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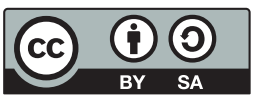

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Stella Boess, Ming Cheung, Rebecca Cain

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DRS2020
BRISBANE, 11–14 AUG
SYNERGY

DRS President's Foreword

Rachel COOPER

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The Design Research Society is a unique organisation comprised of people dedicated to the value of design and design research and its value to our people and our planet. Without a dedicated group of volunteers, we would not exist; people who offer their services to the management of the organisation, people who host conferences and people who submit papers and their combined intelligence to further knowledge of design and its contribution to the world. This year the fragile nature of the planet, of human relationships and the basis of our economy and society has been illuminated (fires, floods and a virus). We have seen the effect of radical changes in patterns of behaviour; both positive influences on the environment and negative influences on health and wellbeing and livelihoods. There are many design challenges and design researchers have come to the fore. This conference is a triumph of that creativity and fortitude, embracing the virtual world and bringing together all those people who so want to exchange ideas. Many of the papers are pre-Covid, and whilst we should not forget the conversations and research directions before this pandemic, it will, of course, shape our future and our conversations. People make the DRS and whether online or in person the conversations will continue. Let us together build a wider, deeper and stronger global design research community.

As a foot note I would like to say that 2020 marks a turning point for DRS in so many ways, we have a new structure of the organisation, that is a new International Advisory Council and executive who are eager to continue to move forward. We have a new virtual conference and I would like to thank the conference team for such a triumph in changing format and delivery mode, and also to you the members and delegates who are embracing this with your attendance. Enjoy the conference and the future DRS.



Rachel Cooper
DRS President 2020

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DRS2020 Editorial

Stella BOESS, Ming CHEUNG and Rebecca CAIN

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Never before has a Design Research Society Conference happened in such uncertain and changing times. When we embarked on planning the DRS2020 Conference in Brisbane, Australia, we were in a different time, when unrestricted travel and meeting-up face-to-face at academic conferences was the norm. Then the COVID-19 global pandemic happened, which prompted us to rethink and reimagine DRS2020 in a new format.

In recent times, the debate around the sustainability of physical conferences has been starting to surface. This was an issue the DRS was starting to grapple with, but the practicalities of a blended or entirely virtual conference were still uncharted territory. Even before the pandemic was born, the devastating Australian bushfires were causing people to consider whether it would be safe to travel to Australia. Ultimately, the pandemic made a physical conference impossible, and the conference host Griffith University made a joint decision with DRS to convene DRS2020 as a virtual conference. DRS2020 marks an important turning point in the history of DRS conferences, being the first conference to go entirely virtual. We are very grateful to Griffith University for embracing this challenge, and for their leadership and management of the virtual conference in such complex and difficult times.

DRS conferences are international biennial events, held to further and promote design research. They are inclusive conferences, bringing together a wide range of disciplines and communities related to design research, with the aim of fostering new debates on the important issues of the time. Historically, DRS conferences have always taken place through gatherings of delegates in physical venues at a host organisation, with face-to-face presentations and discussions, accompanied by written conference proceedings. New collaborative formats have been added over time – for example, Conversations which were introduced in 2014. DRS2020 took on the challenge of transforming these formats into a virtual experience. Also worth mentioning, the DRS2020 Postgraduate Research Day is pioneering in that it is inclusive of both PhD and MPhil students and of their theory-driven and/or practice-led research projects. In this sense, DRS2020 becomes a prototype for a new type of virtual and inclusive conference experience and continues to build on the legacy of innovation from the previous conferences.



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The 144 papers in these proceedings were conceived of and written in our pre-COVID world. Just three authors were able to make late additions to their papers addressing the current situation (165, 398 and 402). These proceedings therefore provide an interesting juxtaposition, whereby what is written represents design research in the world as we knew it, whereas the discussion that these papers will promote during and beyond the conference will almost certainly be viewed through the lens of the complexities and challenges we now face. The discussions and reflections in the proceedings are a timely barometer for what the international design research community is thinking about and working on, and they will surely prove inspiring and thought-provoking for design researchers worldwide. We hope that you enjoy reading them as much as we have enjoyed curating them.

Themes

The overall theme for DRS2020 is Synergy – the coming together of people and disciplines in design research to create a positive impact. On the one hand, design research champions the uniqueness of disciplinary knowledge and creativity, yet on the other hand, the complex world we now live in demands a more synergistic approach to creativity and problem-solving whereby different mindsets, backgrounds and perspectives come together to realise transformative visions of the future. DRS2020 celebrates these emerging synergistic approaches to design research and seeks to explore their exciting possibilities for addressing multi-faceted problems, supporting participation, and transforming problematic situations into desirable ones.

For DRS2020, we used an emergent approach to the development of the conference programme, with a general call for papers around five themes – Situations, Impacts, Co-Creation, Education and Processes. These themes emerged in discussions between the Organising and Programme Committees at an early stage of the conference planning and were felt to capture a broad spectrum of current design research topics from which we would be able to build more focused themed sections. Continuing the collaborative approach to theme building, we asked the international reviewers to indicate to which of these themes (or others) each paper contributed. Following the acceptance of papers, the reviewers' indications helped us to cluster the papers into the rich programme we have here, with the main conference theme of Synergy being an interwoven thread throughout.

Impacts and Co-creation are the biggest theme categories, reflecting the design research community's commitment to applied research. Situations are an emerging theme reflecting the community's increasing awareness of diverse circumstances and contexts. With Australia as the host country for DRS2020, it is worth noting that 12 out of the 144 papers mention Indigenous communities (108, 135, 165, 166, 177, 187, 198, 228, 277, 278, 387, 402). 32% of the accepted papers are from Oceania, 18% from Asia and 33% from Europe, compared with 5% each from Oceania and Asia and 64% from Europe at DRS2018. Themes such as pluriversal design and diversity, design for global health and wellbeing, collaboration, sustainability and education continue to attract new directions in research and illustrate the

potential of design research to change the world for the better. The theoretical foundation of research into (design) Processes continues to be an enduring theme, the development of which can be traced back through all previous DRS conferences. Some sections were additionally clustered by domain, such as graphics, mobility, experience design or data. A point to note is that the paper clustering differs somewhat between conference programme and these proceedings, as the former also needed optimising by time zones to allow presenters from around the world to interact in their session discussion.

A further way we grouped the papers was around existing themes of interest within the DRS: those of the DRS special interest groups (SIGs). These open and dynamic groups of DRS members form around current and emergent issues in design research, and they welcome participation. The DRS SIGs are one of the main ways that the DRS drives forward debates and keeps a pulse on ongoing topics as well as emergent topics of the day. The DRS currently supports eleven SIGs, all of whom have contributed to these proceedings by selecting and grouping just over a third (55) of the submitted papers into SIG themed sections. Some of these sections are chaired as sessions by SIG members at the conference. This way, the SIGs hope to give authors the opportunity to get to know the SIGs and their members and to get involved. The eleven SIGs are Health, Wellbeing and Happiness, Global Health, Design Pedagogy, Pluriversal Design, Design for Behaviour Change, Experiential Knowledge, Human-Object Interactions, Inclusive Design, Sustainability, Networked and Embedded Technologies and Design Innovation Management. While the SIGs selected their set of papers because the papers speak to current and future themes of the existing DRS SIGs, many more of the accepted papers also relate to the SIG themes and all authors are welcome to engage with a SIG. DRS members are also free to propose new SIGs. One of the aspirations of the DRS conferences is to catalyse the creation of new SIGs, through the collective community building and knowledge sharing which takes place.

Review

Despite moving to a virtual conference format, what stays a predictable constant is the academic quality of the work presented at DRS conferences. Our standards remain high, through the excellent work of the authors, our Programme Committee and the community of reviewers. The Programme Committee is appointed by the DRS and chaired by a member of the DRS International Advisory Council. We are privileged to have many eminent scholars in the design research community within our reviewer pool, but also early career academics who are supported in writing peer reviews, a core part of their academic development, and who form our reviewer pipeline for future conferences. We endeavoured to match reviewers' expertise with papers through topic selection and automation, with some manual adjustments. The reviewers provided feedback to authors on how to improve their papers.

In total we received 280 full paper submissions in a one-stage submission procedure, of which 269 were viable to go to review. In total the 192 reviewers wrote 553 reviews, using reviewer guidelines. The reviews averaged 350 words. Each paper received two, sometimes

three reviews. 87 papers (32%) were accepted with minor revision and a further 57 (20%) accepted following (major) revision. This represents a 52% acceptance rate. As in previous conferences, we used the ConfTool system to manage the submission process. The ability of authors to rate and comment on their reviewers as in previous years, helps to drive up the quality of the review process. The authors rated 237 (43%) of the reviews with an average of 4.4 on a scale of 1-5 on the criteria *justified*, *constructive*, *encouraging*, *fair* and *convincing*.

Words of thanks

DRS2020 would not have been possible without the contributions of many excellent people who have devoted their insight and experience to the conference. We would sincerely like to thank the Local Organising Team at Griffith University for their remarkable work in transforming the conference into a virtual experience, and the extra time, effort and resources that this has involved. In particular, undertaking this transformation 4.5 months before the conference launch has entailed a significant level of creativity, courage and perseverance. We also thank the DRS for their expertise and guidance in the programme and review aspects of the conference. The authors, the Programme Committee and all the reviewers all deserve thanks for their valuable time and expertise in ensuring the high academic quality of this conference, as well as the SIG convenors for their role in curating themed tracks. Finally, we thank Griffith University and the Design Research Society for supporting the conference.

We hope that you enjoy these proceedings, and that they provide a thought-provoking and inspiring read.

Stella Boess, DRS2020 Programme Chair
Ming Cheung, DRS2020 Conference Chair
Rebecca Cain, DRS2020 Conference Co-Chair

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Volume 3
Theme Co-creation



Editorial: theme Co-creation

Rebecca CAIN, Stella BOESS

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Co-creation in all its forms – including participatory design, collaborative design, and co-design is continually an enduring theme at recent DRS Conferences, receiving a large number of submissions. Design researchers increasingly collaborate and co-create with other fields such as healthcare, engineering, political science, social sciences and with a wide variety of societal stakeholders and issues such as wellbeing, in addition to addressing developments such as networked, embedded and intelligent technologies. How can design research engage with people, other fields and support new interdisciplinary ways of working?

When submitting papers, authors were able to pick appropriate keywords for their papers which allowed the emergence of six sub-themes within the Co-Creation theme – Participation, Empowerment, Teamwork, Designers and Scientists, Social and Service Design and Mobility and Public Space. This is in addition to three DRS SIGs which also have themed Co-Creation sessions on Behaviour Change, Global Health and Health, Wellbeing and Happiness (SIGWELL).

The first two sub-themes, **Participation** and **Empowerment** are interlinked, with the Participation sub-theme exploring the more practical research mechanics of participatory design, whereas Empowerment focuses more on applications of participation in design. Within the **Participation** sub-theme, paper 246 presents a descriptive analytical framework that explores the materiality of artefacts used in the participatory design process. The framework aims to reduce barriers for participation in design activities and increase participant engagement. Papers 296 and 302 together look at the use of data and analysis within participatory design. Paper 296 develops methods that balance making data-rich video analysis accessible, while allowing novice analysts to make informed judgements. They use a video card game involving primary school teachers. Paper 302 suggests that the underpinning values of participatory design, those of empowerment and valuing lived experience create an opportunity to realise research data in a different way. The sub-theme of **Empowerment** drills down into particular applications of design techniques within collaborative settings. Design sprints aimed at co-designing healthcare services are examined in Paper 231, while in Paper 247, a collaborative co-design research project to tackle food



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poverty is described. Paper 367 presents a pilot study to resolve communication inequities in Qatar's construction industry.

Teamwork is an essential component of participation in design research, and the **Teamwork** sub-theme explores this through three papers which collectively explore technology, learning behaviour and remote collaboration. Paper 378 considers the social and technological implications of how remote collaborative-making mediated by technical tools might foster new ways of thinking and making through play and experimentation, affect social interactions and empower people to become producers and affect relationships between collaborators and the technologies in use through transparent processes. Paper 330 proposes that designers can improve their collaboration effectiveness by fostering team learning behaviours. Paper 398 is one of only a few papers in the proceedings to have re-positioned itself to reflect on its research in light of the COVID-19 pandemic. The paper proposes that in examining remote collaboration as a design problem, a new framework is needed to help teammates understand various differences such as how they build trust, exchange information and cope with creative abrasion. The paper highlights how COVID-19 has meant that design education and workplace activities have been thrust into new virtual spaces, amplifying some of the challenges associated by teamwork.

A popular domain in which to explore interdisciplinary and synergistic working is through the marriage of design and science. The **Designers and Scientists** sub-theme presents three papers all investigating this mode of synergy. Paper 126 addresses collaboration between design and science and explores how designers generate ideas from laboratories and how scientists perceive these ideas. Paper 154 explores through an applied example how narrative thinking helps to understand, communicate and disseminate information naturally and flexibly and Paper 182 looks at the commercialisation of scientific research in universities and explores practical tools to bridge the gap between research and the market. It proposes a multi-disciplinary workshop structure with the inclusion of designers and scientists working together.

The Co-Creation theme concludes with three applied papers within **the Social and Service Design** sub-theme. Within the context of service co-creation, the three papers together present three different international applications of social and service design. In paper 173, holistic service design thinking was used to optimize the services of a public animal shelter in Taiwan using co-creation, highlighting the complexity of stakeholder relationships. Paper 259 describes how a real-world social design project in New Zealand energized design students to engage in their studio activities in a learning process that was informal, generative and supportive. Finally, paper 273 looks at the crisis of social problems in Nigeria and describes a collaboration between three universities on a project to intervene in the crisis. Using a co-design methodology, the project aimed to improve educational materials and strategies in schools.

The final sub-theme within Co-Creation is **Mobility and Public Space.** A number of related papers were accepted, illustrating this as a ripe area for research within the context of co-

creation. Paper 308 proposes a Virtual Reality Platform to discover subjective preferences on public waiting rooms, Paper 364 explores young people's experiences of journeys to work to create a scenario approach designed to bring together transport designers and end users' views, and Paper 396 prioritises fitness runners' experiences and preferences in running outdoors in China, for example by focusing on their music preferences to fit experiential and environmental conditions, and proposes an initial framework combining interactive convenience, environmental factors and running state.

Overall, the papers within the Co-Creation theme demonstrate the extensive scope of the theme. There are many examples of inspiring applications of co-creation within an international context, while at the same time, the theoretical aspects of co-creation as an umbrella of different methods and processes is also evident. In a similar vein to the Impact theme, central to the theme of co-creation is the idea of collaboration and teamwork. As paper 398 in this theme highlighted, the challenges presented by COVID-19 in terms of collaboration and teamwork will no doubt inform and inspire design research into co-creation for many years to come. In this respect, synergistic ways of working creatively in a collaborative way with stakeholders and people will be a fertile area for future research.

