emerge overtime. As ongoing dialogue catalysts, these mechanisms have the potential to grow, expand and change as the ideas and values connected to place do. (Figure 3) While critical placemaking is in many ways an extension of many of its participatory predecessors, we think that it holds value in extending the research methods for urban design and sited interventions in a number of key ways: (1) by using design itself–specifically mapping and visualization—as a mediating tool to facilitate and provoke critical conversations and negotiations between all stakeholders in the process; (2) challenging existing definitions of democratized design, and placing diversity and access at the center of public participation in the design and research process ; (3) challenging the assumptions of the designer through this mediated process, whereby the goals of the design process are more open-ended and experimental in nature and design is seen as "seeding futures" rather than being conclusive in nature; and (4) a rethinking of the engagement process as nurturing cultivation over action and intervention. As the field of design research continues to evolve, and as we continue to consider how people and users can be integrated and collaborated within the design process, we hope that critical placemaking provides an opportunity for deeper engagement whereby a multitude of voices can engage and provide critical discourse on not just design intervention, but also design impact.

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A Place to Be or, at Least, a Space to See: a qualitative inquiry on the experience and appreciation of extensive green roofs

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This study explored the experience of extensive green roofs [EGR] in order to understand more accurately the factors that contribute to their aesthetic experience. The research pursued a comprehensive approach to advise designers in the conception of EGRs and encourage their large-scale implementation to accelerate transition into a more sustainable and resilient way of living. The results of this study were provided by the combined analysis of an *in-situ* experience of 30 EGRs from Montreal and Quebec, as well as from 30 semi-structured interviews conducted with participants from Montreal (Canada). The study revealed a positive perception of EGRs and a greater appreciation than the one given to traditional roofs. Even if the environmental benefits of a green roof were recognized, participants found them useless when a physical or visual access to the roof was not granted. Thus, the paper proposes an intervention on roofs that could go beyond its strict greening. In fact, the design of EGRs should encourage human experience by physical presence when possible or at least draw attention to its observation.

sustainable futures, aesthetic experience, empathic design, extensive green roof [EGR]

1 Introduction

Sustainability issues have transformed urban infrastructure projects by introducing new ways of planning our living environments. In fact, these sustainable projects now increasingly integrate greening systems able to face climate changes like stormwater retention, heat island and air pollution reduction, as well as the enhancement of biodiversity. But taking into account only environmental benefits in designing green infrastructures tends to be seen as a restrictive way of implanting these new projects. As such, understanding how these kinds of projects can allow the invention of new experiences integrating human concerns could accelerate transition into a more

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sustainable and resilient way of living. Therefore, extensive green roofs [EGR] could be one of the most susceptible green infrastructures to be massively installed in the urban density of built environments (Berardi et al., 2014). Green roofs can be divided between intensive and extensive green roofs (Table 1). Intensive green roofs (IGR) have a deeper substrate which allows the planting of a more diverse vegetation. However, it is heavy, it requires more maintenance and it is expensive. Consequently, despite their environmental benefits, such green roofs are not expected to be implemented at a great scale. On the contrary, extensive green roofs (EGR) have a substrate of modest depth, is lighter and less expensive and can easily be implemented on existing buildings of denser neighbourhoods. However, this shallow substrate limits the variety of vegetation to herbaceous plants. Moreover, the frequent lack of irrigation systems on roofs and the limitations to the roofs' accessibility due to security matters introduce other design challenges. Thus, these kinds of limitations distinguish green roofs' landscapes from the green spaces found on land which, in turn, contravenes with people's representations of green roofs and the experience expected from these green infrastructures (Dagenais et al., 2010; Lee et al., 2014). In consequence, people could be less eager to install green roofs if their everyday experience was not enhanced by these infrastructures and particularly so, if we consider their extra costs in comparison to intensive green roofs (IGR) that enable more activities and are less restrictive in their designs as shown in Table 1.

Table 1 Extensive green roof (EGR) vs Intensive green roof (IGR) (*Grant et al., 2003)*

Extensive green roof (EGR)	**Intensive green roof (IGR)**
Lighter because of its shallower substrate (less than 20 cm)	Heavier because of its deeper substrate (more than 20 cm)
Minimal maintenance (usually)	Frequent maintenance (usually)
Not irrigated (usually)	Irrigated (usually)
Smaller size vegetation (usually herbaceous)	Larger size vegetation (herbaceous, bushes and even trees)
Inaccessible or limited access to maintenance	Accessible

Figure 1 Pictures of extensive green roofs versus intensive green roofs

The literature on the benefits of green infrastructures, from an ecological or urban planning perspective, is abundant (Oberndorfer et al., 2007; Vijarayaghavan, 2016). However, a few studies were dedicated to green roofs and their experiences. Some focused on intensive green roofs (IGR) (Yuen & Wong, 2005) and others on IGRs as well as EGRs (Fernandez-Cañero et al., 2013; Jungels et al., 2013; Loder, 2011; 2014). These studies have essentially been looking into identifying appreciation elements of green roofs that were largely based on preferences such as plant characteristics and diversity, vegetation types, design and maintenance (Fernandez-Cañero et al.,

2013; Jungels et al., 2013; Lee et al., 2014). In so doing, studies have shown that preferences are often limited in application due to contextual variables and if not often contradictory. Consequently, studies could have benefited from contextual and experiential refinement. Hence, this acquired knowledge is limited to visual appreciation, is hardly transferable to different contexts and is overlooking the citizens' embodied experiences. In fact, when we consider a place-based design perspective favoring transition, people's experiences become essential to the orientation of projects and requires a more empathic attitude towards citizens' concerns (Manzini, 2015). Moreover, landscape design is an inherently contextual practice, aiming at creating a new space experience that could be beneficial to people. As such, it could benefit from a more in-depth understanding of the experience of green infrastructures and people's perception of it. Futhermore, if we consider that social acceptance of green and grey infrastructures is as much related to their aesthetic experience as to their environmental values, it could be important to consider both in design projects to fully convince citizens (Gagnon, 2006; 2012).

Therefore, based on these assessments, this paper proposes an intensive study on ERGs aesthetic experience in order to guide designers with the implantation of these projects in urban environments. In this perspective, the concept of the aesthetic experience in the scope of the everydaylife and environmental aesthetics is a prolific concept to address the sensitive and qualitative relationships between people and urban landscapes as well as on how design can transform these environments (Saito, 2010; Berleant, 1997; Gagnon, 2006; 2012). The aesthetic experience concerns human perception, attention and sensation to the environment; it is modulated through the body and mind, space and time in a dynamic that challenges human life in all its complexity (Berleant, 1997 ; Carlson & Berleant, 1998). In this sense, aesthetic experience is not only concerned with visual perception, but also with multi-sensorial experiences that are always defined contextually within a space, in relation with the physical conditions of the surroundings as well as with values and personal knowledge such as environmental benefits from green infrastrutures. Saito (2001) adds that aesthetic experiences in everyday environments demand an acknowledgement of the interpenetration of different life elements when people relate to their surroundings. In order to succeed, an understanding of the physical conditions of the experience (i.e. visual, formal and design elements) and its perception (i.e. representations, values, attitudes and meaning) is needed.

In this sense, the comprehension of such experiences for designers could be seen as an opportunity to better orient the design project and could also be understood as a reframing exercise of existing practices. By doing this, designers could include both the point of view of ordinary citizens and expert analyses by combining the examination of visual, formal and design elements to environmental and specific place-based values, representations, meanings and in doing so, aesthetics experience. Thus, designers of EGRs could be more aware of experiential and physical contexts and the results of this kind of research could give them insights into a more meaning and resilient way of living rather than a prescriptive list of criterions for the design project. Therefore, introducing a more sensitive interpretation of realities could be translated, transformed and enhanced in design projects while being oriented for people and potentially appropriated by people themselves. The paper is, thus, based on a comprehensive approach towards a place-based knowledge achieved by a qualitative study of the people's perceived and lived experiences of green roofs.

2 Present study

The aim of this research was to understand the aesthetic experience of EGRs in order to offer guidance to designers. To achieve this goal, we used a mixed qualitative approach to develop an in-depth interpretation of the experience by combining complementary methods (Denzin & Lincoln, 2008). First, an expert experiential analysis of 30 EGRs from the Montreal and Quebec regions was conducted by the team of researchers themselves. These expert observations first allowed the analysis of the EGRs' designs and elements characterizing the experience induced by these types of environments based on previous studies and landscape preferences (Dagenais et al., 2010) (Table 2).

It enabled the establishment of an experience and design typology of EGR which identified different design types of green roofs: contemporary, traditional, garden-like, functional and wasteland-like (Table 3). This typology was used to choose different types of green roofs for the semi-directed interviews to encompass the range of possible green roof designs and the *in-situ* photographs taken during this first phase benefited the elaboration of the qualitative inquiry. Afterwards, from the selection of the 30 EGRs visited for the expert analysis, 5 EGRs were chosen and were presented in a sequence of pictures to recall as much as possible the *in-situ* experience during the interviews [1].

Table 2 In-situ expert analysis grid for EGRs

Analysis grid - Green roof: Location: Reviewer: Date:		Image	Image
ENVIRONMENT DESCRIPTION	**VISUAL ANALYSIS**	**CONTEXTUAL AND EXPERIENTIAL CONTEXT**	**VEGETATION CHARACTERIZATION**
Place: Level: Roof environmental context: 1st level: 2nd level: 3rd level:	Observation context: Observer's viewpoint: Observation distance: Potential viewers: Frequency:	Roof discovery: Surprise effect:	Coverage density: Irrigation system: Growth conditions: Health status: Plant species:
Important landscape elements: Typology: Density, Height:	Composition/Form:	Roof/contextual elements articulation: Spatiality:	
Roof use(s): Visual access: Visual field: Physical access:	Color: Texture: Volume: Vegetation height: Inert materials: Other elements:	General impressions of the reviewer(s)/notes:	

Then, a survey of 30 semi-structured interviews[2] with participants from the greater Montreal region were performed. The 30 participants (16 women and 14 men between the ages of 20 and 60 years old) had a college or university degree and most of them (22 participants) were familiar with green roofs. These research methods were selected to get a better understanding in order to build a finer comprehension of what could influence the experience of EGRs. In that respect, the expert analysis was also aimed at complementing the semi-structured interviews since, for pragmatic and logistic reasons (costs, time, travel), the second phase of semi-structured interviews could not be conducted *in-situ*. The ultimate goal was to help the widespread implementation of EGRs in urban environments by improving their aesthetic experience and hence, social acceptance. Therefore, it was important to capture this aesthetic experience through all the elements that could contribute to their appreciation: representations and meanings of EGRs as well as perceived naturalness (greening as a way to obtain a sense of naturalness), physical and visual access (viewpoints on and/or from an

[1] The selection of the 5 EGRs was made to show design diversity through variable heights, diverse types of vegetation (ornamental, spontaneous, edible, etc.), levels of vegetation coverage, topography, design or intention of design visibility, access and maintenance. Between 10 and 16 photos of each of the 5 EGRs were presented to the participants as well as 2 summary slides for each EGR in order to have an overview of all the pictures for a particular EGR. Moreover, the participants were allowed to ask the interviewer to go back to a picture at any time during the interview.

[2] The researchers made sure that the qualitative research standards were respected (attention to the interview guide, diligence to the interview logbook, completed recordings and transcripts as well as impartiality throughout the process) (Bryman, 2012; Miles & Huberman, 1994). The transcripts were broken down into meaningful units and then encoded through a thematic analysis procedure (Bryman, 2012; Miles & Huberman, 1994; Schroeder, 2007) with the QDA Minor v.3.2 software (Provalis Research, 2004-2009).

EGR), *in-situ* experiences, composition elements and landscape, vegetative cover, appearance and maintenance as well as the effect of seasons and finally, attitudes toward naturalness and environmental attitudes (Dagenais et al., 2010). In all, it was a holistic approach seeking to specify the meaning of EGRs for people through their expectations and aspirations within that aesthetic experience.

Table 3 EGR typologies

Design type	Green roof selected	Dominant features	
Contemporary	Pavillon Lassonde / Polytechnique de Montréal	Roof with relief and medium-height vegetation that resembles long grass (grasses and clover) - not accessible, little maintenance done	
Traditional	St. Mary's Hospital	Flat roof with short vegetation, patterns and sparse plant cover - not accessible, well maintained	
Garden-like	Casse-tête / Rayside Architecture	Flat roof with taller and more diverse vegetation (ornamental and vegetable plants) - garden-like, accessible, well-maintained	
Functional	Public work building / Pointe-Claire	Flat roof with short vegetation (*Sedum* and *Phedimus*) without perceptible design or patterns, with dense plant cover - not accessible, well maintained	
Wasteland-like	Pavillon Faculté de l'aménagement / Université de Montréal	Flat roof with taller and more diversified and denser vegetation without perceptible design or patterns - accessible, not as well maintained	

The interviews were conducted with a guide submitted to two rounds of pre-tests and adjustments and, then, divided into two sections: without pictures and with pictures. The interviews always began without pictures to allow the participants' preconceptions of EGRs to transpire. When this subsection was completed, the subsections with photos permitted interviewers to stimulate the discussion with the participants as well as to allow them to further specify their thoughts in correlation with material realities (Vouligny et al., 2009; Sharp et al., 2012). The topics covered in each section were a consequence of the literature review and are presented in an abridged form in Table 4.

Table 4 Qualitative semi-structured interview guide

Section of interview Chronological order	Main questions	Specific questions about EGR's appreciation
Green roof section / without photos	For you, what is a green roof?	Spontaneously, for you, what does an EGR refer to? / How does an EGR environment look like? / Which elements of an EGR do you like? Dislike?
	Which experiences have you had of green roofs?	In which context? / What do you like to see, touch, hear and/or smell in an EGR?
	Ideally, how should a green roof be?	If there was an ideal nature, how would you describe it and how would you dream it would be like? / Which elements would it have?
Green roof section / with photos	What do you think of this roof?	Did you think it was a green roof? / How does it resemble/differ from your idea of what a green roof should be?
	What did you like/dislike of this roof?	What do you think of the vegetation? / What about the other elements of the roof?
	According to you, is this green roof natural?	Can we say that this is an EGR? Why?

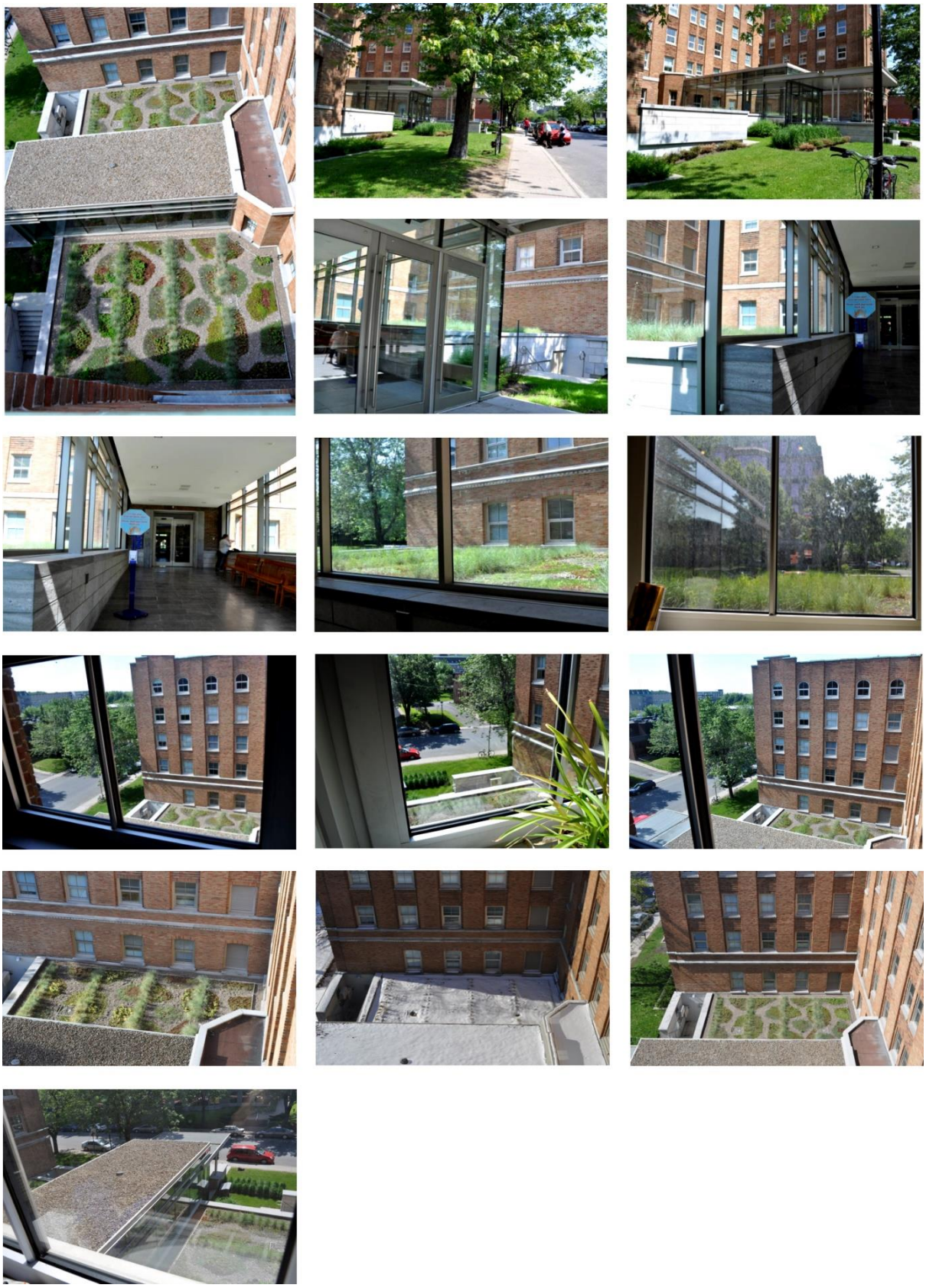

Figure 2 Example of St-Mary's Hospital (Montreal) green roof shown through a series of pictures (from left to right) during the interviews (views on the ground floor perceptible by furtive views at the entrance and views from the windows of the hospital on an upper floor as well as a general view, but otherwise inaccessible since taken from the rooftop of the hospital, shown in the first picture.

3 Results

3.1 Visual and experiential in-situ expert analysis

The visual and experiential expert analysis showed that EGRs could be experienced from indoors and/or outdoors and offered different viewpoints on the surroundings and cityscape. In all, three types of visual access were noted: the furtive view, the fragmented view and the full view. In fact, the experience of the EGRs were conditioned by their viewpoints, especially when a physical and/or a visual access was offered, making the benefits they provide tangible and greater than their already granted ecological advantages. Hence, these viewpoints influenced the way the design of EGRs were experienced for the experts. Moreover, the location of EGRs varied from ground level to upper floors; it was not exclusive to top floors; they can also be implanted on facades, interior courtyards or on top floor roofs. The EGRs on ground levels were somewhat difficult to identify because they usually cover basement space and are therefore, often mistaken with traditional landscapes. The visual access to the different EGRs varied with the viewpoints offered by the building (i.e. frontal or lateral views and eye-bird or low angle views). In some cases, the visual experience of the EGR could be described as a “sneak peak”. Indeed, the view on the EGR was then barely noticeable from areas of activities such as corridors where windows could remain unnoticed in daily occupations. Under these circumstances, one must be aware of the existence of an EGR to get that “sneak peak”. Most often, the visual access to an EGR from inside and outside of a building was fragmented since it was quite uncommon to get an overall view of this type of installation. However, a physical access to an EGR could provide that full view. Moreover, when the observer was on the same level as the EGR, it was the vegetation composition and its different heights that attracted the eye. The EGRs could also be viewed from a low angle, indoors and/or outdoors of the building, often from a fragmented or furtive viewpoint. In many cases, it was still the vegetation’s presence that drew attention to the EGR because it exceeded the roofing.

Figure 3 Mosaic of the 30 EGRs studied

3.1.1 In-situ expert experiential characterization

Although EGRs do not usually allow regular visits, a limited access to people is permitted for maintenance purposes. The degree of physical accessibility of an EGR varies according to the structural capacity of a building and by the integration of secured areas. Among the visited roofs, some did offer a physical access for a terrace-entertainment space, horticultural experimentations or of course, maintenance purposes. The visits on the EGR would then fluctuate from very infrequent, occasional to relatively common.

When access was granted, the experience of EGRs located on the top floors of a building was much like climbing a mountain. In most cases, the efforts made to get to the roof by going through different constructed elements and architectural equipment (emergency stairways, engine rooms, etc.) contrasted with the urban fray feeling when reaching the roof, such as the acquired sensation when reaching a mountain's peak where views on the nearby landscapes are exceptional, especially after a hike in the forest. For instance, the experience of discovering tree canopies was quite fascinating, like finding an urban forest. Furthermore, when the view on the city was particularly open, many landscape structures and geographic elements were unveiled with sharpness. In the cases of EGRs on lower levels, the considerations were awarded to the type of visual access, the attention granted to those viewpoints and the visual trajectory to the EGRs. Hence, the experience of these EGRs were often accidental and the use of vegetation and/or constructed elements are opportunities to catch the eye when the roof is not easily seen. In fact, the *in-situ* analysis has especially revealed the importance of the surroundings of the roof in its appreciation and has also shown how design can induce or compel its experience.

3.2 The relation to context

The potential viewpoints on green roofs and/or the experience they provide to people seemed to be considered by very few designers, if only to catch the eye of someone walking by a window with a view on a green roof or to maximize the viewpoints on the city when the rooftop is physically accessible. The link between design and landscape elements of the immediate environment were not really embedded in the design of most green roofs.

3.3 Qualitative interview analysis

3.3.1 Representations and meanings of EGRs

Generally, EGRs are associated with a place when described as a rooftop terrace, a garden, a lounging space or a compensatory additional space (i.e. the missing backyard). Among the participants, the idea of a rooftop garden is the least recurrent, even though some participants considered urban agriculture for EGRs. In a more functional perspective, EGRs were described as green grass carpets, like a lawn on the roof. Some participants described EGRs as the Gardens of Babylon while others would use more anthropomorphic interpretation and referred to it as the hair of a house. When asked about the ideal EGR, low maintenance was an important element for participants limiting the desire for a vegetable garden that would require more attention from them.

In this perspective, the idea of maintaining an EGR implies a physical access to it. More so, an EGR evokes the idea of a meeting space often linked, but not exclusively, to activities such as gardening or urban agriculture. In other words, an EGR could be a **privileged space** to see without being seen, a **contemplative or a voyeurism space** better than a garden because of its view, a **resting and/or relaxing space** with furniture (i.e. hammock, BBQ, etc.) and a **dining space**.

An EGR was also considered by participants as a green space to see and contemplate, some of them even talked about a large-scale bird-eyed view of EGRs. In fact, the idea of the pictorial aspect and beauty that would be provoked by the green covering of industrial roofs, even during winter, was important when referring to the views offered from the sky (i.e. airplane) or from an especially high building. The EGR could then contribute to the lack of greenery in an urban context. Furthermore, an EGR was also linked to the biodiversity and energy efficiency of a building. However, some

participants showed some concern for the degree of feasibility and costs associated with that kind of installations in residential contexts.

An ideal EGR should also offer a variety of vegetation and colors as well as the possibility of making an edible plant garden. The idea of considering winter in choosing plants was also mentioned by some participants. For most, an ideal EGR should be accessible and should be designed to maximize its solely ecological functionality. In other words, «if we're going to do it, might as well do it right the first time» and conciliate the extra costs of an EGR when compared to a traditional roof by improving the quality of the space and of the living environment while favoring multiple uses and human activities. In fact, some participants were surprised by the design possibilities of an EGR and mentioned that in the end, an EGR is more than a green infrastructure and therefore, more than ecological.

3.3.2 Composition elements and design appreciation

First, the variety and richness of the collected comments allowed us to look beyond strict elements of design preferences. However, some design elements for EGRs were recurrent in the participants' comments. For example, the desire for low maintenance, maximum vegetation covering on the roof's surface and dominance of green vegetation favored a positive appreciation. While, in some cases, participants got the impression that some of the EGRs were low maintenance, for others it was the opposite. In such situations, it is interesting to highlight the link between the idea of low maintenance and the perception of beauty. On the one hand, one of the participants when talking about fallow or experimental EGRs said: «It's beautiful, it's really beautiful, I find it wild and easy to maintain». On the other hand, other participants insisted more on the carelessness or «in-progress» nature of that type of EGR to express their lack of appreciation of it. In fact, the use of «as long as» notion shows that the maintenance factor is important: «As long as we're doing a garden, might as well maintain it a bit». Furthermore, for a particular EGR (Figure 4), some participants noticed that the vegetation grew randomly and gave the impression of «spilling over» the plantation boxes and of being stuck within them. While others particularly appreciated the «overflowing effect» of the boxes because of its bushiness and the «harmonious chaos» feeling it transpired.

Figure 4 Faculté de l'aménagement de l'Université de Montréal EGR

To conclude the interviews, the participants were invited to comment on a selection of international EGRs and the experimental nature of another roof (Figure 5) was also mentioned because it seemed more surprising than appealing for some participants: «It's more than an experiment», «it's an exercise».

Figure 5 Multnomah County Building EGR

The ambivalence between ecological and aesthetic functions is shown through the appreciation (or not) of «sloppiness» expressed towards that type of EGR:

> *«They minimized the impact of the building on the urban fabric, that much is clear. It looks like a careless fallow without maintenance. So, all in all, I don't know what's better? »*

In another case, some participants were confused by the fact that only a part of the roof was covered by greenery and the rest filled with small white stones (Figure 6). In doing so, the environmental contribution of the EGR was questioned by participants who got the impression that the situation was not optimal because of a lack of design efforts and these aesthetic reasons won over ecological ones:

> *«They didn't make any efforts. They only put grass to get a green building accreditation.»*

Furthermore, a homogenous plantation seems to be important for a functional type of EGRs, and even more so if the maintenance of the roof is inadequate or if the vegetation covering is deficient, dry and poorly irrigated. Flowers and color variety are appreciated as well as higher vegetation. Specifically, clover is sometimes considered unattractive and sometimes attractive for its local nature, its resistance and appeal for bees. In short, the functional type of EGR can be compared to a lawn, a field and even tundra when referring to the use of succulents, *Sedums* and *Phedimus,* for their aridity and textural qualities as well as its link to the boreal forest. The idea of spontaneous vegetation is also mentioned, but more in regards to moss that would accidently grow on the roof. Finally, the adequacy between aesthetic, function and ecology seems to be important. Thus, the appreciation for vegetation seems to be articulated around a desire for a controlled carelessness which could be understood as an ambivalent appreciation for urban nature situated between the wild and the organized (Loder, 2011). In fact, the rather positive appreciation of a specific roof demonstrated it quite well, in particular with the limiting quality of the boxes that restrains or supports the vegetation's spontaneity (Figure 7).