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The Politics of Materiality: Exploring Participatory Design Methods, Tools & Practices

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Abstract: As participatory design approaches (PD) become incorporated into mainstream organizational practice, it becomes increasingly important for designers to consider how can participatory design tools, methods and practices be made more accessible, understandable and engaging for a broader audience. This paper presents a descriptive analytical framework that explores the materiality of artefacts used in PD, through various studies of the interaction of material and relational considerations and the implications of these interactions on design outcomes. We develop this framework by drawing lessons from (1) existing frameworks on materiality and PD tools; and (2) a series of empirical studies exploring materiality through a suite of artefacts, across different contexts and studies. We highlight the utility of this framework as a tool to reduce barriers for participation in design activities and increase participant engagement.

Keywords: materiality; design methods; participatory design

1. Introduction

The materiality of design tools, techniques and methods plays a central role in determining how effectively non-designers can be successfully engaged in design practice. The thoughtful consideration of materiality enables the structuring of democratically oriented environments, with direct influence on the social roles, agency and influence of both participants and designers within the design process. This has significant impact on the flow of an activity, as considered selection of materials of design allows for establishing equitable power distribution where the dominance of participant groups is moderated (Björgvinsson et al., 2010); however, if left unchecked, the lack of consideration of materiality may also lead to unintended consequences such as privileging certain participant groups and/or disenfranchising others. Therefore, it is imperative that designers are cognizant of the material choices, their consequences on participation, and how materials can be politically

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valenced in facilitating the use of tools and practices in collaborative design spaces. This can be done by a critical appreciation for the materials of design tools, their users (both designers and non-designers), as well as the intended social context within which they operate.

Design is epistemologically distinct from other disciplines because it is principally concerned not with certainties or even probabilities, but with an open texture of possibilities (Gaver, 2012). For this reason, design can pragmatically operate across ontological and disciplinary boundaries, creating value for stakeholders from different backgrounds, functions, and perspectives. Over the past three decades designerly practices have infiltrated mainstream organizational contexts (e.g. innovation, strategy, marketing, product development, customer research etc.); disciplines which have shown an increased interest in user-centred approaches. In such circumstances it becomes increasingly important that the tools, methods and practices that enable design collaboration are easy to understand and assimilate for non-designers. In this way the tools themselves act in a manner analogous to 'boundary objects', bridging participants across different social worlds (Star & Griesemer, 1989). Brandt, Binder & Sanders (2012) contend that the selection of appropriate tools and techniques must be grounded in the context of the design; hence it is important for participants to understand what can be accomplished when both selecting and using design tools. In order to maximise the value of designerly activity, participants should ideally be equally placed in terms of their understanding of design tools and methods, the affordances, capabilities and agency they provide, accompanied by a participatory mindset (Sanders & Stappers, 2008) when using them in practice. There remain open questions regarding the precise nature of the roles of the materials of these activities in achieving their participatory aims.

Materiality is an increasingly influential perspective within design research. Jung & Stolterman (2011) state that "through the lens of materials, design can be considered as a process of creating meaning with proper materials based on exploratory practice with them." This derived meaning is heavily contingent on how materials interact with their environment, which changes how they are experienced, used, socially understood, and owned. It is hence important to be mindful of the accessibility of the tools and techniques designers develop, because even though skilled design practitioners may be able to appropriate tools to different contexts, this can still pose an entry challenge for novices and non-designers (Brandt et al., 2012). So, there is a need to explore how our choices about materiality can act as democratic mediators among participants in design activities, levelling social hierarchies and domain expertise, and distributing more equitable agency, influence and control over the process for all participants.

Prior work has been done to study the purpose and contexts of PD tools and techniques (Sanders et al., 2010). However, providing the scaffolding to novices or non-designers to achieve a 'participatory mindset' remains a challenge (Sanders & Stappers, 2008). If the use of tools and methods does not align with the participants' motivations for using them, e.g. if participants are only using a 'journey map' because it was prescribed to them by a consultant, and do not fully understand, agree with or have purchase over its purpose, the

value discerned from its use is diminished.

We argue that the materiality of design tools, methods and practices have dimensions in addition to their material properties i.e. normative uses, social conventions, prior associations, that can leverage political agendas of participation to augment how designerly practices are conducted. This research explores whether – and how – it may be possible to shift participants into more participatory mindsets during design processes by facilitating more considered reflections on the material nature of the tools we use and their applications; possibly making the resulting value of those activities more apparent. We present a descriptive analytic framework, to explore material and relational considerations of different design tools, methods and practices. We draw upon (1) literature on materiality in design and PD tools – and (2) findings from empirical studies conducted to explore materiality across a broad suite of tools and methods. The framework maps out a set of dialogic relationships between different elements of materiality (material considerations) and their consequences on participation through possible emergent applications, providing a practical aid for informing how to effectively engage non-designers in design practice.

2. Materiality and Design

2.1 Perspectives on Materiality

Materiality plays an active role in the creation of meaning through the design process. Jung and Stolterman (2012) critically reflect on user-centred design, suggesting a move from functionality as a determinant of form and aesthetics, to their proposal of a 'form-driven' approach to interaction design research, that emphasizes form and materiality. Schön (1984) was one of the earliest to stress the importance of the thoughtful consideration of how materials 'back-talk' to the designer as a means of understanding the practice of design itself. Wiberg (2014) notes how Schön's (1984) use of a vocabulary that acknowledges material artefacts as conversational objects highlights the dialogic nature of design practice and the materials of design. Wiberg (2014) contends that the 'back and forth between wholeness and ideas about design in relation to its practical manifestation including materials, textures and details needed to be carefully crafted to reach the desired outcome' (p. 626). This argues for the thoughtful consideration of the materiality of the tools we use in design practice and the dialogue they have with the users of those tools. The materiality of the tools, methods and practice, should be able to talk back to the user – irrespective of their level of expertise or familiarity to design. Materiality has always been a core aspect of traditional design, influencing both the functional and aesthetic properties of systems (van Kesteren et al., 2007) while also embodying social and economic values (Jung & Stolterman, 2011). Wiberg (2014) suggests this shift of focus to the material can also be seen as a return to the foundations of design as in the sciences of the artificial (Simon, 1968) where materials are seen as a basic constituent of design.

2.2 Materiality of Methods and Participation

There has been significant discourse around design and participation over the years. The Design Research Society (DRS) has had significant interest and influence in shaping the role of design tools and methods over the years, with its formation being the result of the success of the first conference on design methods in 1962 (Cross, 2007; Jones & Thornley, 1963). The interest in the notion of making design more inclusive and participatory within the DRS community can be found as early as 1971, with the theme of the second DRS conference on design participation (Cross, 1971). Concurrent movements in user-centred systems design occurred in Scandinavia, where a 'work-oriented' approach to design had emerged out of pioneering collaborations between computer scientists and workers' unions (See e.g. Ehn, 1988; Floyd et al., 1989; Kyng & Mathiassen, 1979). Over time the practices, tools and methods from PD found their way into mainstream business practice. A revived focus on design within contemporary organizational practice emerged under the banner of design thinking – designerly practices packaged for non-designers. Design is seen to create value as a competitive advantage (Borja de Mozota, 2002; D'Ippolito, 2014; Drew & West, 2002; Heskett, 2009, 2017; Roy & Riedel, 1997; Verganti, 2008; Walsh et al., 1988), a strategic instrument to negotiate wicked problematics (Braga, 2016; Buchanan, 2015; D. Dunne & Martin, 2006; Johansson-Sköldberg et al., 2013) and increase market acceptability for innovations, when co created with participants (Björgvinsson et al., 2010; Buur & Matthews, 2008). Due to its influence spanning across a broad spectrum of domains and contexts - the tools, methods and practices of PD have origins across different worlds; all contributing to the rich repertoire of tools and techniques of design in community-driven, commercial and research applications (Carroll, 2003; Kaptelinin & Nardi, 2006; Rogers, 2004; Sanders et al., 2010). Central to these tools is their materiality i.e. their material properties and affordances which break barriers to participation and act to provide shared understandings between sometimes diverse participants.

There is, however, significant criticism to how design has been used practically, specifically under the guise of design thinking (Khan, Snow, & Matthews, 2020; Khan & Matthews, 2019a; Kolko, 2018), and particularly in versions where it is supposed that anyone can effectively design simply by taking up the methods and tools, whether or not they are using them in their intended spirit. A criticism to the use of design in business is how the tools and practices are packaged under glossy frameworks, toolkits and 'recipe-like-solutions' (Orlowski et al., 2016) which only superficially engage with the practice and inhibit design to perform in how it is originally intended. Similarly, Gray's (2016) study of practitioners, contends that design in practice is more of a mindset than a method, which echoes Sanders and Stapper's (2008) sentiment; and so the intentions behind using designerly tools become increasingly important to address. Yet common to these approaches are the ways in which they organize participation through socio-material means – physical materials, turns, rules, goals – which we analyse for how they can be leveraged as political artefacts (e.g. constrained output forms such as using brick-based tools to ensure output quality cannot showcase difference in skills, or using materials that can only be used as collaboratively due to properties such

as scale or weight). In turn, this opens up possibilities for materiality to be employed as an active agent in making design more accessible in practice.

2.3 The Politics of Materials

The interest of design research towards materiality extends beyond material dimensions in design itself, but also in how materiality can be an analytic lens (Wiberg et al., 2013, 2014). This draws upon critical reflections of how materiality impacts participation with and use of design tools. The vernacular around materiality has emerged within a post-phenomenological (e.g. Verbeek, 2011) perspective, in which it makes sense to speak of material artefacts having morality, as actors1, and being politically valenced (c.f. Winner, 1980). In these cases, interaction with materials are strongly influenced by the relationships we have with them and the social systems in which they play. Critical design uses design outputs to provoke reflection on our current societal practices (A. Dunne, 2008; A. Dunne & Raby, 2001); however reflecting on the materiality of the methods, tools and practices of how we get to those outputs, can also be of significant importance as designers.

Much of the prior work focuses on material-centred design as a whole; our present aim is to take a more targeted approach that explores materiality as related to the choice of design methods, tools and practices used in PD. Wiberg's (2014) methodological framework acts as a guiding tool for exploration of materiality within interaction design research by exploring methods to study materiality. Our stance is positioned slightly adjacent to this. We contend that attention is required into the materiality of design methods, practices and tools of design to uncover design possibilities and implications on participation. That said there are considerations to materiality that Wiberg's (2014) methodology presents which can still be incorporated in our approach. Extending the notion of exploring materiality related to design methods, tools and practices, we can consider how to make design as a whole more accessible to a broader audience, and in doing so make its value more explicit. Our study of the materiality of the methods used to bring participants together provides the opportunity to understand how we can reduce the barriers to participate and engage with design processes. Aspects such as familiarity, agency, and understanding become important to consider when exploring this space.

2.4 Theoretical Grounding

In order to understand how materiality interacts with participatory design practices we draw upon the frameworks of (1) a methodology to study materiality (Wiberg, 2014) and (2) organizing PD tools and techniques (Sanders et al., 2010). This underpins our framework which situates lessons from these two frameworks and adds empirical data from our own interventions to exhibit how materiality influences design to produce more democratically oriented environments.

1 We are cognizant that Latour's and colleagues' (Latour, 2004) notion of '*actants'* might also be a lens to explore the political agenda actioned through materiality, however would require a very different standpoint, the inclusion of which would be beyond the scope of this paper.

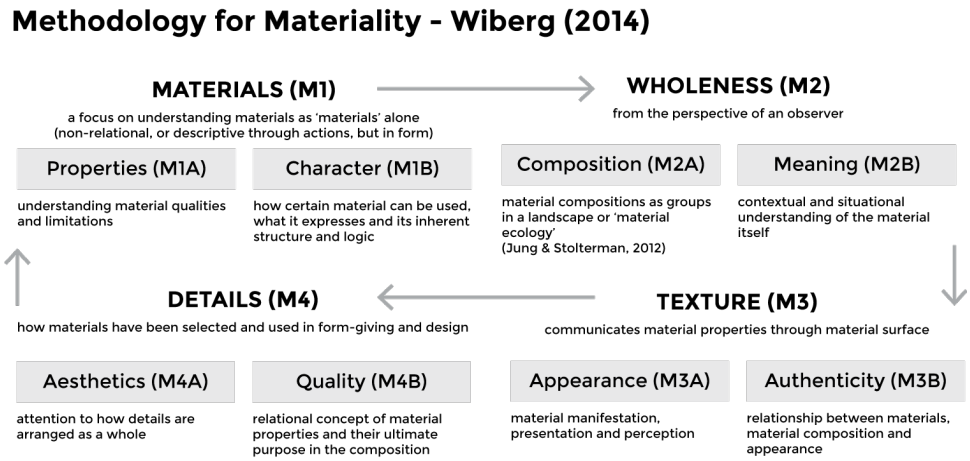

Figure 1 Wiberg (2014) Methodology for Materiality Framework

The purpose of Wiberg's (2014) framework (Figure 1) is to serve as a guide for methodological explorations in material-centred interaction design research. The framework is organized as a dialectic among four lenses: materials, wholeness, texture and details and their further sub categorizations. We also draw on Sanders et al.'s (2010) framework for organizing tools and techniques of PD (Figure 2) as a complement to this. The aim of Sanders et al.'s framework is to provide the PD community a means to discuss relevant applications and to identify potential areas for further expansion of PD within organizational and research practice. The framework is organized along three dimensions: form, purpose and context.

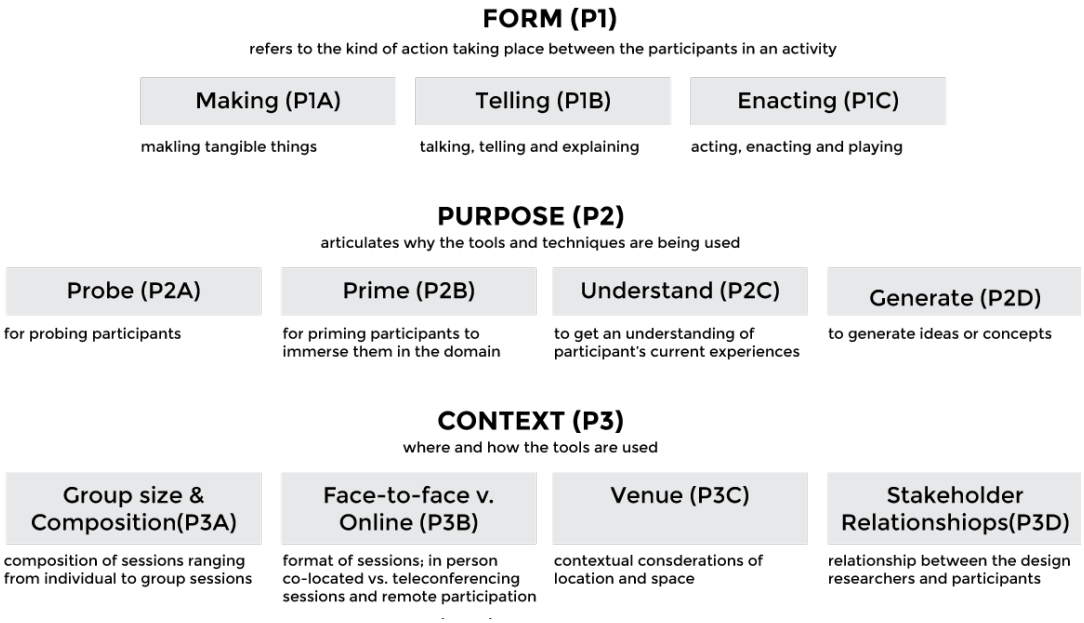

Figure 2 Sanders, Brandt & Binder (2010) Framework for Organizing Tools & Techniques of Participatory Design

Both of these frameworks are very useful in their own right, with Wiberg (2014) presenting a detailed perspective with how to approach materiality at a broader scope, and Sanders et al.