> *«[...] it doesn't evoke the same thing, even though it is more of a wasteland, it is more dense and very lush but there is something more appealing about it, I would say it seems organized in some way. Let's just say that it feels less abandoned and I think there are defined areas.»*

Figure 6 École Polytechnique de Montréal EGR

Figure 7 Faculté de l'aménagement de l'Université de Montréal EGR

Two notions, “better than” and “as long as”, emerged in an important way during the analysis of the semi-directed interviews. Therefore, the idea that a roof with vegetation covering is better than a traditional roof can be summarized by the expression: «it’s better than». For instance, a participant said: «Well, it’s greenery. It’s always better than a roof». In that perspective, it seems that the maximum vegetation covering of the roof and the less paved space the better.

In another sense, the lawn or parterre type of EGR with access derogates from the a priori we usually have of an EGR because of its accessibility, its promenade or its situation at different heights. Hence, some participants were surprised by some of the EGRs, for instance one roof that was almost on ground level (Figure 8):

Figure 8 St-Mary’s Hospital EGR

> *«For me, this is landscaping which happens to be on a rooftop.»*
>
> *«I only saw that from above. I didn’t think it could be on a first, second or third floor.»*

However, this leaves the impression of never being on a roof. Some of these types of roofs are covering underground parking and they are considered an improvement to landscape. In some cases, it seemed to be a necessary layout, «a must». In other words, *as long as* a new construction is being erected it might be important to incorporate a green infrastructure. Furthermore, the access to an EGR would constitute a property investment because it allows the maximization of living spaces. In the cases of inaccessible EGRs, the lack of physical access is deplored by most participants because the space and the cityscape are unavailable to residents.

In summary, the study revealed several aspects closely linked to the notion of physical and visual accessibility of EGRs: **access** (difficulties and control of that access), **security** (risks of people, furniture or objects falling from the roof and/or the obstruction of the view from safety facilities), **beneficial work conditions**, **views** (on and from the roof, contemplative views, far away and vastness views, open sky view, seeing without being seen, cityscape), **nature accessibility** (urban nature access), **activities** (sitting, eating, resting, relaxing, resourcing), **investment and justification of extra expenses**, **design opportunities** (terrace, backyard, green space, greenery, compensatory space). **In that perspective, an EGR particularly refers to a place to be and/or a at least a space to see and contemplate.** (Figure 9)

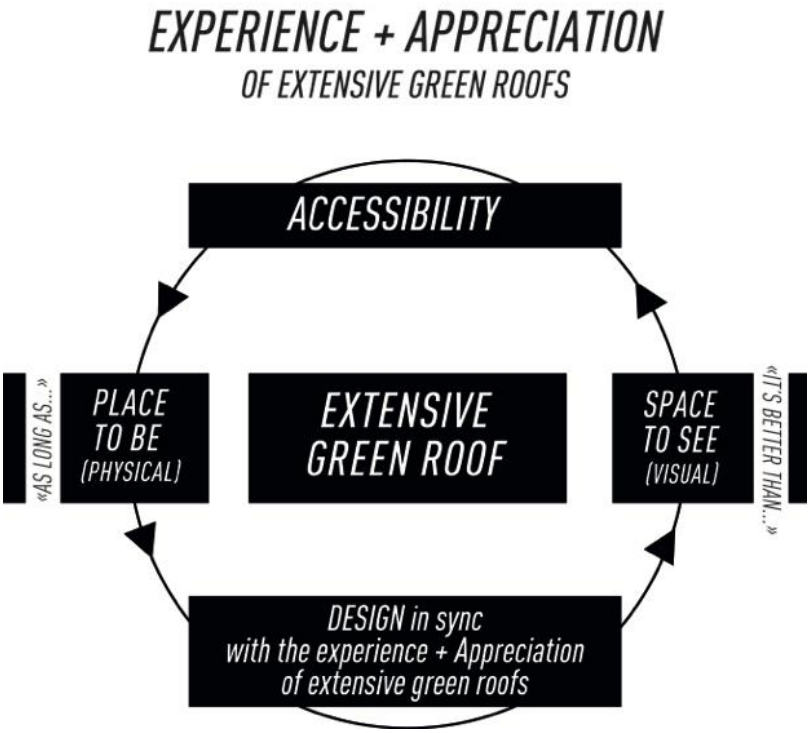

Figure 9 Interpretation of the aesthetic experience of EGRs

4 Discussion

4.1 A place to be or at least, a green space to see

In this study, the interpretation of the appreciation of EGRs has shown the relative importance of the ecological value when compared to the use that can be enabled by it. In fact, the multipurpose value of the EGR was the most recurrent data issued from the interviews. In this perspective, an EGR is then perceived as, not only ecologically beneficial but also as a space to contemplate. In addition, a strong desire to be there, to visit and experience the EGR has emerged from the inquiry. Mell (2013) and Madureira & Anderson (2013) pointed out the importance of the multipurpose quality of green infrastructures because it is then founded on the spatial integration of environmental, social and economic dimensions. Mell (2013) further added that:

> *«[g]reen infrastructures are the resilient landscapes that support ecological, economic, and human interests by maintaining the integrity of, and promoting landscape connectivity, whilst enhancing the quality of life, place and the environment across different landscape boundaries. » (Mell, 2013; p.153)*

Furthermore, the ‘‘as long as’’ notion often mentioned in the interviews tends to infer that an EGR is not strictly perceived as functional on an ecological level, but implies more opportunity of uses. In other words, an EGR should, firstly, meet its ecological performance, but it is not sufficient. In this end, an EGR should be a greener version of a traditional roof with considering enhancement of its aesthetic experience with a design proposition that gives visual access on it and ideally a physical one too. Even though an EGR is always perceived as ‘‘better than’’ a traditional roof, it seemed important to grant an access to it in its design in order to enjoy its benefits and to justify its costs. In fact, the participants in Loder (2014)’s survey also insisted on the importance of making green roofs accessible.

In other words, for our participants and our expert analysis, EGRs should be a place to be or at least as a space to contemplate because of their affordances or the possibilities of new experiences that they would offer if they were accessible. In this sense, perceptions of EGRs could relate to the notion of place when associated with uses : « places generally refer to a specific location, often a person’s

dwelling place, with an emphasis upon its uniqueness and associated meanings » (Devine-Wright & Howes, 2010 ; 268). Or more specifically as a kind of affordance that contribute to their meaning.

> *« Affordances theory acknowledges the role and contribution of a place in this people-place transaction […] Furthermore, affordances exist in multiple dimensions including physical and social dimensions provided by people present in the place. Affordances are "simultaneously determined by attributes of the environmental feature in question and attributes of a particular individual" and functional possibilities of a place can only be defined by the individual who would engage in the functionalities Thus affordances should be understood as relationally specified functionalities » (Lim & Barton, 2010 ; p.330).*

The concept of affordance allows better comprehension of the appreciation of green roofs as expressed by our participants and the importance of allowing green roofs to be accessible was also noted in other studies (Loder, 2014). Furthermore, diverse activities on EGRs could be enhanced when associated with a working environment, a space for resting, resourcing, eating, meeting and gardening. In the case of the garden terrace type of EGR, the impression is like being in a backyard, a garden or a terrace. Thus, these accessible spaces bring benefits not only for working conditions, but also add value for residential buildings by allowing activities and fostering neighborly relations. Garden terrace type green roofs like the one included in our study can also increase the ecological benefit of the green roof in terms of reducing heat island effects, reducing air conditioning needs and improving biodiversity. In fact, contrary to strictly functional roofs, they include a more diverse plant palette, attracts pollinators through flowering species, foster inverterbrate life and cools the substrate through irrigation (Coutts et al., 2013; MacIvor & Ksiazek, 2015; Ouldboukhitine et al., 2014).

As an affordance, the meaning of the view offered from EGRs for people is a highly valued contemplative activity because it offers a different experience of the city from a higher perspective compared to the usual ground level experience. Landscape studies have shown, as well, that the possibility of distant views also contribute to the aesthetic experience of landscape (Dagenais et al., 2010). For instance, the experience of EGRs on higher levels allows the discovery of the cityscape where the ability to see far ahead is granted and creates a vastness that contrasts with the framing effect of the dense built environment on ground level. This experience also offers to see the sky and therefore, the EGR becomes an isolated space above city activities, a contemplative enclave perceived as very beneficial for tranquility and quietness. Furthermore, the fact that people can see without being seen puts them in a privileged position of standing above the scrum, a valued landscape attribute (Appelton, 1996). In a similar manner, visual access to an EGR was widely appreciated. In fact, the presence of visual access to an EGR could make the nearby environment more enjoyable, inspiring and beneficial for work and residential spaces (Lee et al., 2015). Thus, the consideration of the vegetation heights should be an important design criterion to draw attention to the roof from a nearby window.

Nonetheless, an EGR is rarely physically accessible and building codes and standards increasingly limit the access to maintenance even though the participants expected a physical access or at least a visual access to this type of infrastructure. Otherwise, the greening of the roof is perceived as less useful and could easily be replaced by a white membrane roof and be as acceptable from an ecological perspective. The implantation of EGRs on existing buildings by designers should therefore lean to visually signal the presence of the infrastructure to its residents and neighbors. In short, a particular attention should be addressed to the visual and physical accessibility in the design of EGRs.

4.2 The design of green roofs

Generally, the design of green roofs seemed to lean on traditional landscape design strategies declined in variations of parterres, gardens and low groundcovers. The design of very few green roofs have shown the intrinsic qualities of their space, particularly when considering the experience that the roof offers. This kind of experience implies the consideration of possibilities and constraints that come from a view *on* or *from* a roof that is relatively different from other categories of

traditional landscape as well as the physical and visual access to the roof and the path to reach it. This type of space also implies that technical roof elements (ventilation system, chimney, etc.) should be taken into consideration and should be integrated in the design of the roof.

To sum up, the visual aspects of some elements should still be considered in the design of green roofs and be more or less refined from traditional landscaping. For example, the uses and experiences of a green roof (access, activities, etc.) as well as viewpoint contexts (viewpoints of the observer, viewing distance, viewing potential) and visits should be considered in this type of design projects. On an experiential point of view, it is a question of designing a discovery path to the roof, of articulating the design of the roof and particularly, by linking the vegetation to the context elements (constructed elements of the roof, building or landscape as well as to all types of possible experiences). Furthermore, we noted that, in most cases, the design of green roofs were produced on a view plan that limited the experience of the roof to a lawn or a parterre that could mainly be contemplated from a distance if visually accessible. In other words, this kind of design project would benefit from a place-based knowledge in order to create a space worth visiting or at least contemplating. In this perspective, Hausmann et al. (2016 ; p.1) have recently argued that the sense of place is an ecosystem's service that offers potential "benefits for human well-being and biodiversity conservation". Another example could be by intervening beyond the surface of the roof, when delimited by blind walls, by integrating some eye-catching elements like a borrowed landscape or maximizing its appeal at night with lights and in between seasons when vegetation is not at its best. One could also choose not to distract the viewer from an amazing viewpoint of the city by supporting it with the roof's design. A dialogue between urban landscape components could also be considered in green roofs conception. Moreover, the path to access the roof could also be designed to lead the eye on the roof and guide the users in their discoveries. Finally, the distinction between a physically accessible green roof and an inaccessible one should be determined in order to attract more attention on roof viewpoints in the latter.

In this perspective, the paper proposes a design intervention on roofs that could go beyond its strict greening. The design of EGRs should encourage its aesthetic experience and affordances with physical accessibility when possible or at least draw attention to its observation and contemplation by favoring a place-based knowledge to enhance the particular urban experience contexts of these types of green spaces. Otherwise, the needed costs and efforts to implement an EGR could be considered less relevant despite its environmental benefits. The study showed that views from a roof offer a singular experience of the city that is quite different from the everyday experience available at ground level. The rooftop view allows the discovery of the cityscape, the open sky and of landscape viewpoints. The vastness feeling offered by the roof's views contrasts with the ''box effect'' of the built environment on the ground. The roof then becomes a place which is withdrawn from human activities, a space reserved to the beneficial effects of contemplation offering tranquility and calmness. Furthermore, the observer standing on a roof is in a privileged space because he can see without being seen, like being above the fray. However, only a few designers seized the opportunity offered by the rooftop if only to draw attention to the EGR from a window or in taking full advantage of the cityscape when the roof is physically accessible.

4.3 Beyond ecological concerns: Creating small multifunctional green spaces on urban and domestic levels

Finally, the EGR must, first of all, carry out its environmental functions to be appreciated. As an affordance, the participants expected to have, at the very least, a visual access to an EGR and ideally, physical access as well. In the case of a viewable EGR, participants mentioned that it should be pleasant to look at. In the case of a physically accessible EGR, the roof then could be the missing backyard or a socialization space for the neighborhood. The perception of EGRs is thus associated to urban spaces offering many advantages and activities going well beyond the expected environmental benefits.

4.4 Limits of the study

The analysis of each part of this study (i.e. expert analysis and qualitative semi-structured interviews) showed that they were complementary rather than equivalent. Furthermore, the analysis showed that the *in-situ* experience of a green roof is rather different from the one transmitted by photographs (Scott & Canter, 1997). In that respect, the qualitative study strategy adopted by the researchers was not entirely satisfying even though the researchers attempted to accurately represent the *in-situ* experience conditions with photo sequences during the interviews. Nevertheless, the methodological strategy of combining two different kinds of methods in data collection was relevant in order to apprehend complex and profound experiences, for one complements the other.

5 Conclusion

In a way, understanding the experience of a green infrastructure from the point of view of ordinary people was the objective of this research. Moreover, it was conducted to identify how designers could improve their practices by introducing the meanings of a new space that was not traditionally «designed» as it was for the traditional roof. As Manzini points out, transition designers should be more aware of how people will manage the change for a more sustainable way of living and that should inform their actions to facilitate it (Manzini, 2015). Furthermore, the research demonstrates that the solely environmental benefits of an infrastructure is not enough to manage change in behaviour or desirability. Thus, the infrastrucure should improve the overall human experience to allow justification for its care as well as to the time and money invested in it. As demonstrated by our other research on infrastructures, people tend to appreciate projects that take into account their experience of surroundings in order to transform them into more significant ones (Gagnon, 2006; 2012; Gagnon & Côté, 2016; Dagenais et al., 2012). In this perspective, designers should play a stronger role in transforming green infrastructures to create real places that match people's way of living and the meanings they give to these new spaces (for example, as an effort to affordances) and in doing so, enhance human experiences. In our point of view, transition design should greatly benefit from this kind of qualitative research which address the aesthetic of everyday life, in this case, towards green infrastructures or, more largely, towards design for sustainability.

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Design Expertise in Public and Social Innovation

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Over the past decade a new type of design practice has emerged that is aimed at addressing complex societal problems through public and social sector innovation. As opposed to traditional product design teams, design processes in this sector tend to be distributed among numerous actors. In these 'designing networks' it is less clear which type and level of design expertise is required and who should have it. In this paper, we investigate design expertise in public and social innovation through a study of the practices of five innovation agencies. We particularly looked at the expertise of framing. The study provides preliminary answers to how much and what kind of design expertise we need, who should have it, and how we can teach and learn this expertise. The results indicate that designing for complex societal problems requires high level design expertise with regard to framing and managing a design process. This requires capability building beyond the methodical approaches that are currently being offered to public and social sector staff members.

social innovation; design expertise; framing; capability building

1 Introduction

Over the past decade, design has emerged as a useful approach in dealing with the complex societal issues that the world is facing. Dorst (2015) advocates that the new open, complex, dynamic and networked problems of our time require a radically different response, and that expert designers have developed unique approaches to address these new types of problems. Bason (2010) argues that these design approaches and tools can help government to consciously create meaning and value they want citizens, businesses and other actors in society to experience. At the same time many argue that societal problems require interventions beyond what the public and social sector can offer, such as initiatives designed by grassroots organisations (Manzini, 2015).

These theoretical arguments for public and social innovation through design are also reflected in practice. A new practice is emerging in which design approaches are used to design and implement public and social services, products, policies and procedures across domains such as housing, employment, health, crime prevention, and education. At the core of this practice are the new practitioners: pioneers who are experimenting with methods and practices of public and social

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sector innovation and who are often working from innovation agencies or 'labs' inside or alongside public and social sector organisations. Irrespective of their position in relation to public, or social sector organisations, these labs share the aim of generating value for society.

There is an interesting difference between the way that people collaborate in traditional design teams and the way that they collaborate in these new social innovation contexts. In traditional design teams in the product manufacturing industry, there are clear boundaries between the team and the external world. The external voices of the consumer, user, and client are included in the design process through distinct roles in the design team such as the marketing manager, user experience expert, and project leader (see for example van der Bijl-Brouwer & van der Voort, 2014). These external stakeholders might also be invited to be actively involved in participatory design processes. However, the design decisions are made within the confines of the design team's office and it is clear from the start of the project that the client or owner of the design team will implement the solution. In comparison, in public and social sector innovation labs these boundaries between the design team and the external world are much less clear. External stakeholders are often not just participants in a co-design process but are an active part of the design team. Moreover, it is often not clear at the beginning of the design project who will be implementing the result of the design process.

Manzini (2015, p38) refers to these connected types of design teams as 'designing networks': "in a connected world, design processes tend to be increasingly distributed among numerous actors who differ in culture, motivation and professional development". While the design research field has developed a basic understanding of the type of expertise that is required for traditional product design teams over the past decades (Cross, 2004; Lawson & Dorst, 2009; Valkenburg & Dorst, 1998), it is less clear what type and what level of design expertise is required in designing networks that are aimed at addressing complex societal problems. This includes which stakeholders need to have design expertise, how much design expertise they should have, and how this expertise should be taught and learned. In this paper, we investigate this topic through a study that was aimed at understanding the design practices of five public and social sector innovation labs around the world. We will explore what role design expertise and capability building plays in these design networks that are aimed at creating social and public value.

1.1 Design practices and expertise

As the practice of design in the context of public and social sector innovation matures, the research into this area is only just beginning to emerge. A series of case studies by the UK Design Council (2013), on design for public sector innovation of the Sharing Experiences Europe (SEE) network, showed that design contributes to public sector innovation in many different ways. This includes looking at the entire system to redefine the problem from the ground up; understanding user needs; testing iteratively to prevent expensive and risky pilots; integrating the process of problem analysis, solution development and implementation; and engaging teams and departments in collaboration across silos. Yee and White (2015) studied the conditions for design to achieve the desired impact in the context of public and third sector projects, through an analysis of case studies of service innovation projects. They found that community building was the most important condition for design to have the greatest impact in innovation and transformation projects, followed by leadership and building the capacity and skills across the organisation. In this paper we further investigate the theme of capacity building to develop design expertise in the public and social sector.

At the most basic level, design can be described by using Simon's definition of 'changing existing situations into preferred ones' (Simon, 1996). But what are the skills that we need to achieve that? Yee and White mention design skills specifically in public and social sector organisations and focus on the concepts of 'mind set' as well as 'practical skills' to apply tools including user-research and generative design methods. The focus on 'mind set' and 'application of tools' seems to be a common understanding of design in the public and social sector innovation context (also described by Nelson and Stolterman 2012). Although these are important elements required to design, we believe that

the notion of 'design expertise' is missing from the context of public and social sector innovation. Nelson and Stolterman (2012, p225) describe design expertise as the "unfolding process of moving from novice to expert" which is consistent with the understanding in design research and pedagogy. Many scholars have studied the expertise of designers such as architects and product designers to understand how this can be taught.

Lawson and Dorst (2009) conclude that expert designers undertake five main activities: managing, formulating, moving, evaluating, and representing. The activity of 'formulating', the ability to reformulate and organise ill-structured or wicked problems, is of particular interest as it is one of the most important and unique skills of designers. The specific approach of designers to reformulate problems is called 'framing'.

1.1.1 Framing

Dorst (2011) argues that the creation of new frames is at the core of how designers think. The notion of framing stems from the work of Schön (1983). He stated: "in real world practice, problems do not present themselves to the practitioner as givens. In order to convert a problematic situation to a problem, a practitioner needs to do a certain kind of work. [..] Problem setting is a process in which interactively we name the things to which we will attend and frame the context in which we will attend to them" (p40). A particularly interesting aspect of framing by expert designers is the way that frames are used as a strategy to 'problem-solve'. This has been shown most clearly by Dorst and Cross (2001) through an in-depth study of the practices of expert designers which validates a model of 'co-evolution'. This model shows that framing is about the co-evolution of a problem alongside a solution. "It seems that creative design is not a matter of first fixing the problem, and then searching for a satisfactory solution concept. Creative design seems more to be a matter of developing and refining together both the formulation of a problem and ideas for a solution, with constant iteration of analysis, synthesis and evaluation processes between the two notional design 'spaces'–problem space and solution space" (p434).

1.1.2 Levels of expertise

When talking about 'design expertise' for this study, it is relevant to consider the level of expertise that is required in public and social sector innovation. In his book 'Design, when everybody designs' Manzini (2015) describes two ends of a scale of design expertise in the context of social innovation, diffuse and expert design. Diffuse design is the type of design knowledge that he argues is the natural designing capacity of every human being, while design experts are people trained to operate professionally as designers. Lawson and Dorst (2009) argue that design expertise is not acquired in some continuous and seamless manner but that there appear to be more or less distinct layers of expertise, which each enable quite different modes of thinking and action. The layers are based on a generic model of expertise developed by Dreyfus, and include a novice (rule-based thinking), advanced beginner (situation-based thinking), competent (strategy-based thinking), expert (intuitive thinking), master (context-based thinking) and visionary level (domain-based thinking). Lawson and Dorst include a 'beginner 'level because they acknowledge, like Manzini, that most people are already 'novice' by applying design as an 'everyday act'. What is most relevant for this study is to describe the difference between the novice level and the expert level. Novice designers use largely rule-based and convention-based thinking. They consider the objective features of a situation, as provided by the experts, and follow strict rules to deal with the problem. Rule-based thinking allows us to tackle complicated problems with approaches that are often a combination of logic and the experience of many designers before us (Lawson & Dorst, 2009, p68). This is very different from the 'expert' level, where the expert responds to a situation intuitively, applying design judgement and intention that allows outcomes to emerge (Nelson and Stolterman 2012).

1.1.3 Capability building

It is widely acknowledged that building the design capability of staff within the public and social sector can lead to more 'transformative change' that allows the sector to respond to challenges in

new ways (van der Bijl-Brouwer, Kaldor, Watson & Hillen, 2015; Mulgan, 2014; Yee & White, 2015). In the remainder of this paper we will further investigate design expertise and capability building in the social and public sector, through a study into the practice of public and social sector innovation labs.

2 A study of public and social sector innovation practices

The objective of our study was to investigate the practices of public and social sector innovation agencies that were addressing complex societal problems. We were particularly interested in the 'designerly elements' of the practice with regard to framing, human-centred design (HCD), and collaboration. In this paper we will focus on the framing practices. The theme of 'capability building' emerged during the study and was further explored in data analysis.

2.1 Research method

The study was conducted using a retrospective case-study approach (Yin, 2009). We invited five international public and/or social sector innovation agencies to participate, and selected an appropriate case study within each of the agencies. The selection criteria included that the project should be aimed at addressing a complex societal issue, included collaboration with a public or social sector partner, and was executed by a team with at least five years of experience working in the public or social innovation sector. The research method included document analysis of the reports and design documentation, and interviews with the team members from the innovation lab, as well as their main partners in the public or social sector. We conducted 16 interviews in total. All interviews were transcribed, and relevant sections were coded and explored through an inductive thematic analysis. To investigate the framing practices within the case studies, we mapped out how 'solutions' and frames or problem definitions were developed over the course of each project.

Please note that the limitations of this case-study approach are that results cannot be generalised to the practices of the agencies as a whole. Furthermore, it does not reveal the level of detail in the framing process that would be available from a protocol analysis. A generally cited limitation of case study analysis is its small sample size with regard to generalisation to a larger population (Yin, 2009).

2.2 Five case studies

Each case study was focussed on addressing a complex societal problem and involved initial collaboration with a key funder or partner in the social or public sector. In all case studies this collaboration was then expanded to a much broader group of stakeholders. The five case studies are described in Table 1. The agencies each have a different position in relation to government. Figure 1 demonstrates the role each agency had in relation to government within a model developed by Bason and Schneider (2014).

Table 1: overview of the five case studies

Agency	Case Study domain	Country	Outcome
MindLab	Primary Education	Denmark	Several initiatives of which one, the 'Speed sharing event' was successfully implemented
KennisLand (KL)	Disadvantaged Youth	The Netherlands	Seven different prototypes of which some are being developed further
InWithForward (IWF)	Disability sector	Canada	Several initiatives of which 'Kudoz' and 'FifthSpace' were successfully implemented
The Australian Centre for Social Innovation (TACSI)	Disadvantaged Families	Australia	Three prototypes and a 'prospectus' which are currently being tested
CoLab	General Public Services	Canada	Input for the development of an 'Open Government' strategy

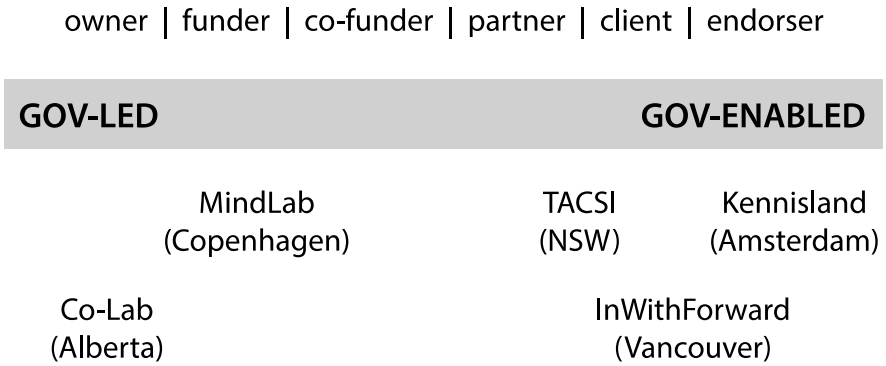

Figure 1 Position of each case study in relation to government

The 'design networks' in each of the case studies consisted of the agencies in addition to a broader group of stakeholders. The leading teams from the agencies each had between two and four members. In four of the five case studies at least one member from the funding or partnering organisation had an active role in the design process. Service providers and/or public servants or managers were actively involved in the design process in each of the case studies through participatory design or through being an active member of the design team, taking part in design and research activities, and decision-making. In all case studies except CoLab, end-users or citizens were actively involved through participatory design or being an active member of the design team.