(2010) encapsulating the overarching structure of PD tools and techniques. The framework we outline later aims to build on both these structures.

3. Materiality Studies

3.1 Materiality of Methods - A Research Program

We present findings from a series of experiments conducted in a variety of distinct, specific contexts to explore materiality as part of a broader program of research. The overall project takes on a Research through Design (RtD) approach, where the individual studies are inspired by Binder and Redström's (2006) exemplary program of research. The experiments and explorations range across a spread of materials, some popularly used in design practice e.g. Lego , Design Cards, Sticky notes, (Christensen et al., 2019; Frick et al., 2014; Roy & Warren, 2019) and other more unconventional materials, that may be more familiar in everyday life to non-designers, and more ubiquitously accessible (Rubik's Cubes, Dice assortments, Playing cards). The aim of using familiar artefacts within a designerly context is to study how prior associations with the tools that are conventionally not a part of mainstream design, may influence participation, i.e. can it yield greater understanding, control and agency for non-designers to participate? The programmatic nature of these explorations employed a broad range of materials in diverse contexts to explore how the materials influence the design process irrespective of the intended outcomes. Each exploration is set as an 'ultimate particular' (Stolterman, 2008) self-contained within their contexts and instances – a composition of the system as well as the organization around it. This allowed for a thoughtful appreciation of the role of that the materials play, what kind of political agenda can they bring to a design process, abstracted from specific use cases. This also acted as a small-scale proxy for how participatory design methods and tools are also employed in situ in different contexts, setups, with various participant types and objectives. Our conceptualisation of materiality refers to: (1) properties internal to the material (i.e. scale, size, shape, colour, weight etc.); (2) actions the material affords (e.g. movement, arrangement, annotations etc.); and (3) the social meaning, presence and value of the material when it interacts with people and the context (prior associations, conventions, invitation to use, value, novelty etc.) Materials can be digital and/or analogue in form.

Figure 3 provides a high-level overview of the various activities undertaken as part of this program of research, covering aspects such as context within which the activities were deployed, participant count and types and a thumbnail of all the materials used within the sessions as well as their description. The facilitation structure is highlighted to provide context, coupled with top-level findings across the various activities. The studies were set across a wide gamut of contexts (See: Khan, 2020; Khan et al., 2019; Khan, Snow, Heiner, et al., 2020; Khan & Matthews, 2019b) to explore patterns and concepts that emerged in

different domains and contexts of the program, as characteristic of strong concepts (Höök & Löwgren, 2012). The lessons from these studies are detailed in the composition of the

framework and discussion further. The studies involve participants from four groups: design educators, students, and design and non-design practitioners. The challenges faced in design pedagogy to students or novice designers are similar to those of teaching design to non-design practitioners. This participant mix provides a range of the considerations we might encounter across the board in industry and educational settings.

	A	B	C	D	E
MATERIALS					
	Lego Classic Kit (303 bricks); text & visual prompts (cards & digital)	Bespoke design cards (12); written narratives;	Rubik's cubes: standard, mini, and mega; blank coloured cards (54); Coloured paper; sticky notes; various bespoke design cards; permanent & dry erase markers; cutting tools	D6 dice (10); yahtzee travel 5 dice set; 7 Dungeons & Dragons polyhedral sets (D4 - D20); blank wooden cubes (10); blank cardboard cube; sticky notes; permanent & dry erase markers	Printed paper based prompts; pens and pencils
PARTICIPANTS	19 participants (non-design practitioners & students)	9 participants (non-designers)	11 participants (design practitioners & design teaching staff)	8 participants (design teaching staff & students)	5 participants (design teaching staff & practitioners)
FACILITATION STRUCTURE	Workshops (face-to-face & online)	Probes (online)	Workshops (face-to-face)	Workshops (face-to-face)	Probes (paper/take home)
TOP LEVEL FINDINGS	• Low-fi structures forced reflection on meaning of form • Metaphors used to cater to material constraints (structure, form, colour) • Quantity (assortment) sometimes problematic, but the modular nature of Lego allowed reuse • Familiar form, low learning curve • Colour used to form meaning when form failed e.g. green represents 'softness' • Low social peril, as no expert skills needed or Hi-fi outputs • Playful elements; lots of tinkering and friendly competitive banter • Easier to communicate through the creations	• Material form easy to shuffle and lay out based on prior understanding of cards • Easy to understand format (similar to Cards Against Humanity) • Narrative forms positioned as fiction stories, easy to consume, comprehend and provoke reflection • Specific and precise tools - did not require much effort to engage with • Could not be annotated due to colour and coating of cardstock	• Novelty sized artefacts command attention in the space (Mega Cube) • Solved states of the cube intimidating to change • Participants reluctant to write on blank cards (thick card stock and rounded corners) because of perceived effort in preparation; comfotable to write on coloured paper • Sticky notes used to annotate large cube • Participants developed various rules, and conditions of using the materials e.g. to make personas, to brainstorm • Card conventions such as fanning & laying them out like poker, observed	• Affinity towards wooden cubes because they can be annotated • Preference to form of the small wooden cube vs. large cardboard cube - parallels drawn to the size of a 'tennis ball' for handling • Various application contexts considered - dice to dictate 'thinking hat' condition • Value seen in material artefact as a social focal point for communication • Articulation of the novelty of form - adding an element of quirkiness to context • Seen as a way of catering to paralysis of choice and distributing onus of responsibility	• Participants found completing all the tasks challenging • The material form was seen as 'not designed' - as rationale for rushed responses citing font selection and paper thickness • Task Fatigue - as prompts required similar output as a drawing for different contexts • Different techniques employed to articulate journeys (flowcharts, icons, lines etc.) • Different forms and levels of annotations made across various participants • Struggle with open-ended nature of task i.e. blank canvas

Figure 3 Summary of Research Program Studies

4. Materiality Politics Framework

Our framework (Figure 4) is designed as an abstraction of a complex design process; it in no way means to oversimplify the considerations that go into the design – but presents a structure for the considerations, that can help designers understand how the material and social aspects of design tools, methods and practices can be best leveraged within their own contexts, to influence and improve participation.

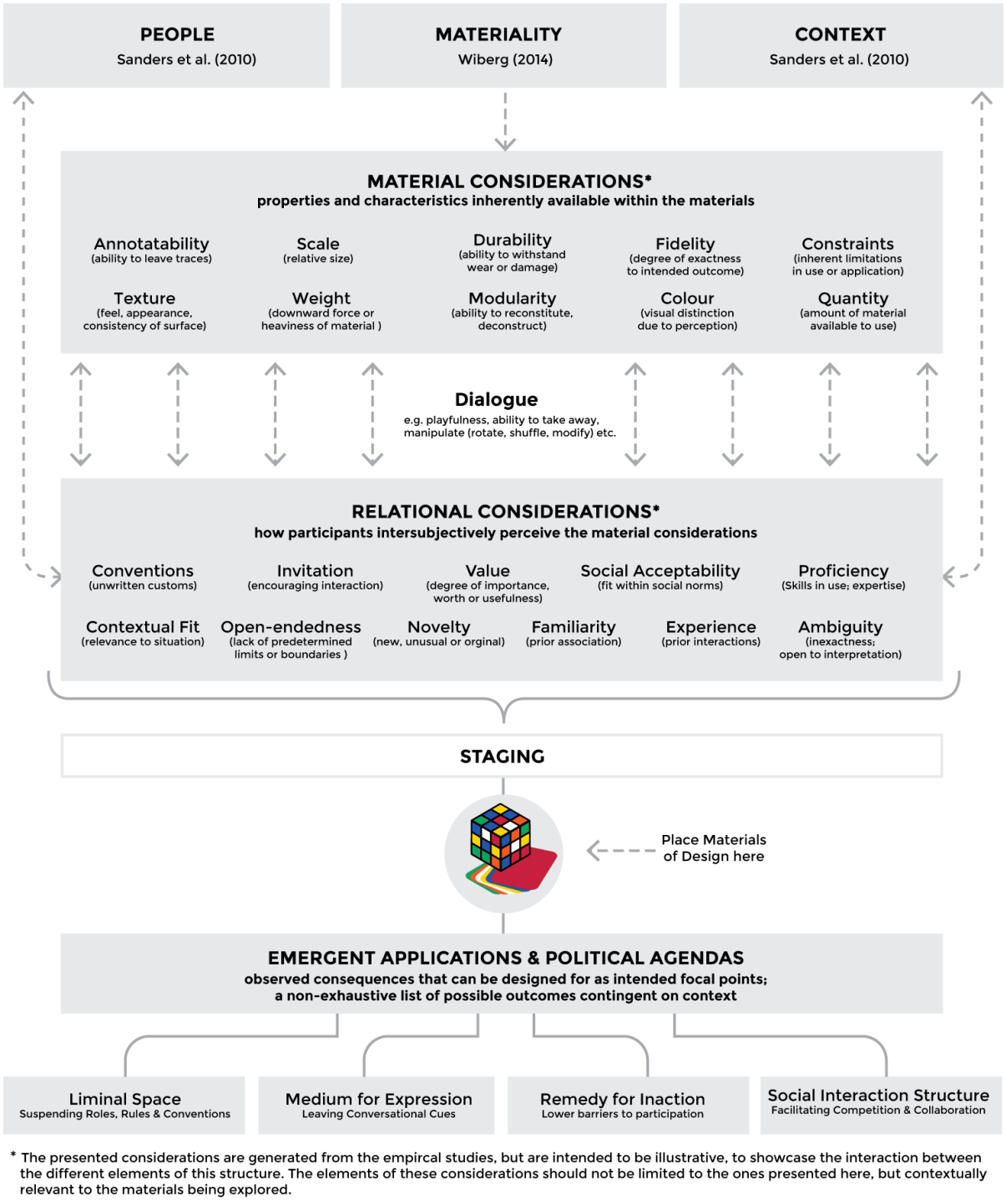

Figure 4 Materiality Politics Framework

4.1 Understanding the Framework

The framework presents a dialogic interaction among purpose, material considerations, relational considerations, staging and emergent applications & agendas. Purpose refers to the actual setting of the problematic, i.e. users and contexts, which is the prerogative of the

designers who use this structure as they are best placed to consider where the tools can be applied and who the intended participants are; this is informed by Sanders et al. (2010) purpose and context stages. Material considerations are properties and characteristics inherently available within the materials, which can impact participation. These are closely tied to relational considerations, the way in which participants intersubjectively perceive the material considerations – and so there is a dialogue between these two facets of the material and the social. The considerations used in the framework are meant to be illustrative of the types of considerations that may be relevant in a design context, the ones described in Figure 4 emerged from the empirical studies conducted. The interaction of the material and relational considerations can be illustrated through the example of fidelity & social acceptability: engaging with materials that are constrained to lower fidelity, allow for less social consequence of skill deficits within individuals when used, and so can have a positive impact on greater participation. This dialogue serves as an extension of Wiberg's (2014) model. Thereafter comes staging, a very important aspect of any PD work –the facilitation structure, rules of engagement, tasks, sequences, intended goals etc., aspects which are very contingent upon the context of use. We do not neglect the structure of facilitation, as the non-material aspects of participation structures play a significant role in shaping the flow of activities and their resultant outcomes, however the focus of this particular framework is to map how the material properties and considerations can influence participation. Beyond this we place our material artefacts, irrespective of whether they are physical, tactile materials, or intangible methods or practices. The way in which different political agendas are materially influenced are represented as emergent applications and their resultant political agenda. These are derived from observations specifically grounded in the empirical studies we conducted and are by no means an exhaustive list. They do however act as exemplars of the breadth of functions different material and relational considerations can serve, and how they can be 'designed' towards specific socio-political outcomes.

5. Emergent Applications & Discussion

5.1 Political Agenda in Emergent Applications

Understanding that material artefacts are morally and politically valenced (c.f. Winner, 1980), provides a lens through which we can trace certain aspects of the dialogue between the material and relational considerations, in light of possible applications. For instance, if the onus of a decision must be shared amongst a collective, exploring what aspects can be offloaded onto the dialogue of relational considerations (e.g. social acceptability, open-ended nature, ambiguity of form, and imposition of conventions associated with the materials) with material considerations (e.g. a mix of the quantity, scale and modularity of the material) – an outcome that results in a 'random' a decision, might be the most optimum use of the materials. This creates the ability to delegate agency, where the arbitrariness of the outcome of the material defers any accountability, i.e. no need to justify the decision and take on responsibility, with the potential for positive social consequences to obviate conflicts within

a team setting (as well as post-hoc finger pointing). Similarly, if one wanted to deconstruct how to disenfranchise a certain group – choosing tools and materials that are contingent on high proficiency or skill, ambiguous in form and can generate high fidelity outputs, can be employed e.g. drawing tasks on blank canvases, where the skill of the participants is very evident in the product of the exercise. Flipping this over – ensuring the fidelity of the material is constrained so the output cannot go beyond a certain detail, renders proficiency of skill level immaterial e.g. it would be impossible to create a realistic car, with 4 Lego bricks.

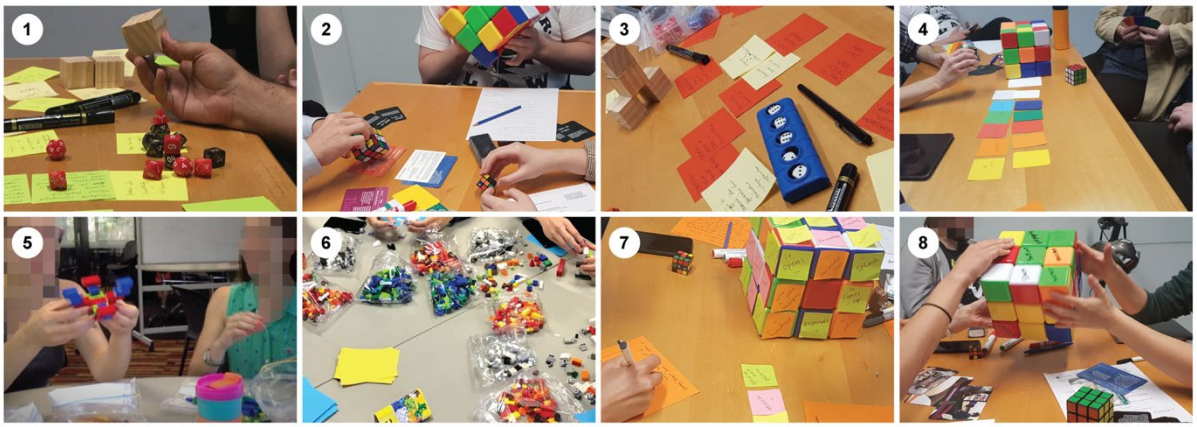

Figure 5 *Montage of Material and Relational interactions: 1. Externalising dialogue using die as a communication tool; 2. Exploring scale of different cube materials; 3. Building modular structures and scribing perceived challenges; 4. Participants creating a card-based game through materials, not writing on the actual card because of perceived material 'value'; prior association of fanning cards; 5. Lego constructions used as complimentary artefacts; 6. Co-located Lego workshop setup; 7. Using sticky notes and puzzle cube for idea generation, where each cube-side represents a different design consideration,; selecting one note from a side as prompts for creating a concept; 8. Rotating novelty sized puzzle cube collaboratively.*

We present below examples of four discrete political agendas for participation that can be structured by studying the dialogue between the material and relational considerations:

Agenda #1: A Liminal Space – Suspending Roles, Rules & Conventions

If leveraged well, materiality can play an active role in reorienting participants from their traditional organizational roles to ones where they adopt a participatory mindset. We can achieve something akin to what anthropologists refer to as liminal space – a state where conventional practices and orders are suspended and replaced by new rites and rituals, situated within that particular context (Czarniawska & Mazza, 2003; Turner, 1969). Some materials are able to achieve this by mere presence within an atypical context, e.g. bringing a giant Rubik's cube (C) or Lego (A) into a boardroom disrupts conventional norms of materials you would find in that ecology. If such materials are able to find a way into uncommon environments - their play element fractures existing conventions and is able blur hierarchal lines and role structures of participants; immersing them within the material and domain (P2B), putting them in the 'mindset' (Gray, 2016; Sanders & Stappers, 2008) of participation.

Agenda #2: A Medium for Expression – Leaving Conversational Cues

Materiality can also play a significant role as medium for expression. Schön (1984) contends, materials are dialectic with designers; however as artefacts also provide the affordance for use as props for dialogue, from their material character (M1B). Materials can be pointed at, used as descriptors through ostensive definitions (1965); inherently reducing the burden on the participants to think in abstract ideas when speaking, to offloading meaning that is embodied in a shared focal point, that can be spoken through (M3A). This was observed across a range of studies – In study (A) participants assigned meanings such as 'fragrance' and 'opacity' to plastic bricks, structurally conflicting properties; yet this was a very effective use of metaphors embodied in the material to communicate to a group. In study (C), the Rubik's cube took on the role of a talking device - any participant who held the cube was named 'the cube master' – and was the only one who could talk, hence delegating turn-taking in conversation to the material artefact, which could be moved around and shared amongst the collective. In study (D) participants highlight that the novelty of the form of the dice would allow navigation through some of the challenges the participants uncovered with communication (cultural barriers, communication breakdowns, varied language proficiencies). In doing so, material properties can actually be leveraged in a purposive manner – where in the case designing PD tools – circumvent the challenges of communication by attending to the details of quality (M4B) and expression (P1B, P1C) to better articulate their experiences (P2C).

Agenda #3: A Remedy for Inaction – Lower Barriers to Participation

As active proponents in design materiality can also be mobilized to cater to challenges for participation such as low engagement or being overwhelmed by choice; this can be catered to by exploring how the materials in themselves can be a remedy for inaction. One of the contextual challenges discussed in in Study (D) was that when novices trying to navigate complex contexts, may be paralysed by inaction, due to uncertainty of knowing what the 'right' thing to do is. Materials, if positioned strategically can help cater to this, by inherently nudging participants action along. This can include aspects such adding constraints, as observed in Lego (A), where participants were challenged by brick colour, count, assortment constraints, or the Rubik's Cube (C) where participants used the 3x3 grid to map out a finite number of possibilities to a dimension; but this can also be made even simpler by eliciting very basic, explicit outputs – such as the roll of a die (D) as an instructive step. Structuring the material to embody a directional set of options that is agnostic of the order or sequence of what is done next. This is leveraging the material character (M1B) and makes a very tangible (P1A) and playful (P1C) way of diffusing an otherwise daunting decision.

Agenda #4: A Social Interaction Structure – Facilitating Competition & Collaboration

A core aspect of participation in most design contexts is having participants engage with one another. There is a degree of social peril that may be associated with interactions with others, for which exercises such as icebreakers have become a normative part of

collaborative work. An emergent application that was observed and can actually be leveraged through the facilitation structure as well as the materials themselves is the use of competition and collaboration. In study (A) participants developed complimentary responses to prompts e.g. a participant designed a soap form, and the other designed a soap dish. Participants were also seen to share access to materials (e.g. bricks of specific colours), however in more contrasting instances participants attempted to sabotage their peer's work (stealing bricks, invoking rules, physically intervening) as well as introduce friendly banter. Participants even used materials as means to interject conversations (D) to draw attention towards themselves. In study (C) participants had developed their own version of a design card game (completely abandoning the core material – the cube) – however they very quickly got into discussions over what the rules of using the materials were - dominant participants interjected, moving out cards laid by other participants. This emergent behaviour is difficult to locate within the materiality framework – but would most likely be situated in (M3B) – relationship between materials, material composition and appearance. Some degree of the generative nature of coming up with participants' own 'house rules', might be placed within (P2D) of the PD framework, and some of this is context dependent (P3C), however it cannot be more meaningfully located within the literature. It is interesting because the affordances of being able to control the shared space, and access to materials becomes an interesting element to play with when trying to explore how to bring in levity whilst maintaining agency and not marginalizing others within the design process.

5.2 Utilizing the Framework

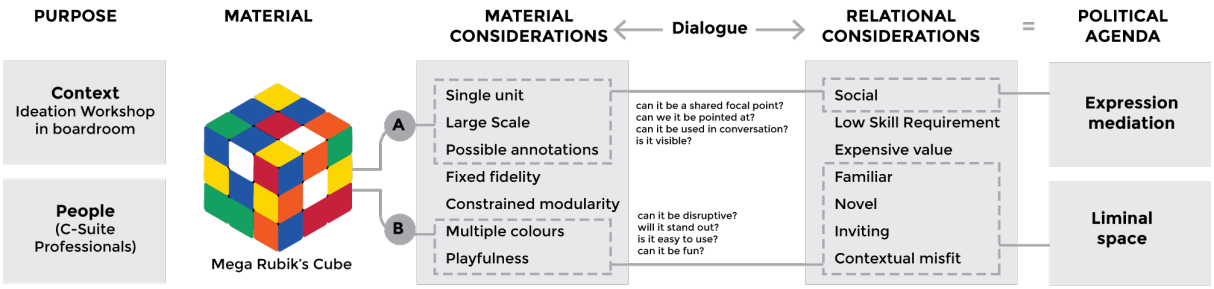

Figure 6 *Mobilising the framework - structuring two emergent applications / political agendas: A. Expression Mediation; B. A Liminal Space*

Our discussion highlights a series of different observed patterns from the interactions between the material and relational considerations, grounded in the literature. However, the real pragmatic value of the work comes to light when we start tracing pathways of materiality from the emergent applications to the material considerations. In doing so we can start to uncover what aspects of the considerations can be leveraged through their political affinities, to pathways that are beneficial to the study and participants at large. Figure 6 illustrates two different paths that are meant to act as a possible mechanism of operationalising our framework. We map out the framework by providing a purpose of use, putting the material of design at the start and then mapping out the material considerations, dialogue, relational

considerations, and emergent applications and agendas. The boundary between the relational and material considerations is marked specifically for aspects that lie at the fringes of both these considerations and to reiterate the dialogic nature of this exercise. We propose (1) placing the material artefact (which in this case is the novelty cube) as our starting point, after defining the audience and context. This draws attention to the material, and allows us map out a path from the material considerations to how it is understood in context by people and what relational considerations come into play (See: Figure 4). The idea then is to (2) map out different aspects of considerations within each layer and exhaust them. The considerations in our framework may only serve as a starting point, and can be modified and supplemented with provocations and questions in the dialogue. Thereafter considering (3) what aspects of emergent applications are best suited to the context and mapping it at the far right. In our example we have mapped out two paths: (A) Expression Mediation and (B) A Liminal space. If we focus on the path B, Liminal Space then becomes the point from which we work backwards, spatially reorienting the different considerations to follow a path that best serves this motivation. Other modifications which can be made to supplement or add richer understanding could be using tokens or placeholders for participants or contextual factors, where we can present a different pathway which explores mediation of expression (communication) between participants through the materiality reminiscent of Schön's (1984) articulation of material artefacts as conversational objects and Wiberg's (2014) notion of the dialogic nature of materiality.

6. Looking Ahead

We have presented a descriptive analytic framework, that explores the material and relational considerations of artefacts that can be used across different design tools, methods and practices. Materiality is key to participation. While considerable attention has previously been given to PD methods and techniques, as well as materiality as a whole, our framework has been developed by extending the frameworks of Materiality (Wiberg, 2014) and PD Tools (Sanders et al., 2010) that cater to these areas specifically, in conjunction with a series of empirical explorations that together bring a new perspective on participatory design tools, methods and practices in light of materiality. Using the framework, we aim to enable creating a more level playing field for participants, through materiality that engenders a more participatory mindset and results in better outcomes for participation in design processes. We demonstrated how placing material artefacts through this analytical lens allows us to uncover pragmatic possibilities of our tools, methods and practices – and challenges us as a community to explore how to create more participatory access points for design. This is one of the first studies to specifically address materiality of PD methods. Our aim is to extend our understanding of how to reduce the barriers to participation and increase engagement within design processes through materiality as a core proponent, and encourage further work in this space to make design methods, mindsets and practices more universally accessible and actioned in their intended spirit.

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Preserving Sequential Context: Developing Participatory Video Analysis Practice

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Abstract: An open challenge for participatory design research is how to engage users and other stakeholders early in the design process, not only as informants, but as participants in the analysis of field data, prior to the formulation of design problems. Involving novice analysts introduces additional complexity as they are simultaneously domain experts but with little time available to engage with activities that do not directly inform their practice. In this paper, we develop methods that balance making data-rich video analysis accessible, whilst preserving enough of the sequential context of the video so that novice analysts can make informed judgements. We introduce a modified version of the Video Card Game, adapted to involve primary school teachers in video analysis for design. We evaluate two instances of the method. Our findings, among others discussed, suggest the approach enabled participants to leverage their domain knowledge in analytic tasks.

Keywords: video analysis; video data; participatory; education

1. Introduction

Facilitating participation in the formative stages of design can be challenging, particularly before problems have been defined, the design context has been understood, or stakeholders have articulated their values and priorities. Yet without participant input, design researchers may develop a myopic view of the problem space that misses key insights that would lead to better understanding of the problem space and potential design solutions. Participants bring a deep contextual knowledge, which enables richer considerations of formulating the problem space beyond what any lone designer is likely to achieve. Participatory techniques in such instances are not a means of outsourcing the challenging work of analysis, but are ways to bring in other perspectives into the design process to aid in problem articulation and reduce designers' own bias; problem setting is seen as a core aspect of reflexive practice of design (Schon, 1983). The design process benefits when participants are provided with the opportunity to articulate their viewpoints, augmenting the problem

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definition with new perspectives, and occasioning an opportunity to shift the designer's own ontological understanding of the design space. In practice, such facilitation is intended to lead to the creation of outcomes that are much more closely tied to the participants' needs, and thereby increase the fit and uptake of the systems designed (Buur & Matthews, 2008).

Within complex organizational settings, aligning the designer's perceptions to the orientation of stakeholders is challenging, but of paramount importance in realising the value of participatory design processes (Brandt et al., 2012). Designers often rely on methods (generative workshops, prototyping and evaluation sessions) to engage participants (Gray, 2016; Kwiatkowska et al., 2014a, 2014b; Lloyd, 2017; Malins & Grant, 2010; Rasmussen et al., 2011) with the aim of providing platforms and avenues to bring participant perspectives into light – to help shape possible design solutions. The challenge however is in creating opportunities where multiple participants are empowered to play significant roles in framing the problem space to begin with, whilst also catering to pragmatic considerations (time, effort, comfort etc). Prior work in participatory design has provided practitioners and other stakeholders with a multitude of methods, tools and techniques to facilitate open dialogue, including with, and through, video. The use of video in such design practices has evolved over time. Early uses saw video as "hard data" (Buur et al., 2000) a fairly neutral fly-on-the-wall perspective of real world events, available for objective and rigorous analysis, so that design requirements and contextual challenges could be identified (Jordan & Henderson, 1995). More progressive (and critical) uses of video in participatory design have since emerged, where video is understood as an actor in the situation, as a fluid material for design ideation and exploration (e.g. sketching scenarios, improvisation, e.g. Binder, 1999), or as a social medium for participants to come to shared perspectives on design spaces (c.f. Ylirisku & Buur, 2007).

However, in bridging these various traditions of video use, an aspect of these methods that remains under-explored is how to effectively bring participants into initial analyses of field data, to generate shared understandings and collaborative insights. In particular, bringing participants early into the design process and providing them with opportunities to evaluate raw data can be a time-consuming task for stakeholders who rarely have the imperative to undertake such activities. Participants have often been reduced to the roles of informants (Druin, 2002), rather than co-analysts, for example. One of the established methods developed to bring participants into the analytical stage of the process is the video card game (Buur & Soendergaard, 2000). This study extends and modifies the popular video card game genre of participatory design methods to elicit non-designers' input in sequential interaction analysis by (1) making analysis a shorter process than the traditional video card game; (2) increasing the number of video cards per clip to gain richer contextual understanding in the analysis; and, (3) having the participants watch the entire video with the cards in sequence.

Video data is often gathered as a means of capturing some of the richest interactions in design research. We see an opportunity to explore how to evolve the video card game, which currently requires a significant time investment, into a more accessible and pragmatic format, whilst maintaining the contextual integrity of the data. As we detail below,

maintaining a balance between accessibility (of video analysis methods) and preserving enough context in segments of video remains a challenge for design research. This study uses video data from novice designers (8-10 year old students) to elicit both teachers' reflections and pedagogical expertise in reviewing student interactions with tangible artefacts. We present results from a series of design workshops that explore the method.