3 Results: design expertise and framing

It is clear that framing was a key element of the design expertise throughout all five case studies. All groups spent considerable time framing the problem, although different principles and approaches were used to develop and evolve these frames.

3.1 Framing principles

Two principles in terms of how the problems were framed could be distinguished in all the case studies: 'opening up the brief' and 'systemic thinking'.

3.1.1 Opening up the brief

All case studies started with a briefing process, in which the agencies and their partnering or funding organisations negotiated the initial brief. In this process, all agencies 'opened up' the brief to allow for a broader framing and/or a more positive view on the problem.

> *[CEO, TACSI]: "So we started off with a brief. [..] And then from there, we really started, I guess, pounding the pavement and seeking to really test, unpack all of the assumptions that were sitting behind the framing questions. And I think what we learnt very, very, very quickly was some fundamental things that opened up the brief to a whole new level.[..]"*

> *[Team member, KL]: "it is also about deproblematising of what first is seen as a problem."*

This opening up of the brief was often done through broadening the framing from being just about the perspective of the client, to being about what is required for society.

> *[Team member, KL]: "We sometimes realise that a point of inquiry is set because we have a client [...] who defines the problem from the perspective of their organisation or system, what might not be the question that would be posed by society."*

3.1.2 Systemic thinking

Three of the five studies framed the problem explicitly on two different levels: a strategic systems level focused on the broader system in which the problem sits, and a service level that was aimed at addressing specific problems for the target group. For example, TACSI developed service prototypes to address problems for families in the short term, as well as a 'prospectus' of the big picture systems changes that were required to generate larger scale changes. KL developed specific interventions that were directly targeted at helping youth, as well as prototypes on how to develop policy. TACSI refers to this process as 'two-track thinking':

> *[CEO, TACSI]: "So I guess we've got these two tracks now. We've got these prototypes that our family members can go, "Oh look, we're doing these things" that are tangible and alongside that, we've got this prospectus that we've created that we're just working with another set of funders around now, to look at well how do we actually start to conceptualise what a different system or different parts of the system could look like."*

The strategic systems level is aimed at developing solutions that allow the system to adapt and evolve, beyond just the target group in the specific case study. This is in line with what Nelson and Stolterman (2012, p57) call the 'systemic nature' of design expertise, which focuses our full attention on the connections and relations between people, subjects, objects, and ideas – rather than just the things themselves. The other two remaining case studies also clearly included this focus on broader relationships in how they framed the problem.

3.2 Input for the development of frames

In the process of developing frames, the groups used different types of 'input'. All approaches were human-centred, but the way this was integrated in the design process differed significantly between the case studies.

3.2.1 Framing using qualitative human-centred research

All case studies adopted a human-centred approach, using different types of resources to understand the needs and aspirations of end-users and other stakeholders. Methods included for example the collection of stories from different stakeholders, deep or rapid ethnography, social theories, light institutional immersion and co-design.

The time spent on gathering insights into end-users' or stakeholders' needs, aspirations and perspectives differed significantly between the five case studies. In three cases there was a very rigorous 'research' stage, involving elaborate field research based on long ethnographic studies

and/or many stakeholder interviews, and a rigorous data-analysis stage to identify themes in the data.

> *[Team member, IWF]: "We don't do one-day interviews, we're really committed to immerse ourselves in the ethnographic work. We build these great relationships… we were committed to this."*

In the other two case studies, human-centred research was applied in a more pragmatic way where research into stakeholders needs, aspirations, and perspectives was conducted at those stages when it was considered most useful and relevant in the design process (this is referred to in the next section).

3.2.2 Working with assumptions

In three case studies the participants clearly showed how they started with assumptions for an initial framing of the problem, rather than doing research first to frame the problem. Research was then used to confirm or open up the frame. For example:

> *[Team member, TACSI]: "TACSI has a testing assumptions model - we start in the office and we frame our assumptions and we name our assumptions and then we go out of the office and we test our assumptions. So we tried to model that kind of on a weekly basis."*

In all the cases, the research is not just used to 'confirm' assumptions, but to open up the process and lead to new frames and ideas. This was most clearly explained by MindLab:

> *[Team member, MindLab]: "We engaged directly with the teachers so they could also come up with new ideas on how to come closer to this desired future state…we made these future scenarios with props like paper figures and [context pictures], because that kind of sets a tone, [makes it concrete] and it gives people a direction. But it still leaves, [..] an openness for them to come up with ideas that [we] hadn't come up with ourselves. So this is also a crucial part of what we do. Giving people direction, but at the same time, maintaining an openness to exploration."*

But if the framing is not 'driven' by human-centred research, then how did the teams generate their initial framing? Two of the case studies had explicit strategies to achieve this. To generate the initial framing, CoLab used specific systemic design methods and tools, including systems mapping, risk mapping, affinity mapping, brainstorming and role-playing the user's perspective etc. MindLab adopted a more solution-focused strategy, using provocative prototypes to provoke stakeholders thinking about what they might need. The prototypes were developed by the MindLab team using desired future-state thinking, and using metaphors to generate ideas.

> *[Team member, MindLab]: [we asked ourselves:] "what is the desired outcome?" and we thought about what other tools that are useable in this context, and then we had a brain storm about it from other businesses, what are some of the solutions that we maybe could take some inspiration from."*

3.3 Evolution of framing

All cases showed a divergence and evolution of the framing of the problem and the development of solutions. For example, the IWF case study started with a problem frame of 'how do we reduce social isolation amongst adults living with cognitive disabilities', to a focus on 'isolation from learning and purpose', to 'how can we help people with identifying interest for employment opportunities'. What is interesting is the way that the case studies differed with regard to the relationship between human-centred research and framing, the way that framing is 'planned for' and the co-evolution of problem and solution.

3.3.1 Linearity of human-centred research and framing

The case studies that used elaborate human-centred research approaches as input to their framing, differed with regard to the 'linearity' of that process. In one case study, there was a linear approach

in which the research preceded the framing and the generation of solutions. In other cases, the research was used to let the framing evolve. This can be illustrated through how IWF used social theories. Rather than first finding social theories and then using that to frame the problem, they included the theories in a more iterative way:

> *[Team member, IWF]: "So one thing that we did during the ethnographic research part is that we used quite a few different articles but without like specifically choosing for one or another. There was a stage where we just took what we thought resonated or was inspiring and then we tried it out in a design research tool and then we were trying like does this make sense, is it something that helps our understanding of this population group or not."*

> *[Team member, IWF]: "Later on when we started prototyping, it was like at least half year later, we came across other social theories that would then actually be really useful in shaping what it was that we were doing and one of those theories was social cognitive career theory."*

This is a more strategic application of HCD in which it is not just used to 'respond' to a problem that has come up in the research, but rather is used strategically in the evolution of the problem frame (van der Bijl-Brouwer & Dorst, 2017).

3.3.2 Co-evolution of problem and solution

As described in the introduction, design expertise is characterised by a co-evolution of problem and solution. This was very clear in the MindLab case in which the team used a solution-focused approach to explore the problem, although they explain that other approaches are also used in their agency:

> *[Team member, MindLab]: "we agreed [..] to go out and prototype things fast and learn about the present via provocations about the future. But we also have colleagues who are more keen on [..] making more thorough research, really trying to understand what is the issue at hand here before they go about doing more prototype'ish sort of things. So both approaches kind of live side by side here anyway."*

IWF also showed a very clear co-evolution of problem and solution, through continuous iterative prototyping loops which are not just about how to improve the solution, but also about how to frame the problem. In two of the case studies it is unclear how the problem and solution co-evolved because the agencies were either not involved or not yet in the prototyping stage.

One case study clearly showed no explicit co-evolution of problem and solution. In that case study the step from problem exploration to solution was made in one session, using a methodical approach including templates or 'canvasses' to move from themes to ideas, without an explicit way to refer back to the problem framing. This led to some expressions of discomfort from participants (referred to in the next section).

3.4 Planning and managing the design process

Another important theme that emerged was the extent to which the design process was planned.

> *[Team member, MindLab]: "It's important actually to understand that we didn't have a plan from the beginning as we didn't have a set plan how it would evolve."*

This is in line with the 'unplanned' and intuitive nature of framing in expert design practice, as explained through a quote from a CoLab team member:

> *"To me reframing is something that you are looking for in design, but you are not planning for it…you don't know when that moment's going to come, but you are definitely open to looking for it."*

Lawson and Dorst (2009) refer to this activity as 'managing' – stepping out of the "flow of the design activity, and asking if the process is going well or might be steered differently" (p58). It is this unplanned and 'messy' nature of the design process that makes it uncomfortable for those stakeholders in the network who are not familiar with design, for example:

> *[Public servant, MindLab]: "… it was a challenge for us as well because we didn't know the outcome. Normally we know like somewhere where it's going but in this project, we had to let go and just let them decide on the way."*

Interestingly, the opposite was also true. In one case study the facilitators structured the process very carefully through a method developed by the agency itself, which involved a structured number of steps with clear tools and templates to guide participants through each of the steps. The most difficult step was to go from investigating the problem space to developing solutions. A participant mentioned:

> *"From these themes, [the agency] facilitated a creative session to generate ideas [..]. We used a canvas for that. [..] The canvas helped us associate from themes to ideas [..] It was a kind of brainstorm session, but it all had to happen within one evening and to be honest that did not completely, I was not completely satisfied with that. I felt like we needed more to diverge and associate. [..]"*

And two other participants in a separate interview had a similar response to that same process

> *[Participant 1]: "[..] if you would give that some more time and more rest, then it would be able to 'simmer' and now there is this 'jump in the process', and you continue and you don't look back, you close off a few pathways."*
>
> *[..]*
>
> *[Participant 2]: "[And] I stood there thinking, ok, well, last week we talked about this and that and thought yes, but, it's not yet. It has not evolved enough."*
>
> *[Participant 1]: it has not matured enough, it's not ripe."*

4 Results: capability building

Three of the case studies had a deliberate approach to build design or innovation capability in the network in addition to achieving project outcomes. In two of those, CoLab and KL, capability building was the priority, and the case served as an example to learn about the design or innovation approach. In the other two cases the focus was on project outcomes, not on capability building. These differences in focus are illustrated in Figure 2.

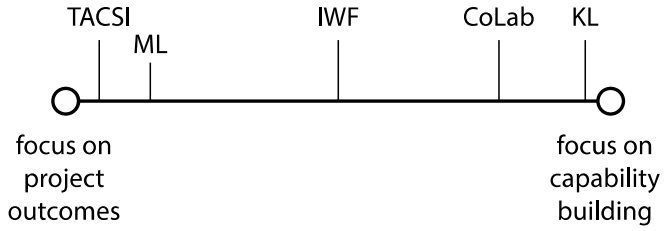

Figure 2 Focus of the case studies regarding project outcomes or capability building

As capability building was not an initial focus of this research project, we have limited insight into the impact this had on participants. However, we do have some anecdotal evidence of the learning outcomes of some of the projects and how that transfers to other parts of participants' work.

In the KL case study, all interviewed participants indicated that they had learned from the process and would apply it in their work.

[Public servant, KL]: "So in my policy about [one of my other projects], I am going to [collect qualitative user data in a similar way to this project]. So, it does have impact on how I work."

MindLab, which did not have a deliberate training approach, but did involve all stakeholders in the process through co-design, managed to impact on people's thinking.

[Public servant, MindLab]: "I have two other projects. I can feel that I changed my way of thinking because of this project. And then I have a different approach to these projects and I couldn't have succeeded that much in those two if I didn't have some experience from this."

At the same time, the public servants involved in the MindLab case study recognised the expertise required to get to a successful result at the completion of the design process

[Public servant, MindLab]: "We need both. We are not as good as we want to be in this thinking. […]. We would not have ended up with [this solution] without the MindLab thinking."

5 Discussion

5.1 Design capability in public and social innovation

In this study, design expertise could be recognised in the case studies through the way that the design networks framed the problem. In all cases this was mostly driven by the design teams from the social innovation agencies. Indicators of design expertise in framing could be recognised through 1) the principles that the agencies used to frame and 2) the 'non-linear' approach to framing and managing the process

5.1.1 Framing principles

The agencies used two main principles for problem framing–'opening up' the brief and applying systemic thinking. As discussed above this is in line with the 'systemic' nature of design as discussed by Nelson and Stolterman (2012).

5.1.2 Non-linear approach to framing and managing the process

The 'non-linear' approach to framing and managing of the design process included an evolution of the framing that was not 'planned' in advance. In all but one case study the frame evolved continuously through either reflecting on solutions (co-evolution of problem and solutions) or bringing in new human-centred research whenever it was deemed appropriate. This messy and intuitive nature of design is something that makes design hard to understand by novices.