2. Literature Review

While there is a wealth of design methods that have been developed as a means of cooperatively involving stakeholders in generative and evaluative aspects of design, the same cannot be said of methods to engage stakeholders in co-analysis of raw research data. There are a number of possible reasons for this. Many forms of (research) analysis are derived from, and wedded to, particular philosophical positions. To enact them faithfully often requires a significant degree of understanding of their epistemological foundations (Lincoln & Denzin, 2000). This does not only entail what should be done in analysis, but often (and more importantly) what should not be done, i.e. what analytic moves are invalid from an epistemological stance. Certain contextual approaches (such as ethnomethodology) avoid the importation of concepts derived from theory; whereas others are founded in particular theoretical frameworks that are intended to guide the analysis, priming the analyst for what to look for and the kinds of relationships to expect in the data (Shapiro, 1994). Indeed, there is an argument that cooperative analysis itself is founded in a philosophical viewpoint that knowledge, understanding and action are irredeemably situated in the social and the ecological settings (Lave, 1988; Vygotskiĭ, 1997) in which they appear, and as such our methods of analysis should capture this milieu. So, while Design Thinking and Participatory Design have advanced many ways of making the generative and evaluative activities of design available to non-design oriented stakeholders for participation, the co-analysis of data can present unique hurdles to participation.

Muller, Wildman & White (1993) recognised that the lack of involvement of participants in 'up-stream' design process methods meant that participants had a reduced ability to define the problem space. Methods such as CARD (Muller, 2001) and PICTIVE (Muller et al., 1993) were developed as participatory design tools that sought to involve users in both the macro and micro levels of the design process. These have been integral in the further development of methods to involve users in the analysis of data (Buur et al., 2000; Chin et al., 1997; Ylirisku & Buur, 2007).

A number of these methods have based themselves on the principles of video interaction analysis (Jordan & Henderson, 1995). Video interaction analysis is a rigorous analytic that provides for the collaborative generation of rich insights that are grounded in the context of study. Jordan & Henderson (1995) discuss the benefits of having multiple viewpoints involved in video analysis, as it challenges researchers' 'preconceived notions', and compels analysts to contend with competing frames of what is taking place in the data. Further discussions on the use of video in collaborative design processes have resulted in video

being reconsidered as 'design media' (Buur et al., 2000), not only containing rich data, but also being open to various interpretations and meanings, both in its viewing and what (and how it) is recorded. The Video Card Game (Buur & Soendergaard, 2000) was one such early method in the engagement of users with video, developed during a project conducted in an industrial setting in which participants were able to direct what the camera was viewing and to tell stories to the camera. This resulted in participant-led video recordings that were then cut into clips of one to three minutes. The 'game' component was a format for analysis, providing an engaging and enjoyable way for people of differing backgrounds to discuss work practices. With each video being represented physically as an annotatable card, the cards became a means for users to take ownership of the video clips. Having non-designers participate in the analysis stage provided further engagement in the design process. Since the game's introduction, further adaptions of video have been made to contexts such as education (Brereton et al., 2003) and everyday practices of select groups (Moore & Buur, 2005). As well as exploring types of tangible tools such as 'scrabble tiles' (Buur et al., 2014) and 'Video action walls' (Buur et al., 2004).

Chin, Rosson & Carroll (1997), describe a process of developing scenarios (Carroll, 1996) from raw video data, observations and field notes. The scenarios consisted of both textual and video content and were grounded in events that the external participants (in their case teachers) were familiar with and could relate to. The results from the study showed that the teacher-participants engaged and contributed meaningfully to the scenarios using terminology that both participants and designers were able to share.

The above methods have enabled analysis to be an engaging activity for participants. They have done this through adapting raw video data to create novel methods of engaging non-designer participants. In spite of these advances in participatory forms of analysis, there remains an open challenge for researchers to strike a balance between making the data accessible to participants, and preserving enough contextualisation in the data to enable stakeholder analysts to generate observations grounded in the sequential organisation of the phenomena as they unfold. It is this balance that is a challenge to achieve when participants have divergent domain experience and theoretical commitments, and yet must provide meaningful insights from short engagement with video data. The holistic ecology of everyday phenomena, as witnessable in an ongoing sequence of video data, has often (by necessity) been sacrificed in order to create accessible formats for the participation of non-researchers in video analysis activities. For this reason, we have experimented with a hybrid approach that has sought to preserve the sequential order of small clips of video in presentation to novice analysts yet provide them compartmentalised resources (such as video cards representing short 30-second segments) to annotate and thematise.

3. The Study

The participatory video study formed part of a much broader study, in which its main overarching objective was to understand how students use technology in a design process,

exploring how technology can be developed to support students' learning of design skills. We utilized ethnographic methods to understand the context, and video logged students' interactions as detailed below. From the video data, we ran two iterations of sequential analysis activities to explore and refine the proposed method.

3.1 Prior work

Video clips were sourced from a study of students in a one hour after school class designing tangible technological artefacts, taking place over a span of 25 weeks. Students had the opportunity to design a technology solution to cater to a problem of their own choice. Examples of the type of projects included: designing tools to provide soothing sounds to someone who is feeling upset; and a teddy bear that detects the heartrate of anxious children in hospitals. An adapted 'design thinking' process tailored to the educational context (Razzouk & Shute, 2012) was given by helpers and teachers, providing a support structure to help students through this process. Design support consisted of methodological tools to help guide them through several iterations of research, defining the problem domain, ideation, prototyping and testing. After the problems had been articulated, they ideated, prototyped and tested with tangible technology, finding ways to appropriate technology to find a solution to their problem. It was in this phase of interacting in a collaborative way, that we collected 25 hours of video data, from four different groups of students exploring the technology available to them, and conceptualizing and designing their proposed solutions. From this video data four researchers, working in pairs, logged the clips, using Jordan & Henderson's (1995) principles as a framework.

3.2 Contextual Challenges

To capture the ecology in which the students engaged with the technology, we sought to incorporate teachers' views on both the interactions with the technology and pedagogical importance of the process. Being familiar with the video card game (Buur & Soendergaard 2000) as a way to enlist practitioners' views on data and position them as partners in the design process, we ran a collaborative activity around video analysis. In the formulation of the method to the given context, we considered several factors that we needed to employ when undertaking design activities with teachers as participants in a design process.

The first is that teachers are notoriously time-poor, which means that any designed activity requires careful planning to reduce the amount of time they need to devote outside the classroom, or from class planning and preparing feedback. For this reason, obtaining large numbers of teachers for an activity can also be problematic, as it is unusual for a school to allow several teachers for an out-of-class activity, let alone one that is centred on design research that is not immediately of direct benefit to their pedagogical practice. From discussions with teachers, we found that an activity of approximately one hour with about two participants at a time would be achievable. Furthermore, being a stakeholder in a design process does not necessarily equate to valuing the relevance of what the designers are trying to achieve. Therefore, it is imperative that the designers make activities as constructive,

relevant and meaningful to the stakeholders as possible. Previous work (Buur et al., 2014; Buur & Soendergaard, 2000) in this space has been conducted with companies, who have a stake in the design outcomes, or as a part of a university course as a component of assessment (Brereton et al., 2003). In our case working with teachers, we have a different onus—our solutions will not necessarily directly benefit them immediately, and we have greater need for them to undertake an analysis activity as participants. The intent was that by providing a set of sequences to teachers that depict activities of students problem solving with technology, we would create an engaging opportunity for teachers to reflect on pedagogic practices around technology; this would also serve as an opportunity to reflect upon their own practice (Schon, 1983). Additionally, it had the potential to provide us with valuable insights into how the technology impacted the students development. In this way we adapted our activity to suit our particular domain for the ways primary schools are notably distinct from the industrial contexts that inspired the original versions of the Video Card Game. Our sequential interactive analysis activity was designed to preserve aspects of the original version of the video card game, but to tweak them in ways that better mapped to our particular institutional conditions. We discuss our activity below.

4. The Method: Sequential Interactive Analysis Activity

Our game involved video taken from three sets of problem-solving sequences that we had identified were recurring patterns of problems (Jordan & Henderson, 1995), and two sets we considered interesting phenomena. These five sequences were chosen in response to time limitations. The problem-solving sequences depicted a problem the students were trying to solve i.e. understanding how heart rate monitors worked or trying to get a speaker to play a sound. The sequences ran for approximately three to four minutes. We structured the activity so that it could be played within an hour. In order to help participants keep track of their observations, we made visual cards (Figure 1, Step 1) which were numbered sequentially to correspond to sections of the video. Keeping the video and cards numbered in sequential order afforded navigation through fast-paced, complex and rich data, and had the added benefit of helping us to understand the process the children in the videos went through to obtain a designed solution with the given technology (the aim of our initial study).

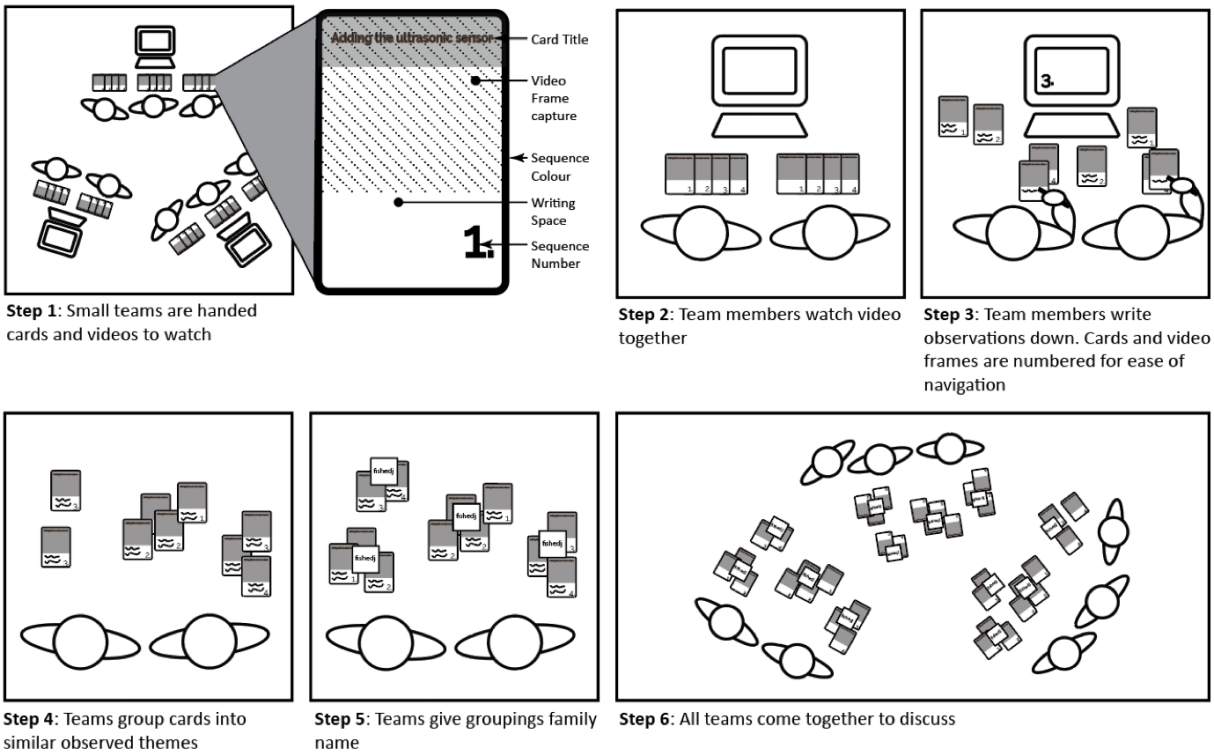

Figure 1 Story Board of Sequential Interaction Analysis Method

After watching the short videos, participants were instructed to write down observations on the cards—things that caught their attention or that they found interesting or noteworthy (Figure 1, Step 3). From these they were to produce insights in small groups of two or three (Figure 1, Step 4). After they had organised their (collective) insights, the participants competed with each other for how many themed families they could find, adding a fun and engaging game element to the method (Figure 1, Step 6).

We ran the activity in two instances. The first instance (see Table 1) was a multi-disciplinary set, which included a number of researchers from journalism, interaction design and anthropology. This allowed us to understand how the format of the game might work for participants for whom the context itself (children/classrooms) was outside their domain. In this instance, it was important for us to evaluate how the activity would make the data accessible and what observations it would make available to participants. The second instance (Table 1) was with the target group—two teachers, each of whom were paired with a researcher. Having two instances of running the activity enabled us to reveal the extent to which domain knowledge has an impact on the type of insights that can be gleaned, but also to provide us with a broader range of design insights to consider.

Table 1 Participant Overview.

Groups	Instance	No of Participants	Video
G1	1	3	1 & 2
G2	1	3	3 & 4
G3	1	2	3 & 5
G4	2	2	3 & 4
G5	2	2	4 & 5

The two sessions were audio recorded and photographed, to capture how participants of the game utilised the elements (tangible cards, video and post-it notes) and tasks to generate insights. We were also interested to understand the types of observations game participants were able to make and bring to the ensuing discussion. From each session, we photographed the annotated cards and their layouts on the tables, so we had access to the physical artefacts and themes that featured in the discussion. The audio data was reviewed with selected sequences then transcribed. The audio, cards and photographs were then thematized as a means of evaluating the activity and the insights it generated. In our results we refer to what was written on the cards in single quotes i.e. '*control*' and what was spoken by participants in double quotes i.e. "*declarative*".

4.1 Method findings of first instance

We had eight game participants for the first instance – two groups of three (G1 and G2), and one group of two (G3). Each group had a device on which to play the video that they could control as they liked. Videos were distributed between the groups, with only one video viewed by two different groups (Table 1). Most participants had at least a limited understanding of the context or the technology, and all were familiar with qualitative analysis.

From the outset we observed each group approached the task in slightly different ways. Teams used different strategies in how they decided to frame the data they were obtaining, how they distributed that information amongst their cards and then organised their cards in family groupings. Our analysis breaks down our observations from the activities which we have organised into themes: framing, information distribution and card organisation.

Framing

Applying different frames to the problem, such as viewing the information from different standpoints or framing it to their own lived experience were strategies that were employed to contribute to both the observations and later discussions.

Framing to lived experience - Participants who had some professional educational expertise, found an opportunity to bring their domain knowledge to their observations. For other groups, their lived experience of having been a school student was a valuable resource. One collective group's experience in classroom practices focused their attention on the social

elements of the video. They drew attention to the positions of the children and their access, or lack thereof, to the technology.

Viewpoint frame - Participants tried on different perspectives: from students, teachers and technologists. One observed conversation discussed the appropriateness of terms to frame their observations. *"What else [other themes] have you got?" "Testing and problem solving… and a little bit of trouble shooting I guess." "Yeah, I like those terms, because that is what they [the children] probably see themselves as doing."* Rather than donning a theoretical or technology-oriented view, participants tried to incorporate terms the students themselves would likely use. Other groups used terms they thought teachers would use such as '*risk-taking*', and others formed themes from a technical viewpoint, e.g. '*false signal interpretation*'.

Distributing information

The cards provided an opportunity to cognitively offload and organise the data. Some participants used the cards as placeholders in the video, writing down a rough transcript of the interactions and audio they observed. In some videos this became difficult because of the noisiness of the environment in which the audio was taken, and so having quotes placed on the cards helped them to make out what students were saying. Other groups opted to write observations on post-it-notes, then distribute their main/interesting observations between the cards, creating a sequence that wasn't attached to the video, using the numbers on the cards as a guide.

Card Organisation

After writing on the cards, the cards offered enough flexibility to enable participants to sort out data though adding extra notes, or colours to segregate different themes coming through linking meaning onto various actions observed (Figure 2).



Figure 2 *[left] Individually writing down observations on cards while watching video. [right] Creating overall themes from observations as a team.*

4.2 First Instance Outcomes

Two broad outcomes were produced from the groups participating in the method. These were '*Social rather than technical*' and '*Tool as mediator*'. Outcomes are discussed below.

Social rather than technical - Although not all researchers had an interaction design background, all were familiar with the domain. Our assumption was that they would identify more technology-related problems the students were having, being critical of how the technology kits were designed for the tasks they witnessed in the video. However, this wasn't the case. Researchers were bringing up how student's social issues were being impacted, unrelated to technology more than other types of observations. Themes that were brought to light were: time management "*we only have nine minutes left*"; defining types of control such as negotiation, power and acting out '*only one device so difficult to negotiate*'; team dynamics such as '*blame the colleague*', lack of results and lack of order '*verging on chaos*'.

Tool as mediator - One group explored themes relating to how students navigated the social using technology as a mediator, commenting on how students use technology as '*a social tool for attention*' when uttering phrases as "*look at this*" or "*should this sit up here?".* It was observed how students shared differing hypotheses around the technology to create understanding between themselves '*create some kind of intersubjective understanding of what is being attempted, what is going on*'.

4.3 Reflections on the first instance

Several issues arose in undertaking the activity in the first instance, making us re-evaluate the activity prior to running the second instance. The first was in the *distribution of videos*. Only two groups of the three had one video in common. When game participants came together to discuss, this was limiting their discussions as some teams had no data in common. To improve this in the second instance, we decided that teams should have at least one video in common, to order to aid discussions between teams (Table 1).

A second issue was with respect to the degree the *game* aspect of the activity was not engaged with. Certainly, time was a factor. But additionally, participants were not particularly motivated to play the game, preferring instead to discuss the findings they found interesting in the video. A third issue was with respect to *mindset*. Trading off the casual qualities of playing a game, and the seriousness of analysing, some participants were not always focused on observing the videos, being drawn into defining and solving the problems they observed rather than analysing what was visible in the video data.

Moving forward, it was integral to the purpose of our study that we obtained the teachers' expertise of what was happening on the videos, in helping us bring another frame onto our video data, to understand genuine design problems before exploring solutions. We felt that for our second instance we needed a sharper strategy, to ensure participants had occasion to carefully analyse the videos, and to facilitate a more open-ended discussion after producing families of observational themes.

4.4 Method findings of Second Instance

Modifications to Activity

To compensate for the reduced time, we separated the teachers and paired each with a researcher who was familiar with video analysis. We then brought the groups together to discuss the types of themes they saw coming through the data. We had two groups of two participants. The first group (G4) consisted of a researcher who hadn't seen the data, and a teacher who had been a part of the project supporting the students, and so was intimately aware of the projects undertaken by the students. The second Group (G5) consisted of a researcher who had previously participated in the first instance (of the modified game) and a grade 6 teacher who had not been part of the project but had undertaken similar projects in their classrooms.

Framing

Teacher participants were familiar with the type of activities and context represented in the video. Therefore, they were able to frame their insights in particular ways, such as towards the learning outcomes of the students. From comments made it was obvious that even from the two-minute video capture, teachers were able to draw on their knowledge and appreciate the complexity in the data: "There is a lot going on there, we might need to see that again".



Figure 3 *[left] Insights are produced from observations contained on the cards. [right] Small teams work together, discussing their observations and writing down themes.*

Distributing information

In both sessions, game participants waited to annotate cards until after the entire video was watched. The cards were used as placeholders for thoughts, e.g. '*I wonder if…, I think…. Sparking curiosity, making predictions, highly engaged' 'Recopy, Control, Instructions – shout when works*', rather than as a detailed description of what was happening. Although the cards were used as placeholders, teachers tended to use them as prompts of what they had witnessed in the videos. The themes produced covered a broad range of issues (Figure 3).

One teacher, when seeing the volume of notes from the other group, said, "*We thought we had too many [themes], you must have had good videos*".

Initially, discussions started with broad issues—terms used such as '*curiosity*' or '*growth mind-set*'. However, as the discussion progressed the teachers brought in detailed information from what they had seen from the videos. "*You saw she was really curious, you saw when she picked up the laptop she was looking at the code, she was trying to make a connection, I think, between when she was practically looking at it and what the code was saying." "Practical like project based they really um enjoy it um so yeah you could just tell that engagement was there, umm yeah so just experimenting when they started moving it around the arm you could really see that was happening*".

Engagement

Two interesting phenomena emerged when the teachers participated in the method. Firstly, having a video that took a snapshot of a sequence focused the teachers to look closely at interactions between the students and the technology. These are behaviours that easily can go unnoticed in a busy classroom of 24+ children, however having a short sequence to focus on allowed them to reflect on what the students were learning. "*It was really interesting to watch it back, because watching them on the day they were doing it, I didn't see some of the behaviours, and now watching on the video, I am oh my goodness they didn't work as a team at all and um the boys are very much had to be perfect they wouldn't take a risk on something where as the girls were oh we will try this…*". Secondly, even in the short time frame of the workshop, their initial understanding of what had happened in the video changed through discussion and analysis. The same teacher who initially had a negative reaction to one of the groups' conduct, on further reflection and analysis of the data, came to the realisation that that team might have been more on track compared to the team who looked like they were working well together. This raised a discussion about the difference between good collaboration and team functioning being something that was not necessarily coterminous with students' possessing high quality understandings.

4.5 Second Instance Outcomes

Some interesting outcomes from the workshop were: students' use of language '*statements were very declarative, not exploratory*'; comparisons between the two videos '*the first more experimenting the second was more understanding…*'; students approaches to technology "*found there was a little collaboration when it worked, and a little bit of discussion because it worked… it is very interesting to find ways to give little victories, you need more opportunity to have those experiences*".

5. Discussion

Ownership of artefacts engages participants in analytic activities: Understanding the balance between making video analysis accessible and still maintaining a level of engagement with

our game participants led us to design an activity that allows meaningful input from not only non-designers but those who wouldn't directly benefit from the outcomes. This balance was achieved by having artefacts such as post-it notes and cards that allowed game participants to make their own with annotations, giving them partial ownership of process. This can be seen in how both instances the teams organised and distributed information as they saw fit. This ownership also gave both the teacher and researcher participants the impetus to fit frames that were meaningful to them. We see this in the way researchers would try to make sense of the data by considering frames from the users in the video. Teachers, in particular, saw this as an opportunity to reconsider their pedagogical practices through a different lens. A clear example of this is when game participants were discussing their insights, they would point to the cards and say statements such as "*in this one*" or "*we found*" then extrapolate with examples from the video. Teacher participants would explicitly refer to their changed perception "*now watching on the video*, *I am oh my goodness they didn't work as a team at all*" as one that had changed after engaging in the activity, this statement is also mirrored as an insight on the cards (figure 3). These examples show that it was very much a participatory design tool that not just researchers, but the teachers were invested in, and not an external methodological imposition. This emerged in the post activity discussion of how teachers perceived using the tool.

Including domain experts in analysis provides rich insights for design: As designers we only gained from the process of involving teachers. While bringing in other researchers to analyse data made us challenge our 'preconceived notions' (Jordan & Henderson, 1995) such as seeing tangible 'tools as a mediator' and advocating for social inclusion, involving the teachers as domain experts provided a unique lens on the data that was more easily translatable to design applications. For example, in the design of technology that supports the learning environment, the teachers' contributions highlighted the need to balance between making technology complex enough to realise students' design ambitions, whilst still providing opportunities for "small victories", and providing ways the technology can support collaboration through discussion. Buur et al (2000) describe this type of analysis as video acting as a material to design with. These insights wouldn't have been derived had we not engaged teachers with our raw data.

Sequential video offered unique opportunities for domain expert participants: Having a sequential video that was situated in a context that was familiar to our domain expert participants, enabled them to see how students acted not just with a component of technology but rather in a complex and rich environment. Teachers were able to offer insights regarding students' actions in a social environment, interacting with technology, and how these interactions were hampering or encouraging learning in the ecology of the classroom. The teachers drew our attention to how parts of the system gave rise to students engaging in an emerging understanding (Sawyer et al., 2003) of both technology and problem solving strategies.

In these respects, the activity successfully negotiated a balance between preserving (enough) local context within video data to make it meaningful to participants yet constructing an

accessible (enough) format for both domain novices (researchers) and research novices (teachers) to engage in the painstaking work of video analysis for design. However, there were considerations and trade-offs being made when it came to perform the activity with teachers. We did not offer all videos to participants; we only showed those videos we identified as a repetitive problem-solving issue or if the video was particularly interesting. This was done to reduce the amount of time for the activity but also as a way of directing discussions. Another consideration was having short videos meant that a teacher who had been there throughout the data gathering time, saw a lot more value in the data than a teacher for whom the data was unfamiliar. Further studies to understand how well context was preserved, for example experimenting with longer video sections (5-10 minutes) to give additional context, would clarify the extent to which this may be indicative of a more general issue; yet this may also result in making the task of analysis more laborious to stakeholders.

In taking our analysis activity to both researchers and teachers, we were able to determine how the process afforded open-ended discussions and insights for design solutions to be gathered. Our activity resulted in engaging a range of participants 'up stream' (Muller et al., 1993) in the design process, extending long-standing design methods and formats that have been developed to create participatory bridges between the activities of design and analysis.

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Invisible Impact: Revaluing data in design research

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Abstract: Design research as a way of understanding and responding to the world around us has grown significantly over the last decade, particularly in the domain of health. Design can offer a deep interrogation of the complexity experienced by stakeholders in a given health context, engaging in an empathic and creative way to capture lived experience as data that can inform, influence and engender meaningful change. Ordinarily, this data is valued in its contribution towards the intended study aims and is traditionally realised in project reports, academic publications, and lay-person summaries. However, this paper argues that value should be reconsidered to take account of invisible impacts, the unintended outcomes that emerge as a result of engaging and conducting a study. This paper suggests that the underpinning values of participatory design, those of empowerment and valuing lived experience create an opportunity to realise participant contributions and research data in an alternative way.

Keywords: value; participation; engagement; design research

1. Introduction

Design research as an epistemological, ontological and methodological way of understanding and responding to the world around us has grown significantly over the last decade. Recognising the possibilities afforded by creative stakeholder engagement, for example through framing intangible and complex problem spaces and with an increasing focus on circularity, future sustainability and positive social and political impact; design research is now adopted, applied and diffused across more disciplines than ever before.

Design research is frequently aligned to the design process, foregrounding critical stages of research enquiry: define, engage, ideate, prototype, test, communicate. Such an approach can enable a deep interrogation of the complexity experienced by stakeholders in a given context, engaging with them in an empathic way to capture valuable data that can, in turn, inform meaningful change. Contrary to traditional notions of the lone designer as the problem-solver working to produce an outcome in isolation, design research is instead positioned as an enabler, an approach that can support the co-creation of a solution. Akin

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to the epistemological underpinnings of the social sciences, the value of design research is in understanding, and the inclusion of the lived experiences of stakeholders (Koskinen, 2016; Manzini, 2015). The participatory nature of design in this way can result in the collation of rich data sets of lived experience captured through creative endeavour.

It is acknowledged across the literature that research must move beyond the advancement of academic disciplines to be more accessible and impactful across social, political and civic life and as such, new ways of exploring and disseminating data are required. From a design research perspective, taking into account the intrinsic and inherent role of stakeholder engagement as a core element, real-world impact can be seen as a deeper understanding of the needs and desires of publics; as a route to engaged and informed communities; and towards the co-creation and scaffolding of meaningful change.

Across disciplines, research outputs are traditionally articulated in a body of written text. Framed around a well-established research approach, the output traditionally articulates a problem; describes the chosen methodology; presents data collected; offers a discussion of insights, and concludes with an applied meaning generated through analysis of the insights. In recent years, the demand for research that moves beyond the advancement of academic disciplines towards accessible impact has encouraged alternative means of dissemination (Collie *et al.,* 2014; Robson and McCartan, 2016). Despite this, participant-generated data is still predominantly valued in its contribution towards the intended study aims, recognised for providing essential insights and supporting research activity. The output is traditionally realised in project reports, academic publications, and lay-person summaries.

Despite a growing awareness of the potential impact of research more broadly and growth in non-traditional research outputs, dissemination is yet predominantly limited to the final reporting of research activity. There appears to be a scarcity of situations in which research findings are explored and shared in new ways, suggesting a potential space for innovation and impact. In design research, the capture of lived experience as data is core. However, the experiences captured are often limited to informing the research activity itself. Little thought is given to additional ways of re-exploring the data captured to create added value.

One domain within which design research is active, both across scholarly endeavour and in practice is health. Inclusive of medicine, care and wellbeing, design research in health offers a deep interrogation of the complexity experienced by multiple stakeholders in a given context, engaging in an empathic and creative way to capture lived experience as data that can inform, influence and engender meaningful change. However, this paper argues that the value *for* design research participants and the value *of* research data should be reconsidered to take account of invisible impacts, the unintended outcomes that emerge as a result of engaging in a study. This paper suggests that the underpinning values of participatory design, those of empowerment and valuing lived experience create an opportunity to realise participant contributions in an alternative way.

Drawing on a design research project as a case-study example, this paper discusses found poetry as an approach to recognising and articulating value in design research data beyond

traditional means. The poetic narratives of eleven people who experience chronic pain are presented, highlighting the potential of both reimagining data and extending the empowerment of research participants. The emerging value is realised in articulating notions of self; increased visibility within a community; and a broader attempt to influence and inform socio-political impacts through dissemination.

2. Case Study: The Language of Pain

2.1 Project Introduction

Chronic pain is a common, complex and challenging condition, generally accepted as pain lasting longer than three months. While recognised as a condition in its own right, it is also an umbrella term for severe pain occurring from a multitude of clinical conditions (Hepburn and Jaatun, 2018). The societal burden of chronic pain is significant, underpinned by the recognition that management focuses on promoting rehabilitation and maximising quality of life rather than achieving a cure (Mills *et al.*, 2016). As such, innovative approaches to managing chronic pain over the longer term are required.

The Language of Pain was a design research project led by The Digital Health and Care Institute that aimed to explore the potential of a digital intervention to improve the relationship between health professionals and people experiencing chronic pain. Through the translation and interpretation of interactions, it was proposed that an intervention could potentially create new learning opportunities resulting in more effective, efficient and meaningful experience for all involved.