5.1.3 Levels of design expertise

The framing principles and non-linear approach show a high level of design expertise. But what did we learn about the 'lower' levels of expertise? One case study is of particular interest here. This team showed design expertise in the initial framing of the problem, opening it up, and taking it to a systems level. However, parts of the process were so methodical and 'templated' that it did not allow the problem and solution to co-evolve. Rather, the problem was explored and framed *before* solutions were generated. This is in line with a more 'rule-based' approach, and seems to lack expertise with regard to managing a non-linear design process. However, the fact that this team did manage to reframe the broader problem does show higher level expertise than novices. This is in line with Lawson and Dorst (2009) who state that there are many elements to design expertise and that you can be more expert in some elements and less expert in others.

The anecdotal evidence of the learning outcomes of participants shows that many have changed their thinking around how to address problems, but that this is still rule-based. However, they did improve their expertise beyond 'everyday' or innate design expertise levels (Lawson & Dorst, 2009;

Manzini, 2015). This in-between level of design expertise needs to be explored further to be able to develop appropriate capability building programs.

Another question is who needs to have which level of expertise. A tentative answer could be that practitioners need high level expertise for complex challenges, and that people working in the public and social sector need at least enough expertise to recognise when a problem can be solved using 'beginner' expertise, and when they need to engage with expert designers. This shows that we will need to develop more specific indicators of design expertise in public and social innovation.

5.2 Teaching design in public and social innovation

The complex nature of the challenges that public and social innovation agencies aim to address requires a different approach to design. Burns, Cottam, Vanstone, and Winhall (2006) refer to this as 'transformation design', the expertise to address complex problems and to create fundamental change. It "seeks to leave behind not only the shape of new solutions, but the tools, skills and organisational capacity for ongoing change" (p.21). More than one decade later, we can see how innovation agencies are indeed focusing on this need to build design capability within organisations. However, we argue that the teaching and learning models for this capability building need further exploration in terms of the targeted learning outcomes in relation to levels of expertise, and the learning models in relation to these levels of expertise.

It is undisputed that design can only be learned by doing. The experiential learning model is therefore widely adopted in design curricula. An essential part of experiential learning is reflection on the experience (Moon, 2004), as visualized in the well-known learning cycle of Kolb (1984). In design curricula this is achieved through, for example, the 'studio-model' and the design critique. In design practice, ongoing reflection individually and as a team supports professional practitioners to keep developing themselves (Lawson & Dorst, 2009).

The learning models described in the case studies do have experiential elements. This is in line with what Yee and White (2015) found with regard to capability building in design projects in the public and social sector, in which key stakeholders are often invited to apply 'tools' to go through a learning cycle of experiential learning, and in some cases explicit 'training' is offered. This would suffice for the 'rule-based' practices of a beginner designer. However, it comes nowhere near the years of education that traditional designers receive. Cross (2004) discusses the time that is required to obtain high level design expertise, and concludes from studies of expertise that it requires a minimum period of practice and sustained involvement. Referring to Ericsson (2001), who is an expert in the study of expertise, "superior expert performance is primarily acquired... many thousands of hours of deliberate practice and training are necessary to reach the highest levels of performance" (Cross 2004, p428).

This level of expertise is clearly far beyond what can realistically be achieved in any 'design capability building program'. For this level of expertise, public and social sector organisations need to hire or work with experts that have built up expertise through years of experience of designing within a social innovation context. At the same time, we need to acknowledge that this field of design and social innovation is young, and that continuous professional learning needs to be supported, as outlined by Nelson and Stolterman (2012, p228): "Designers as professionals need to have both training and learned experiences to develop the multiple forms of expertise needed to create desired changes in the complexity and uncertainty of today's world."

An interesting paradox in capability building is that addressing complex societal problems requires high-level design expertise, but to acquire this expertise, novice designers need experience in working in this context. The case studies that were focused on capability building in this study used the latter approach–working with novices in a real-world context which had less impact on the project outcomes in comparison to the other agencies that relied on high-level expertise. This suggests that organisations need to be aware that they need to balance getting outcomes for the project with getting learning outcomes for participants. A better articulation of design expertise and

learning models could contribute to helping public and social sector organisations set a strategy with regard to building innovation capability.

6 Conclusion

The study described in this paper contributes to developing a better articulation of what design is and what it means in the context of public and social sector innovation, as well as to the development of strategies to increase design expertise in designing networks that are aimed at addressing complex societal problems. The study indicates that public and social sector innovation in the complex context requires high level design expertise. This type of expertise requires years of practice. Even though toolkits with step-by-step methods and templates are great for creating 'design literacy', these approaches are unlikely to get inexperienced people in a designing network beyond the novice level to 'design fluency'. Further research is required to better articulate what level of expertise is required for which type of role and situation in a public and social sector context, and how it should be taught.

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Design for Future Retailing: an investigation into the changing status of city-based retailers in the UK

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This paper forms part of an on-going research project to critically examine how design enable city-based retailers to find new business opportunities through understanding transforming consumer behaviour patterns and its mutual relationship with city lifestyle transformations. In relation to the threat of declining physical retail store closures and the importance of those retailers towards city orientated social interactions, design and design thinking has been identified as the strategic tool to bridge current circumstances with possible future scenarios, which could achieve business innovation and long-term sustainable success. The primary method of data collection was achieved through public online review data and primary observational analysis with selected six retail outlets in this study to identify and examine how design is currently being utilised by retailers in their pursuit of innovation and new business models. This study categorised four aspects that demonstrated the values of design for retailers which are design for product innovation; design for in-store atmosphere creation and services; design for enhance multidimensional interactions; and design for add social and emotional value. Further work will be through collecting more detailed and qualitative research data to explore ways that design thinking can be used to identify latent customer needs.

city-based retailing; design thinking; experience design; design for innovation.

1 Introduction

Under the backdrop of the thriving development of e-commerce over the past decade, brick-and-mortar shops (those that operate within a physical building) (Encyclopædia Britannica, 2017) have been through a series of phenomena. For instance, the increasing number of store vacancies on the high streets and booming of outer town shopping centres making investment in physical retailing in the city centre high street a financially difficult strategy. Those who are still operating a retail store are challenged by the uncertainty of future survival. The perceived notion by consumers are that conventional retail outlets are old-fashioned in the new age of internet retailing. Now it may be

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argued, that city-based retailers have reached a critical transition time in the way they conceive and plan their commercial activities (Wrigley et al., 2015).

City planners argue that the government should rethink the high street landscape as an economic system (Fletcher et al., 2016); sociologists argue that the future roles of city retailers are way beyond just consumption but as social glue improving social interactions (Crawford, 2005; Yu, Tullio-Pow, & Akhtar, 2015). In addition, marketers propose, that to achieve high satisfaction of consumers experiences retailers should take primary consideration of in-store atmosphere design (Pantano, 2014; Turley & Chebat, 2002; Wakefield & Blodgett, 1999). When viewed in entirety, all these critical points highlight the need for retailers to be proactive in their overall offerings and that strategies should take greater consideration in the creation of meaningful customer experiences and finding the new business models.

However, on closer examination, none of them provides operational tools and strategic directions to achieve these aims. What strategies retailers can adopt to meet the satisfaction of consumers and have positive impact on the social development remain under-researched. This paper argues that design and design thinking are invaluable approaches in bridging the gap between theoretical reality and endless future possibilities. With the capabilities of design for innovation and to strategic business planning activities, this paper draws upon the use of public online review data and primary observational analysis on a purposive selected group of high street retailers in the UK. Therefore, demonstrate how design thinking could be used in the context of commercial space innovation within a physical social environment.

2 Theoretical Overview

2.1 The Current situation of city high street retailing

The growth rate of store sales revenue was only about 1% in 2016, (PwC, 2017) and the continuing rise of empty property units in city centre high street retailers since 2008 economic crises and continued austerity (Hughes & Jackson, 2015; Wrigley et al., 2015) concern not only policymakers but also businesses.

The downwards momentum is primarily caused by multiple factors. Firstly, the convenient and data supported online shopping platforms are one of the major threats to traditional high streets (Zhang, Zhu, & Ye, 2016). With the high-speed development of mobile devices and the improvements of door-to-door delivery service, the trend of emergent online retailers seems unstoppable (Digital High Street Advisory Board, 2015; Singleton, Dolega, Riddlesden, & Longley, 2016). Secondly, out-of-town centre shopping projects are another main threat for city-centre based shops. Low commodity prices and easy parking make shopping in these environments more desirable to consumers (Hughes & Jackson, 2015; Wrigley & Lambiri, 2014). However, on the other hand, even though the e-retailer is on the rise, physical stores still take up 79% of the main channels for generating sales (PwC, 2017). David Bell (2014), in his book *Location is (still) Everything,* articulated in many ways that learning from physical shopping is even important for who doing e-commercials. Alongside these factors, the overall social (demographic change) and economic (technology innovation and city-branding) changing trends are forcing established city-centre based retailers to find new ways of business practice in light of these emergent conditions (Bevan, 2014; Coca-Stefaniak & Bagaeen, 2013).

From the perspective of city development, city high street shops are essential. Like Crawford mentioned in his paper *A Brief History of Urban Form* "…*Cities have been consistently arranged around a centre hosting commercial and social activities*…" (2005). High streets as 'system' are directly associated with the life and death of the larger system so called the city (Dennis, Marsland, & Cockett, 2002; Hallsworth, 1995; Williams, 1996). Furthermore, the competition between cities for creating their 'brand' (Coca-Stefaniak & Bagaeen, 2013), city high streets development links with secure investment and to attract and retain businesses which determines the economic success of a city (Hodgkinson, 2011). From city planner's view, Cultural, entertainment, health, social and more

possibilities (Department of Communities and Local Government, 2013; Zhang et al., 2016) should all be considered in this transition of city high street in order to shape future smart cities (Crawford, 2005; Fletcher et al., 2016). Regarding specific debate about the functions and roles that retail outlets play in the city and community activities, Mary Portas in her review (Portas, 2011) offered a comprehensive summary. She suggested that *"high streets are not just in commercial terms, but as dynamic, exciting and social places that give a sense of belonging and trust to a community, providing an important catalyst for both the investigation of, and policy debate on, topics."*

From the perspective of consumer needs, American psychologist Abraham Harold Masolw (1943) purposed the famous Masolw's Hierarchy which illustrated five levels of human needs from physiological to self-actualization. E-commerce takes over physical retailer's function of selling and buying on fulfilling the needs in physio pleasure (Jordan, 2000) and to some extent socio pleasure. However, to achieve the higher level in socio, psycho, and ideological pleasures, will need multiple channels working together simulating consumers' full senses which including see, hear, touch, smell, test and feel (Masolw, 1943; Norman, 2005). In the field of consumer behaviour, Philip Kotler (1973) presented forty years ago that physical shopping space have significant influence in the purchase decision making, even than the selling product (or service); stores have to consider the "total product" which includes tangible products and intangible features associated with it (Sherman, Mathur, & Smith, 1997). And environmental psychology suggests that consumers react more emotional than cognitive in a physical shopping environment (Gurel-Atay, Giese, & Godek, 2010; Wakefield & Blodgett, 1999) and creating a positive in-store atmosphere which hugely contribute both to pleasure and purchase decision making processes. From the perspective of business strategy, in order to achieve the paramount of consumer experience, they have integrated tools and "*communication techniques*" (Morschett, Swoboda, & Schramm-Klein, 2006) to deliver the brand message to the customer, and by doing that, brand can improve the customer satisfaction and loyalty and promote economic gain (Yu et al., 2015).

It is demonstrable that the significance of city-based retailers and the expectations towards Omni-functional future stores are fully explained. However, none of them gave city-based retailers specific tools or path leading them to find new opportunities. This paper will introduce and argue that design and design thinking are the key tool enables city retailers to better understand consumers, to connect consumers, and to be able to identify new business opportunities. Having now explored the macro retail landscape, the following sections introduce design as a strategic business asset which then is followed with six purposive selected mini-case examples to support current literature on design as a driver for change.

2.2 Design for business

2.2.1 The design and business dimension

Often the term 'design' is commonly, and sadly, used to articulate how either a product or object looks, mainly at a very superficial level of understanding. With this rather limited definition of usage, it is seen as a frivolous activity offering no real worth to the organisation. However, enlightened organisations regardless of size, really understand its 'value' not just at a tactical level of engagement, but as a vital ingredient and source of both inspiration and opportunity. When carefully managed and orchestrated, design has the innate ability to offer a distinct range of value-propositions that are desirable in the eyes of the consumer and end-users alike. With the advent of globalisation in full force, competition between companies is becoming increasingly fierce, and as such, design is now becoming the commercial 'imperative' in the continual struggle towards long-term survival and continued sustainable success. Alongside increased competition in the commercial marketplace, emergent technologies are both shaping and destroying established business models on a daily basis. Design is what connects technology to consumers' needs; it is the powerful link from the organisation (supply) to the marketplace (demand) offering powerful transformational 'experiences' based on exceeding customers and desires (Dorst, 2010). The nature of design practice merely offering creative propositions that meets customers' needs is now not enough to remain

competitive, the organisation has to use design far beyond this base level of application; offering more of the same is a redundant short-term strategy that will eventually lead to market failure and inevitable commercial decline.

2.2.2 Design leadership

It is widely agreed that the role, remit and responsibility of design and its overall management have considerably changed from an early stage to maturity and wider acceptance; as such, it is now considered a vital source of competitive advantage. Design is increasingly gaining more attention within the organisation and that it is becoming more strategic in its role as a mechanism to envision new futures for the company.

Business leaders and key decision makers drawn from traditional non-design backgrounds are exploring the numerous opportunities and challenges of this unlikely relationship with design. Brown (2008) argues that design thinking is "…*a discipline that uses the designer's sensibility and methods to match people's needs with what is technically feasible and what business strategy can convert into customer value and market opportunities*". Furthermore, Liedtka (2010) actively encourages organisations to engage more proactively with design arguing "…*business strategy desperately needs design*..." With this flourishing symbiotic and mutually rewarding relationship in ascendency, designers are now extolling the benefits of design to new and traditionally highly sceptical audiences, thus developing a 'design consciousness' within the organisation and establishing design as a core competence. In conjunction with this growing recognition from and by business leaders, design and designers are increasingly well-placed to initiate, develop and support NPD (New Product Development) opportunities and wider innovation activities. A core competence has to provide a significant contribution to customer-perceived value, and indeed design has played a leading and direct role in the 'lifestyle' offerings from organisations.

2.2.3 Design as strategy

If design is to add value to the business; it must be a fundamental element of the business, able to take part in that crucial interplay in the pursuit of long term success. This is often made difficult, however, by the differing mind-sets of designers and business owner-managers. Entrepreneurs may have clear ideas of what would sell and make a profit but does not view design as a central component of this activity. Designers have clear ideas of "*good design*" for products, or marketing purposes but often lack wider commercial awareness. Both believe they know what to do to make the business successful; that is, both have complementary ideas of "effectiveness" that are tacit and often competing versions of the business process. However, if significant progress is to be made in the integration of these two perspectives of both parties to understand what design in a business context is, and how it links to overall business effectiveness – in essence, it is all connected to strategic 'alignment'; by this I mean alignment from top to bottom of the organisation, and from the inside (internal environment) to outside (external environment) connecting the company to the end-user (Cooper & Press, 1995).

The role of design and in particular, designer can play a significant role in corporate strategy development; this often occurs within three levels of active engagement – top, middle and bottom. Starting from the top, this is the highest and most powerful form of decision making or 'influencing', impacting upon every aspect of design 'touch-points' within the organisation. Design recognition and advocacy at Boardroom level is fundamentally connected to driving the overall vision of the organisation in terms of long-term direction, company goals, management structure, finance and human resources. In essence, design is not only considered but recognised and celebrated as a strategic resource of organisational innovation. However, strategic design thinking at this level within the organisation is heavily concerned with both renewing and re-imagining what it offers – either through their products, services, experiences or all of them combined in a carefully orchestrated manner.

One fundamental element of strategy development is placing primary emphasis on the appraisals of the external and internal business contexts. The former uncovers threats and opportunities in the external environment (which are beyond the control of the organisation), the latter reveals strengths and weaknesses of the organization, which can be internally controlled and managed when undertaking the external review of the wider marketplace (i.e. researching current marketplace activities and to identify any emergent patterns or trends that could trigger new business opportunities). Alongside this, the internal audit would focus upon examining the strengths and weaknesses of the organisation, carefully balancing the strategic options, which both exploit internal opportunities with external circumstances (opportunities and threats).

2.2.4 Design 'thinking' for competitive advantage

Design has and is continuing to play an increasingly important role in delivering business propositions; often in a variety of subtle ways. Firstly, the proposition contains elements that are highly tangible to the consumers which are manifest in both physical and intangible forms. These may include built physical environments, digital applications, graphics and a wide array of supporting promotional material, physical devices and complementary packaging elements. The intangible proposition is equally powerful, but requires far more consideration in both development and delivery due to its subtle nature; these could be achieved through the offering of memorable services, clearly defined policies and processes that are so heavily informed by and through design. Taken in entirety, the holistic application of design addresses all attributes of a product or service offering it physically or virtually or both; what is important though, this activity has to be intelligently and carefully orchestrated at both strategic and operational levels of implementation. In essence, it could be argued that design and design management is the manifestation of strategic intent making the intangible values of the organisation visible to a wide variety of both internal and external audiences.

3 Primary Research Questions

RQ 1: How can design be utilised to enable high street retailers to identify new business opportunities through the identification of latent consumer needs?

RQ 2: In what ways can design thinking be used to identify latent consumer needs?

4 Research Methodology

As a social science research, the paper aims to gain an in-depth understanding of the performance of current seek-for-change retail outlets and how the consumer will respond to the in-store experience and how design enabled this. Therefore, a qualitative methodology, observation, has been adopted. Regarding the sampling technic, the study used purposive sampling where cases are pointedly selected for how each is able to illustrate different values that design can offer to retailers. The representativeness of selected cases supported by mainstream public online consumer review data which including consumer reviews on Google map, TripAdvisor and Facebook; and news reports of selected cases on numbers of online news agency such as Timeout, Creative Review and The Guardian. Through visiting selected retail outlets, the researcher recorded the experience(s) that retailers created to influence consumers and how the strategic design approaches were implemented to improve consumer experience(s). The unique features of the selected retailers including - geographical location, the selling products (or service), in-store atmosphere and their USP (Unique Selling Point). Combine researchers' primary investigation and online review data, five different types of retailers based in London and one bookshop in Manchester were chosen for this study (see Table 1).

Table 1 The six retailers selected for investigation

	Strategic Approach	Retailer name	Store type	USP through Design

1	Concept presenting	Dyson	Product Showroom	“museum style” presenting Dyson’s design and technical strength
2	Scenery creation	Nike	Sportswear retailer	Planting the seed of your professional sports dream
3	Interior design	Libraria Bookshop	Bookshop	Reflecting the philosophy of knowledge and reading
4	Business model	Kioskafe	Kiosk and café	The kiosk in the café shop for worldwide travellers
5	Product selection	We Build This City	Souvenir store	The shop represents London’s image with high quality local artists’ works
6	Nostalgia	Paramount Books	Bookshop	The memories of growing and living in this city

Central London was selected due to its status as a leading retail destination in the UK attracting well-known international brands and independent innovators. In order to have a clear illustration of social and emotional value of a city-based retailer, a second-hand bookshop in Manchester was selected for the research study. Not limited to that, the case will also introduce how design thinking was utilised in the discovery of new business opportunities for physical retailers. Findings from these cases will be further explored in the latter sections of this paper. In the analysis section, the study draws upon Maslow’s Hierarchy of Needs as the foundation of categorisation, six cases’ common characteristics are located in four categories that (product, in-store atmosphere and services, interactions, and add social and emotional value) present how design can bridge brick-and-mortar stores into an innovative future.

5 Observations

5.1 Case Example 1: Dyson Demo

Location: 447 Oxford St, Mayfair, London W1C 2PR, visit period: July 2017,

(Official website: https://www.dyson.co.uk/inside-dyson/dyson-demo.html)

Figure 1 Dyson Demo showroom. Source: all photos in this paper are taken by author with shops’ permission.

Dyson is an established British household appliances technology company founded in 1987(Dyson, 2017), their most successful product lines include, vacuum cleaners, bladeless fans, hand dryers, and recently revolutionary supersonic hair dryer. In 2016, Dyson opened the first British store in Oxford Street, central London; the store is not solely aimed for selling products but more akin to a design museum highlighting their product ranges. Another famous innovative brand - Tesla is adjacent to the Dyson retail outlet. On entry to the retail environment, huge plasma screens display the technology that underpins Dyson products. Product categories are divided by usage, and the display takes the customer through a narrative journey of their development from idea to commercialisation. Store assistants explain to customers particular aspects of each products and their operating principles.

This multidimensional retail environment carefully conveys the essence of the Dyson brand with emphasis on allowing the customer to see, touch, listen, and engage with the Dyson brand story, imprinting on the consumers' mind subtle messages stronger than videos projected via wall-mounted flat screens. No matter you buy or not, the recognition of the brand image is significantly enhanced.

5.2 Case Example 2: Nike Town

Location: 236 Oxford St, Marylebone, London W1C 1DE, visit period: July 2017

(Official website: https://www.nike.com/gb/en_gb/)

Figure 2 The Nike Football section and the mini boot trial area.

Nike is one of the world's largest retailers of athletic footwear, apparel, accessories, sports equipment and services that covered worldwide markets. This Nike Town is located in the central corner of Oxford Street. The store is the brand's largest flagship store cross the world with 70000 sq.-foot dedicated to a full range of Nick products (Porter, 2017). In total, the store has three levels, the overall store is well designed with interior, product layout, advanced technological communication devices, and friendly staff supporting.

Within the Nike store, there is a dedicated section to football and in particular football footwear, with an extensive array of products being displayed. To further emphasise the technical excellence of the footwear, a traction wall illustrates how the football studs work with all types of ground, i.e. firm ground, artificial grass, indoor court, etc. Behind the wall they created a mini boot trial area.

Area front part design like lounge which includes score board, bench and full sizes in all the sellers. The majority of customers waited on the line for trying were teenagers, and their parents were waiting outside. A store assistant will ask you some questions about your foot size, where you normally play football and check if you wear the right socks. Then there is a “coach” waiting inside of the fence and guide you how to use different postures to kick the football to the target in order to feel how the shoes feels. All the children were very excited to wear professional shoes and get to learn some new techniques, and their parents were also happy to watch their children get trained.

5.3 Case Example 3: Libraria

Location: 65 Hanbury St, London E1 5JP, visit period: September 2017

(Official website: http://libreria.io/)

Figure 3 Libraria interior environment and layout books by themes.

Libraria bookshop is located in the northeast London Spitalfields area which is popular to graffiti artists and independent designer retailers. The shop was opened in 2016 by the founder of the vibrant co-working space Second Home, Rohan Silva and his business partner Sam Aldenton who created the store concept as a ‘no distraction reading space.’

The whole concept of the shop design was inspired by Argentinian author Jorge Luis Borges’s short story, the ‘Library of Babel’ in 1941. “*This fantasy story features an almost infinite library where hexagonal galleries contain every possible combination of letters*.” (Frearson, 2016). The outside facade is considered normal, but once customers enter the shop, they will sense the boundless world that the literature explores. The bookshelf in both sides designed with the erratic outline, with the help of mirror ceiling and back wall make the space endless. There are a few seats, as part of the bookshelves and if people wish to read inside, then they have to follow Librarias “no-phone” policy. Unlike the ordinary way that people category books with subjects, Libraria put books together by themes, such as Love, Power, Ways of Seeing, etc. By doing this, consumers will be surprised by meeting some new books and feeling incredible that the unexpected connection between books. Not all the books in store can be found online or in mainstream bookshops, as some of them are published by independent publishers with erudite writers. Silva was saying in the interview (Clark, 2016) that without coffee and tech devices, this is the place where emphasis on reading and creativity, wish we could free ourselves from the overloaded information chaos.

5.4 Case Example 4: Kioskafe

Location: 31 Norfolk Pl, London W2 1QH, visit period: October 2017

(Official website: http://kioskafe.com/)

Figure 4 Kioskafe interior environment and service range, they provide print-on-demand service and home-like restroom.

Kioskafe is the second café that the British lifestyle magazine Monocle launched in 2015 (Rchael Steven, 2015). With the background of a media publisher, the brand aimed to explore the new business model for news retailing and to see how newsagents can be integrated into people commuting life. Therefore, the name could show its function as the hybrid of the kiosk with café. The Monocle creative team designed the Kioskafe brand identity system based on the potential of expanding and franchising internationally. It inherited the Monocle style by the chosen colour combination and the design format.

Kioskafe is located not far from London Paddington train station where commuters converge across the locale. The street where the store is located is not like the business high street but added the sense of order with residential homes and hotels. Walk into the café, the major area is placed with magazines instead of tables and chairs. 300 different kinds of newspapers range from art, design, fashion, culture and more in 60 languages are selected across the world. Also, there was a printer near the sales counter to allow consumers to select thousands of newspaper choices around the world from their print-on-demand catalogue. This is something that you cannot find in a normal kiosk and easily get from Internet at one time. Alongside the magazines, the table in the middle displayed with items, which aimed for travellers, for instance, small size shower gel, shampoo, pens, and toothbrushes. More thoughtful, in the back corner, store created a home-like restroom for travellers to have a break. It is understandable to be like it with the chosen location. Two long tables under the window with few seats allow people to drink and read the magazines while shortly waiting for their train.

5.5 Case Example 5: We Build This City

Location: 56b Carnaby St, Carnaby, London W1F 9QF, visit period: September 2017

(Official website: https://www.webuilt-thiscity.com/)

Figure 5 We Build This City shop storefront design and London local artists' work sell in the store.

We Build This City is a souvenir shop opened in 2014. London is the most popular tourist city in the world, but like the common situation over famous locations, the poor-quality kitsch in normal souvenir shops hardly represents the creativity and diversity of London. Therefore, the shop founder Alice Mayor had the idea with her artist and designer friends, to open an alternative souvenir shop selling high quality and London-inspired goods from artists, designers, and makers who passionately understand this city of London (Steven, 2016).

The shop is located in the one of London's favoured shopping destinations, Carnaby Street and since it opened, more than 250 London-based artists, designers and makers have sold their work through the shop. Design is in the gene of this store and its products, the storefronts changed almost twice a year are designed by different artists and designers; all the products in store are well selected covering all kinds of items in life, you can see designers put the sense of humour into those personal goods. On the two sides' wall, original art paintings, drawings show different versions of the image of London. Though the price is higher than ordinary souvenir shops, it deserves because the memories associated with it about London travel back home with the customer. Not just individual consumers, local interior design agencies and nearby fashion brands are becoming their major clients. The atmosphere in-store is more akin to an art gallery, the creativity and diversity are what London feels like.