From the beginning, the Language of Pain project acknowledged that the ways pain can be described, interpreted, understood and translated vary considerably, compounded by the contrasting literacies of medical practitioners, people experiencing chronic pain and the broader network of health professionals engaged in care delivery (Hepburn and Jaatun, 2018). To understand the complexity of the context in-depth, the project adopted a design research approach and facilitated series of participatory design workshops and in-depth interviews to capture the lived experiences of those involved.

The role of design in delivering an evidence-based and experience-based co-design approach for health has grown exponentially (Robert *et al.,* 2015), and design has a recognised role in shaping future services as well as informing new ways of thinking around health, care and wellbeing. Articulated in approaches including experience-based co-design; co-creation, co-production and co-design; the essence of participatory design for health and care is in the embodied agency that enables and values participant's engagement, underpinned by ethical principles of participation and consent; minimising harm; beneficence; and power (Kelly, 2018). Positioning design as more than just the generation of new ideas, this approach reinforces the potential value in representing invisible or under-represented voices; in engaging multiple, often disparate communities; and in communicating and translating complex contexts.

2.2 Found Poetry

The text-based data collated during qualitative enquiry is traditionally considered and coded thematically, with the application of analytical frameworks and theoretical lenses based on an underpinning disciplinary or epistemological paradigm. This involves the dissection of text to generate and apply meaning across nodes or thematic groups. This approach contributes to the creation of rich insights, informing research activity and addressing the intended outcomes of the enquiry. However, when considering emotive data sets, for example, transcripts of lived experience, such approaches often fail to capture the personal narrative or essence of a story in its entirety. Found poetry offers an additional way of interrogating data (in addition to the thematic analysis), in repurposing text to create a poem that captures the essence, or core value.

Scholars have used found poetry to represent the data gathered from participants in several ways (Faulkner, 2016; Bhattacharya, 2013; Cahnmann-Taylor, 2009; Prendergast, 2006; Ellis & Berger, 2003; Richardson, 2003; Glesne, 1997). Reflecting upon the social impact of poetry, Reilly *et al.* (2018) recognise the value in exploring relatable experiences, that represent what it means to be human, and that allows the reader to empathise in a deeply connected way. As an alternative framing of daily life, found poetry can provide space to share participant's lived experiences beyond the traditional 'static data-driven text' of research (Burdick, 2011, p3), and offers an alternative route to wider engagement and dissemination beyond the outcome of the wider research study.

2.3 Found Poetry and Chronic Pain

Chronic pain is a condition that attracts considerable public attention. Much of the debate is centred what constitutes, and is experienced under the term chronic pain and recognises that as an often invisible or 'hidden' condition, much of what is experienced is not visible externally, creating additional challenges for people trying to manage day-to-day. For participants, found poetry can offer an alternative outlet for their voices, valuing them in a way that moves beyond the aims of the initial study. In this way, found poetry of lived experience can offer an articulation of truth in a given moment in time.

Denzin (2014) also reflects on the potential impact of found poetry, describing it as a driver of change, engaging audiences with the aim of challenge and altering existing perceptions. In addition to the personal challenges associated with a long-term condition, people experiencing chronic pain must also negotiate a range of societal, political and work-related issues, constantly repeating their narrative to address the different facades of power. Responding to this, the potential impact of emotive narratives in raising awareness and framing political activism is acknowledged (Faulkner, 2018) and could offer a new way of addressing the socio-economic challenges faced.

The role of the researcher is critical in the crafting of the poetry, in rigorously re-reading paragraphs of text and curating that which both captures and represents the narrative but also aligns to the style and format of poetry selected. As such, the subjectivity of

the researcher is entirely embedded in the work. Some scholars have questioned the validity of such poetic works, questioning their structural content and whether they can be truly understood as poetry (Cahnmann, 2003; Piirto, 2009). However, drawing upon the interpretive approach to qualitative research (Lincoln and Guba, 1985); the goal is not to create high-quality poetry, but rather to enable a new way of exploring and understanding data gathered and representing participant voices in a new way.

3. Methodology

This study adopted a qualitative and phenomenological approach, recognising the ability of design to support the gathering of lived experience to better understand complex contexts. People living with chronic pain were invited to participate in one of five small design workshops that took place across three geographic locations in Scotland. Respondents were recruited via posters placed in doctor surgeries, via social media adverts and through a peer-support group for chronic pain. These workshops, similar to a focus-group approach aimed to explore of the language used to describe pain; to identify challenges and opportunities existing within current chronic pain management experiences, and to identify any knowledge gaps and potential of learning opportunities for people living with chronic pain. Each workshop lasted approximately three hours, and respondents took part in a series of making activities, including developing a visual representation of their lived experience in the form of a cartouche (Hepburn, 2019).

The workshops were audio-recorded with informed consent and transcribed, resulting in over twelve hours of content. The verbatim transcripts were read and re-read by the researcher to encourage a deep familiarity with the texts. Using Nvivo as coding software, sections of the transcript were identified, highlighted and coded by each respondent. The qualitative data was interrogated to identify common themes emerging, and this contributed to the creation of traditional academic and project outputs as described earlier, disseminated in project reports and publication. However, an additional second iteration of coding was also undertaken. This analysis highlighted words and statements per respondent to identify key themes emerging in a similar way to the first, however, what was important in this analysis was that the highlighted text was recorded in an ordered way, with no changes to the sequencing. This approach was deemed to be most representative of the narrative flow and intended meaning conveyed by the respondents.

"I've done it more to describe the way I am now as opposed to the way I was before. I do think I'm very strong, a lot stronger than I was before. That strength is coming from a desire to live as good a life as I can, and I find joy in little things whereas before, that was all lost. I went through two years of absolute hell and for that reason, I do... it took me a long time to give myself credit for being a bit of a warrior because I am a bit of a warrior. People don't realise it is actually the roll of the dice. I thought I was healthy, never had health issues, and what keeps me going is the love I have for my family and I'm looking for that key to unlock or reset my health again, just something to restart it." *(Participant 1)*

Figure 1 Example analysis from the transcript – Participant 1

The highlighted text from each transcript was then curated into stanzas of between two and five lines. Another reading of the curated text was undertaken alongside the transcript to ensure that the poetic narrative was representative of the essence and could be described as a true interpretation of the underpinning dialogue captured. The outcome is then presented as a piece of curated found poetry, seen in Figure 2, with the researcher allocating a title that draws on the content expressed.

As with the analysis of visual research, the synthesis of the text required an aesthetic and empathic approach. To this end, the author reflected upon the experience of engaging with the respondents during the workshop to ensure that the narratives retold the lived experience in a way that captured, and could convey to the reader the emotions involved, the feelings and thoughts of respondents. Richardson (1993, 2002) refers to this in more detail and discusses the role of ethnographic poetry in making the lived experience accessible to others, and this provided the underpinning rationale for the creation of these ten poetic narratives.

A total of eleven poetic narratives were created using this methodology. The narratives were collated into an anthology, and this artefact was shared with participants both digitally and in printed form. A focus group session was held as a follow-up event four weeks later, where participants were invited to discuss the narratives created with the researcher. The discussion was audio-recorded, transcribed and emerging themes related to value were highlighted. These are discussed further in section 6.

KEY
I'm very strong.
Stronger than I was before.

That strength
is coming from a desire
to live as good a life
as I can.

I find joy in little things
Whereas before
that was all lost.

Years of absolute hell.
A long time.

I am a bit of a warrior.
People don't realise
it is actually
the roll of the dice.

I was healthy
never had health issues.

What keeps me going
is the love
for my family.

I'm looking for that key
to unlock
reset
my health
to restart it.

A lot of people see
weakness.
It's not weakness.

I don't go out screaming
Ranting
Raving.
They see it
as weakness.

You feel it's something you've done
that's brought it on.
I don't know.

Figure 2 Example poetic narrative generated from the analysis

4. Poetic Narratives

Three of the final poetic narratives are now presented in figures 3 as an example of the content provided in the anthology. The final artefact framed the narratives with a summary of the research study, and each participant had one poetic narrative featured in the anthology. The narratives were anonymous to protect participant confidentiality.

HUMAN
The second I was born
I had these different problems.
They didn't care.
I wasn't a human.

That's how they act.
I did have a lot of problems.

All of a sudden
like a ton of bricks.
Every day became a battle
It just leaves you exhausted.

In that limbo
It's like your stuck.
There's no balance.
One day you can be fine
The next day you just can't do anything.

DICE
I used to be a warrior.
Living life with plenty strength.
Life was rosy
I was flying high.

Now I feel like a fish
In a big pond.
So many different emotions
Angry.
Sad.
Frustrated.

Every morning
you get up.
The roll of the dice
Locked in a cycle.

Night time is my worst
Pain.
Ice cold.
I just want to take off somewhere.

Emotional.
Realising your feelings.
Frustration
Every day.

SUDDEN
A human
Working away
Doing things.

All of a sudden
Wham bam
Downhill.

Touching
When you're really sore.
You just back off.
You just don't touch it.
Makes you cry.

There's days
You just burst out.
You can't help it.
You get angry.

But
You've got somebody.
Looking down on you
All the time.
Somebody's watching you.

There is actually love there
That helps.

Figure 3 Poetic Narratives

5. Findings & Discussion

Four weeks after the anthology was distributed to participants, a final focus group session was held. The session aimed to feedback the findings from the study overall as well as creating an opportunity for participants to reflect upon and respond to both the experience of participating in the design research project and the poetic narratives created. The subsequent discussion of the poetic narratives identified several emerging themes concerning notions of value, and these are now discussed.

5.1 From invisible to visible

The main finding emerging from the discussion was a revaluing of self and increased awareness of the individual contribution made to the research study. Participants initially discussed chronic pain as a hidden condition, one that does not always display physical symptoms: *"I look ok on the outside, it's hard because people just don't understand how hard it is to look normal, how much pain I'm in"* (participant 4). This sense of "feeling invisible" (participant 2) resonated across all participants and was accompanied by associated emotional responses described as *"frustration"* (participant 1); feeling *"sad and alone"* (participant 5); *"ignored" (*participant 10); and *"…a burden on society, like I don't have anything of value left to contribute"* (participant 7).

Participants also described the challenges inherent with describing and constantly recounting their chronic pain narrative or health story. In the first instance, this referred to having to

repeat what one participant described as *"the story of my chronic pain"* (participant 4) each time they visited a health professional. Another participant described the same challenge but from a social and community perspective: *"I think people forget that I'm in pain, they are so busy with their own lives that they expect me to keep up. I feel guilty having to remind them that I'm not able"* (participant 11).

Reflecting upon the poetic narratives, participants discussed how the repurposing of their data in this way offered a new perspective on their lived experience: *"It's like I'm reading about myself from a distance, I actually feel really proud that I'm living this life and doing so well"* (participant 3) and *"Are those my actual words? It's amazing, it sounds so strong…*I *sound so strong"* (participant 9). This appreciation of the words they had shared as part of the project (the lived experience captured as research data) represented a notion of *"voice"* (participant 3) and appeared to support participants to revalue the perceived contribution made to the wider study: *"I knew I talked away for ages, I just didn't think it would be useful, you know"* (participant 1), a sense of self-value that might otherwise have gone unacknowledged.

5.2 A tangible asset

In addition to the value generated through the realisation of the contribution made to the research, participants also discussed the collated anthology of poetic narratives and described it as a tangible asset that served as an important artefact.

Building upon the invisibility as described earlier, participants also referred to the physical artefacts associated with chronic pain: *"I've got walking sticks, and a chair for, when, sometimes for when I'm tired…and a stairlift, slings and bandages, you name it, like a walking pharmacy"* (participant 10) and *"…a disabled parking badge and a disability car"* (participant 6). These artefacts were predominantly discussed negatively, as barriers rather than as aides: *"…I mean, I'd rather walk without the stick, so that people don't see me as disabled"* (participant 9).

In response to this, participants referred to the anthology as a *"something positive about my condition, to do with my pain"* (participant 11) and *"…a reminder, but a good reminder you know, one that I'm happy about"* (participant 1). This suggests an articulation of value that contradicts their usual experience of assets related to chronic pain. The anthology presents a tangible and concrete articulation of their lived experience, framed in a way that the artefact becomes a positive physical part of their condition.

Additionally, participants also described the value of the tangible asset as a tool for sharing their experiences: *"…a way for me to explain what it's like to live like this"* (participant 3). Some participants described this as a feeling of empowerment: *"I've been showing it to everyone, anyone who'll look"* (participant 5) and

> "Usually I don't like to talk about my pain. I feel like people are rolling their eyes, here she goes again, moaning about her life. But now I've got something that looks professional. It's my words but it looks real, authentic. I'm really proud" (participant 4).

From this perspective, the anthology of poetic narratives appears to provide participants with an asset that can represent their experiences in a new way. Furthermore, all participants described a sense of surprise that participating in a research study would generate something positive for them: *"I was really surprised, it was so unexpected"* (participant 2); *"…you know, you take part in these sorts of things for the greater good, not thinking that anything will come of it. I was surprised"* (participant 9); and *"I didn't think I'd get anything, apart from a cup of tea like. I was delighted"* (participant 8).

In this way, the response to the anthology as an output of the research activity and also as a representation of a positive physical artefact of the chronic pain experience suggests that value was created and realised by participants, in unexpected and surprising ways.

6. Discussion and Conclusions

Participatory design strives to empower participants, using creative methods to engage support conversations that draw on lived experiences to inform and influence change. Found poetry offers an interesting approach to extending that empowerment beyond the life of a research project, and beyond the stated project aims. By reimagining interview transcripts or other written texts that capture rich lived experiences, participant data can be explored to recognise and articulate value for those involved. The emerging narratives can be curated to extend the reach of participant voices, raising awareness amongst new audiences, and offering an emotive connection to stories that are often untold.

In this case, found poetry offered an opportunity to revisit and revalue the data collated, enabling a rich interpretation of lived experience in a way that would otherwise have been lost. In addition to the creation of a body of work that is representative of a given moment in time, the poetry also became a concrete, tangible and personalised artefact for participants and acts as a way of valuing, and articulating their contribution.

Two articulations of value are described in this paper. The first explores the importance of making the invisible visible, creating new ways to express and value personal lived experiences. The second explores poetic narratives as a tangible asset and considers how they can be revalued. By curating the lived experience of people with chronic pain through found poetry, it may be possible to create a new representation, awareness and appreciation of what it means to experience human life in this way. The poems are an articulated truth, a revaluing of the contribution of participants and offer much to support the understanding of life within a complex society. To this end, they are just as important as the traditional research outputs, if not more.