5.6 Case Example 6: Paramount Books

Location: 25-27 Shudehill, Manchester M4 2AF, visit period: September 2017

(Official website: http://paramountbooks.co.uk/)

Unlike the other five examples, design can enable those physical stores to gain strength and create more connect spots with consumers in different ways. It is the creative feature of design to think strategically. This case is to show how design thinking also takes physical and social connection into consideration. Not a well-known brand but quite famous among local Manchester customers, this second-hand book store opened in 1965 is located in the central Manchester side of the Arndale shopping centre. It is hard to ignore this shop, the classical jazz music booming from outdoor speakers attracted people to find the source. The shop logo has not changed since half century ago when it was first established. This antiquated feeling seems to have a lot of story to tell.

Figure 6 Paramount Books in Manchester.

Materials in the store are varied: comic and graphic collection are the best you can probably find, the modern paperbacks, science fiction, fantasy, and classic novels are spread in the store. Above all this, the great selection of out-of-print books will surprise customers with the diverse range of themes. The shop owner has placed cloth dolls on unexpected corners around the shop, making the in-store atmosphere playful. Shop owner was there talking to a consumer, in between of their conversation, he often said hi to people who came in, he seems knowing everyone. After he got free, I went to talk with him, I asked why he put dolls in the shop, he said, *"this shop is not just a place for making money, my kids also grew up in here, they read in here, play in here. It is like a second home."* At this time, a man holding two big boxes of books walked in and said to the owner "*I will leave them here, and let me if you want to keep some.*" I asked, "*how did you get those books?"* He answered: "*like him, people were my customer, and then became my friends, then my suppliers, they bring books to me, sometimes I bring book from travel to Japan, American, Thailand, and you name it. We made friends around world. I told them my shop, people came to visit me*."

6 Analysis

Following the presented findings from empirical observations, this section will examine all the cases by locating them into four categories illustrating how design can offer innovative inspiration and new business opportunities for high street retailers. Regarding different levels of consumer needs be achieved from physiological to self-actualization, Maslow's Hierarchy used as the foundation of categorisation. The four categories are 1) Design for product innovation; 2) Design for in-store atmosphere creation and services; 3) Design to enhance multidimensional interactions; 4) and Design for add social and emotional value.

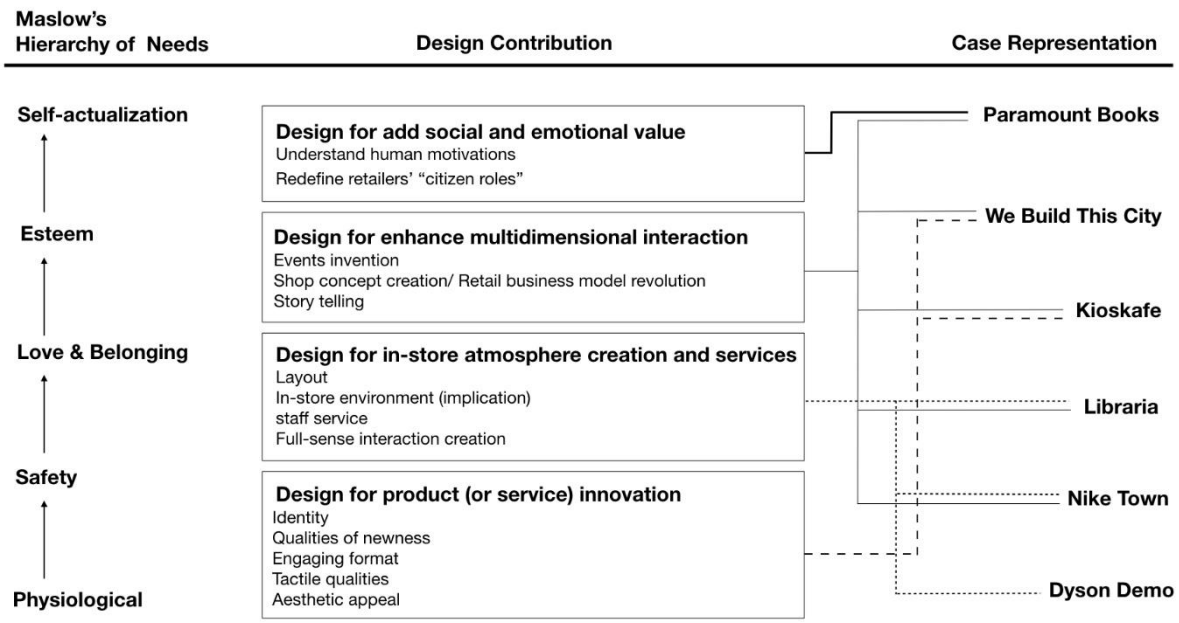

Figure 7 Based on Maslow's Hierarchy, fig.7 illustrates design values from low to high represent with selected cases.

6.1 Design for product innovation

"*Design is in the guise of new product and services."* (Lawor, O'Donoghue, Wafer, & Commins, 2015), Product (or service) is the core which connects the brand mission with target consumer needs; it is also the main source for a retailer to gain profits and represent the brand value in the market (Stein & Ramaseshan, 2016; Swoboda, Berg, Schramm-Klein, & Foscht, 2013). Regarding Kioskafe, it is a news supplier operating as a café, worldwide magazines and print-on-demand service make the brand distinctive from ordinary newsagents. It has clearly defined target consumers who are in their travelling, products like personal hygiene products and the space for them to refresh and rest offers brand uniqueness. The well-designed business model, brand identity and selected presenting products and services closely relate to their target consumers' needs which will allow brand adoption in any transport links worldwide. Furthermore, Meaningful product design enables the brand to differentiate from its competitors (Brunner, Emery, & Hall, 2009). We Build This City changed the image of regular souvenir shop, offering unique and playful designs with characteristic of a creative London image. Products featured with high quality and originality make the shop unique in what could be considered as a crowded marketplace. Through the eyes of local artists and designers, their products offer a distinct personality, which could be an interface for travellers to understand London alongside with famous scenic spots. Product innovation in those cases are strongly connected with the brand mission and the needs of their target consumers. Design is a vital mechanism for retailers to understand their customers and to be able to serve them more effectively.

6.2 Design for in-store atmosphere creation and services

In earlier literature of this paper found within theoretical overview, it discussed how consumer behaviour is closely linked with positive shopping process satisfaction and behavioural intentions with the space atmosphere design. The natural advantage that physical store competed with virtual retails is that it can create 'full-sense' experience (Norman, 2005) which will simulate consumer's deeper response and brand associations. As one of the important components of store atmosphere creation, store environments are attached with deep knowledge of the product and brand, contributing largely to consumer satisfaction (Mohan, Sivakumaran, & Sharma, 2012; PwC, 2017). The Dyson Demo store, by showing the product working mechanism, design and development process, allows consumers to directly communicate with the leading technical innovation that the company represents. All the elements in-store, including decoration, layout, materiality, light, sound,

colour movements, and the professional and friendly human assistance gives people full degree of exploring what Dyson represents. The showroom itself cannot create direct profits for the brand; however, channelling the brand story to mass audiences could reach potential consumers and create word-of-mouth marketing. Similarly, good store atmosphere creation is the key in the case of Nike Town, for instance, the overall in-store environment of Nike town, the vibration and energy filling the air, and the mini boot testing area giving children the imagination of being a professional sportsperson. Lastly, the elegant interior design in Libraria affords people the fantasy of a world of endless literature and creativity; the in-store atmosphere allows customers to focus on quality reading and self-reflection.

6.3 Design for enhance multi-dimensional interaction

Although Internet and technology create a broader channel making connections with people around the world, human as physical existence, the interactions in real life still dominate the overall wellbeing and customer satisfaction and loyalty as for brand (Yu et al., 2015). Regarding the featured cases, they all created a positive influence in different terms of interaction, human-human, human-social, and human-culture interactions. For instance, Nike is a good example illustrating how a retailer can connect friends and family together; Well-designed souvenirs and artwork offered by We Build This City enables travellers to make lasting connections arising from their visit to London; Libraria provokes browsers the possibility of serendipity and help them discover unexpected relations between books, allowing the customer to make interactions with high quality information; Kioskafe collects multi-language magazines into one place; and more than half century existence Paramount Books made itself as the city's memory bank, nostalgia of past times reflecting and connecting every time when consumers visit it.

In addition, the benefit to business activities, entertaining experience and temporary activities can increase the likelihood of reaching potential consumers (Lowe, Maggioni, & Sands, 2017; Sherman et al., 1997). Like the workshop that We Build This City designed for consumer interactions with art and design; Libraria allow people to rent the space to host events, both of them overcome the conventional image of souvenir shop and bookshop, and allow new business opportunities emerging and testing.

6.4 Design for add social and emotional value

From the previous analysis, design can bring strength to business activities from task to strategy. Design can help retailers achieve innovation; in addition to that, regarding the fundamental importance of physical stores towards city life, which is associated with our past memory with living place, and the psychological safety and belongingness generated from social and environmental interactions (Harris & Williams, 2011), design can also capture the emotional value for city high street store development. Paramount Books, the invisible and strong bond between the retailer with their customers was developed slowly over time, involving past figures of the city and memories of the past. Though the bookshop does not have well planned and delicate design like other five cases to distinguish it, the image of "timeless" and "history recorder" make it special to customers and more likely to maintain high level of "brand" loyalty. The extra emotional value, which Paramount books offer, cannot be measured by organisation scale but by connecting deeply with the consumers life narratives. Design strategy for city-centre based store innovation should take human fundamental emotional needs into consideration, and the name of 'innovation' should not be a trending slogan but truly for the benefit of a better city life.

7 Discussion and Conclusions

This paper explored the proposition that design is a strategic tool that can help city high street retailers create strong connections with their customers and define new business opportunities. Observations from the six selected innovative retailers illustrate different capabilities of design in business operations. Through finding and analysis arising from the case observations, it can clearly be seen that city high street shops are not only for delivering merchandise but also can achieve

higher level of consumer satisfactions through meaningful experiences. Design as a tool and strategy helps retailers to generate new links with consumer and search new possibilities that were clearly illustrated by the mini-case examples.

By strategically planning design, including but not limited to product design, service design, in-store atmosphere design, and business model design, retailers can achieve what business management aimed to meet consumers' emotional and social needs; what marketing talked about to identify unique selling points; and what city planning emphasised to build stronger connected communities. With innovative design thinking, city-centre based retailers can shift their focus on selling-and-buying competition with e-retailers to explore more possibilities by redefining "citizen roles". Design can build varies channels to allow brick-and-mortar stores and consumers communicate with each other, During its process, business model is shifting and adapted to fit new contexts of consumers' city life. Reconfigured business landscape is on its way being discovered, and design will keep the equilibrium between old and the new.

8 Next Phase of Research Activities

This early-stage interpretivist study examining design's capability to discover new opportunities for city-centre based retailers is the first phase of the overall research project. Regarding understanding the interrelationship between design, the city-centre based retailer and consumer behaviour, the next phase will focus on exploring in-depth literature and to conduct primary detailed interviews with consumers, city retailers and design experts. As such, subsequent findings will enable to demonstrate how design can be applied to understand consumer behaviour in relation to the creation of new business opportunities. Data will be collected from diverse perspectives, which will include geographic environment, levels of design understanding, and city-centre based retail practices to understand and define current city retailing business models. Through collecting more detailed and qualitative research data, the second research question 'In what ways can design thinking be used to identify latent consumer needs?" will be revealed. Offering a comprehensive set of guidelines for city-centre based retail practitioners to use design thinking will be developed as a final research outcome.

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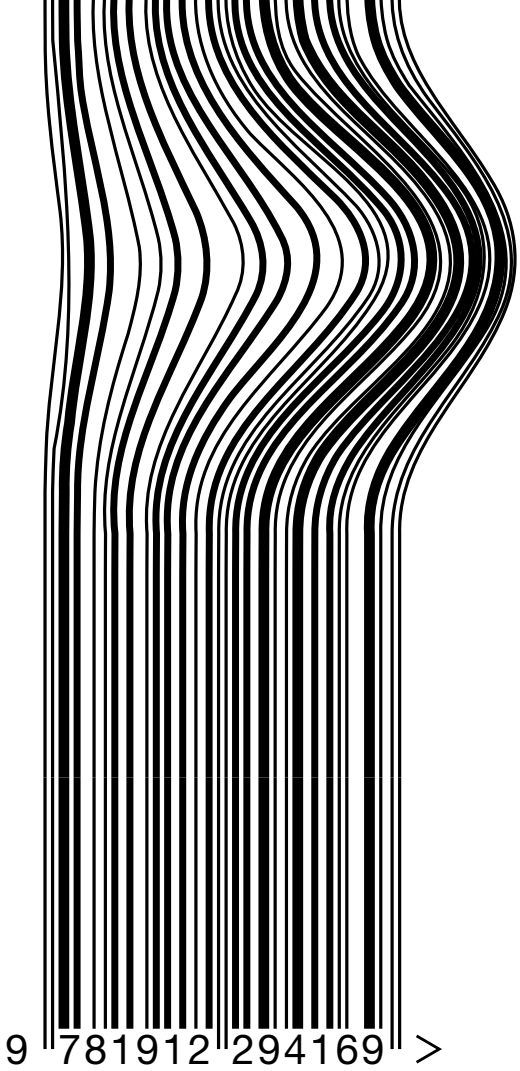

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