7. Limitations and Future Work

This research offered a new form of interaction and created an opportunity to revalue the data captured through traditional methods. The value discussed in this paper relates to the experience of participants and as such, is based on the small sample size of participants

engaged. Planned future work will include a follow-up with participants to review the findings and consider whether notions of value have been sustained. Additionally, there is a desire to explore the use of found poetry as a design research approach in more depth, and considering the extension of the value beyond participants.

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Healthcare design sprints: what can be changed and achieved in five days?

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Abstract: This paper focuses on three design sprints aimed at co-designing healthcare services by employing service design methods and co-design approaches. The design sprints each lasted for 4–5 days, consisting of multiple teams and involving healthcare professionals, students, end-users, and facilitators from the service design field. The design sprints were examined to determine strengths and weaknesses in relation to health-related service development. The results highlight key insights from the three design sprints, which included learning and understanding through design methods, design thinking and dialogue and how these affected organisational culture and change. The findings, which are discussed in detail, include these insights and the effectiveness of design sprints in healthcare.

Keywords: service design; design sprint; healthcare; design process

1. Introduction

Healthcare is a continuously changing environment designed to tackle challenges associated with competitive advantage (Clack & Ellison, 2019), an aging population and internal and external pressures to change (Fry, 2019)—challenges which are pushing healthcare towards more innovative solutions. However, changes and innovations in healthcare are often complex and difficult to implement due to organisational resistance to change (Vink, Joly, Wetter-Edman, Tronvoll, & Edvardsson, 2019; Wang, Lee, & Maciejewski, 2015), along with a lack of focused and secure management (Fry, 2019; Nilsen, Dugstad, Eide, Gullslett, & Eide, 2016). In this context, innovative service design can be crucial for innovation, and it can help organisations obtain competitive advantages (Clack & Ellison, 2019), improve learning and undergo transformation (Kuure, Miettinen, & Alhonsuo, 2014). In line with this, many healthcare organisations are investing in service design in an effort to redesign existing

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services or create new services in a participatory way (e.g., Freire & Sangiorgi, 2010; Mager & Alonso, 2017). In addition, there are increasing opportunities for future research into how design can spark change within existing social systems, especially in the healthcare sector (Rodrigues & Vink, 2016). The primary aim is to understand the user's experiences before, during and after using a service (Sangiorgi, 2011). In the design process, the designer acts as a facilitator rather than an expert service user or provider but leads the design process and supports these efforts with design methods and dialogue with stakeholders from different fields (Gleason & Bohn, 2019; Sanders & Stappers, 2008; Yu & Sangiorgi, 2017). However, little research has been dedicated to agile design processes, such as design sprints, and what can be achieved in a limited time frame. This is especially true in healthcare, and the strengths and weaknesses of design sprints in health-related contexts require more attention to determine if design sprints can be employed to tackle complex processes that are underpinned by hierarchies and various stakeholder groups.

Empirically, this article introduces three design sprints in the form of case studies held in three different locations: Gothenburg, Sweden; Tallinn, Estonia; and Rovaniemi, Finland. The data were collected through research diaries, as well as semi-structured interviews with the hospital staff and student participants. The facilitators' (also the author in this paper) own observation field notes were considered. The primary aims of the design sprints in this project were to develop joint research and innovation initiatives within the Nordic-Baltic region, engage all relevant stakeholders and support interaction among them to increase innovative capacity by transferring knowledge. An additional aim was to advocate design thinking as a methodology to help build services where end-users can act as co-designers of the healthcare system. The main outcomes from each design sprint included the investigation into and development of health-related service solutions for local hospitals.

In Hence, this study discusses the key findings from agile design sprints lasting 4–5 days and what can actually be achieved from these design sprints. The design sprints were employed to determine the strengths and weaknesses of health-related design sprints and what should be considered to create better synergy among the design sprint participants. The remainder of the article is organised as follows: first, we briefly introduce our theoretical background; we then describe our methods, databases and findings; finally, we conclude with outcomes, discussions and conclusions.

2. Theoretical background

In this section, we introduce our theoretical background, which includes three general areas: (1) health-related service design; (2) design process and design sprints; and (3) synergy through co-designing and design thinking. We focus on these topics as the main characteristics in the paper and reflect our findings through these topics.

2.1 Health-related service design

Over the past several decades, service design has been increasing in the design field. Its roots

are in the early 1980s, when it was part of marketing and management disciplines. Since service design has evolved to achieve more valuable co-creation, customers have become more involved in facilitating the creation of their service experiences (Heikkilä et al., 2011; Mager, 2009). Service design overlaps with many different well-known design disciplines, such as human-centred design (Buchanan, 2001), participatory design (Hendriks, Wilkinson, Huybrechts, & Slegers, 2018), co-design (Luck, 2018; Steen & Koning, 2011) and experience-based design (Bate & Robert, 2008). The practices and definitions may vary slightly based on countries and approaches. Regardless, the value of service design and its participatory methods involves designing with people (Polaine, Lovlie, & Reason, 2013). The participatory and co-design methods are human-centred, where participants are often part of "an iterative cycle of design, test and measure, and redesign" (Miettinen, Rontti, Kuure, & Lindström, 2012). Connecting cultural, social and human interaction are fundamental areas of service design (Miettinen, Rontti, Kuure, & Lindström, 2012). In its simplicity, service design is a mindset, process, toolset, cross-disciplinary language, and management approach (Stickdorn, Hormess, Lawrence, & Schneider, 2018).

While the role of service design has become important in healthcare, it has also become highly challenging. There is an urgent need to perceive a changing world, where new technologies, aging populations, continuous growth, and social and healthcare reforms meet (Clack & Ellison, 2019; Fry, 2019). Also, according to Bazzano and Martin (2017, p. 736), "Addressing the burgeoning inequities in global health is one of the most complex and urgent social challenges of our time, inherently linked with economic issues, good governance, proactive and collaborative strategies, political will, and community engagement." Mulgan (2014, p. 4) highlights the changing of designers' skills as a challenge that affects implementation in an organisation. In addition, Fry (2019, pp. 382–383) argues that healthcare change is quite challenging, and she describes the challenges using the following key points:

1. Hierarchy prevents growth, which may be especially true in professions and silo structures (e.g., Donetto, Pierri, Tsianakas, & Robert, 2015; Radnor, Holweg, & Waring, 2012).
2. Failing to learn from failures can be tragic, where the failures in hospitals include the consideration of their patients' life and death (e.g., Edmondson, 2004).
3. Importance of staff management is necessary when new change must be adapted in their work routine (e.g., Nilsen et al., 2016; Stickdorn & Schneider, 2016).
4. Healthcare innovation cannot be disruptive because risks to clinical service and costs must be managed (Jones, 2013).

It is clear that the complexities and challenges in healthcare are multidimensional, and they pressure designers to consider all the issues mentioned. This study reflected on these aspects through our health-related design sprints.

2.2 Design process and design sprints

In the design field, people often face different variations of design processes, which commonly include different steps and aspects (Miettinen et al., 2012). The typical phases of design processes start from research and fieldwork, then continue by defining findings and insights that result in the development of new concepts. Thereafter, the best solutions are concretised and tested, and the chosen idea(s) are finally implemented (e.g., Mager, 2009; Miettinen et al., 2012; Moritz, 2005; Van Oosterom, 2009). The service design process is often adapted based on the needs of humans, organisations and the problems to be solved. In addition, every process must be adapted for the project and must consider the complexities of the challenges, the people involved, underlying ideas or challenges, budget, time frames and other resources (Stickdorn et al., 2018).

Many service solutions and change initiatives fail when the implementation is perceived as insecure or unfocused (Fry, 2019; Nilsen et al., 2016). This can be clearly seen in intensive, usually five-phase (and five-day) design sprints that employ design thinking by a small team (Banfield, Lombardo, & Wax, 2016). New information generated from the process is quickly gathered and defined and from that, findings are wildly ideated and wisely iterated, and final concepts are quickly presented. Figure 1 visualises the design sprint as a process. The design sprint is a highly successful business strategy that can create innovation that any development team can use (Knapp, Zeratsky, & Kowitz, 2016). The concepts themselves are relatively weak and not structured to perfectly fit existing healthcare ecosystems, which are often complicated and multi-layered. However, instead of producing valuable and polished outcomes, the concepts can open doors for design thinking and design methodologies, and through those, it is possible to affect change in organisations. Little research has been conducted on the subject of health-related design sprints. The novelty of understanding the strengths and weaknesses of design sprints in the healthcare field and what can be achieved were the key points found in our study.



Figure 1 The design sprint process in a nutshell

2.3 Synergy through co-designing and design thinking

Synergy can be defined as a collaboration in the co-design process, whereby stakeholders from various fields practise with design methods and design thinking. Synergies occur throughout the entire design process. Since the 1970s, the value of having end-users and other stakeholders involved in the design process has increased (Sanders & Stappers, 2008). This involvement can be linked with participatory design, human-centred design, and co-

design. Co-design applies creative cooperation across the whole design process (Steen, Manschot, & Koning, 2011), with its roots in participatory design techniques. Co-design is critical to service design because it incorporates perspectives associated with different stakeholders, technologies and processes. This links service design with co-design, where the aim is to understand people's behaviour and experience in service processes and how technologies and other touchpoints holistically support customers' journeys, while stakeholders represent their own fields and backgrounds. Healthcare representatives and service end-users (e.g., patients and family members) have knowledge of their experiences that guides and supports the design outcomes. More specifically, bringing patients to the co-design centre is valuable because they can take "a more direct and ongoing role in identifying, implementing, and evaluating improvements to healthcare services" (Robert et al., 2015, p.1). Such value is highlighted in many studies (e.g., Donetto et al., 2015).

Design thinking is a primary characteristic of the design process and service design. Through design thinking, people can "create concepts, solutions and future service experiences" (Miettinen et al., 2012, p. 3), which creates value for the service providers and end-users. Designers, often as facilitators in the co-design process, coordinate and guide stakeholders through the entire development project (Miettinen et al., 2012). This requires designers to empathise with people, guide dialogue between them, choose correct methods and visualise data, insights and outcomes. Designers must also allow participants to lead at times so that the latter can practise their design thinking. Participants' views and thoughts can be linked using different and creative design methods, design research, design thinking and visualisation techniques, while empathy, integrative thinking, optimism, experimentalism and collaboration are common characteristics of good design thinkers (Miettinen et al., 2012).

3. Research methods and data

This article focuses on three case studies (i.e., design sprints), and as a research strategy, this enables multiple levels of analysis from a single study (Yin, 2009) and allows a focus on understanding, describing, predicting and controlling the individual (e.g., process, organisation, group or culture) (Woodside, 2010). In general, case studies are criticised for lacking rigour, being difficult to generalise, taking up too much time and producing large amounts of information (Yin, 2003b), but as a methodology, it enables the exploration of a single phenomenon in a natural setting by using mixed method approaches to reach in-depth understanding and knowledge (Collis & Hussey, 2009). In this case study research, the phenomenon was health-related design sprints in the hospital context, where different stakeholders co-design by using different design methods. For this project, case studies offered three approaches to perceive synergy in groups and compare findings.

In this study, the design sprints were held in Gothenburg, Sweden; Tallinn, Estonia; and Rovaniemi, Finland. They all included international and multidisciplinary participants (Sweden n=22, Estonia n= 20 and Finland n=6), which created design sprint teams of three to six persons. In Gothenburg, the design sprint teams consisted mainly of students from

different disciplines, but four of the participants were from the healthcare sector: two from local hospitals and two from Tallinn's medical centre. In Tallinn, 19 participants were students, and one had a healthcare background. In Finland, all six participants in teams were international students, mainly from design backgrounds.

In all three design sprints, healthcare practitioners from the local hospitals were involved as part-time mentors and/or facilitators. Mentors were healthcare professionals from different wards (e.g., the IT department and administration unit who supported the participants part-time in the design sprints). The facilitators were service designers and the authors of this article, who led and facilitated the design sprints. In Tallinn and Rovaniemi, the hospital representative (i.e., the contact person between the design sprint project and hospital) also participated as a facilitator. During the case studies, members of the wider public were used in field work to provide general data and to understand the brief. These participants were given semi-structured and open-ended interviews, being asked questions such as "Are you familiar with this service?", "How do you find the service?" and "How would you like to change the time in your referral?" The interview questions were specified for each brief, and the ethical considerations were discussed beforehand with the teams.

3.1 Data

The data were collected through research diaries, facilitators' field notes, and semi-structured interviews conducted by design sprint participants. In addition, two unstructured interviews were administered to two design sprint participants during and after their project. In the following paragraphs, these instruments are described in detail.

In each design sprint, the research diaries evolved with minor changes. In Gothenburg, the data set consisted of nine research diaries kept by 22 participants. Every participant received an email after every design sprint session, with three to four questions regarding the methods used during the day, as well as participants' feelings and thoughts. The research diary data collection method revealed that it was challenging for the participants to complete the entries in their research diaries after long, exhausting and intensive days. In Tallinn, the research diaries were paper-based booklets. The same questions were asked and answered at the end of each day, such as "Good thoughts from today", "Questions which arose for you" and "Idea you'll put into practice". From 20 participants, 15 research diaries were returned. In Rovaniemi, instead of asking participants to write their thoughts down in the email or research diaries after each day, we focused our time on semi-structured debriefing interviews after each of the first three days. We asked the same questions, which were highlighted in previous research diaries in Gothenburg and Tallinn. In addition, we sent an online questionnaire after the sprint was completely finished to gain insights and reflections regarding the overall experience. We received four detailed questionnaires from six participants. The data from all locations were then scanned, transcribed in Excel and categorised by topic, using a thematic analysis approach.

Field notes were taken by the first author of this paper, who observed the design sprints in

Gothenburg and Tallinn and facilitated the design sprint in Rovaniemi. The field notes are researchers' remarks (e.g., how team participants were reflecting and discussing while using design methods, how design methods cleared up the brief and how the synergy was seen in groups). Findings from the field notes were added into Excel, as were research diary data.

Semi-structured interviews focused on understanding the participants' experience during the design sprints and reflecting the experience afterwards. In Rovaniemi, instead of asking the participants to document their thoughts in research diaries, we interviewed them after the first three days of the design sprint. We formulated the interview questions in such a way that could be used both for interviews and our personal notes in our research diaries. The interviews were not recorded, but another facilitator wrote down the key points. In addition, the first author of this paper had in-depth discussions with two student participants. One student participated in each design sprint, and the other participated in the design sprint in Gothenburg and Tallinn. The notes were taken during the discussion and were added into Excel, along with previous data.

3.2 Case studies

The three case studies utilised multiple design methods and tools which are familiar from the service design field. The aims of the design methods were to find needs, challenges and opportunities by using interviews in the field and, with the mentors, to collect and analyse the data in visual forms and templates for understanding the insights of the topics and deepening the understanding by formulating user personas and point-of-view charts or by discussing scenarios through desktop walkthrough methods. In each case study, the ideation was done differently and the ideas were concretised by prototyping. The following table (Table 1), visualises the three design sprint processes and the design methods used in each location. The last vertical row highlights the amount of collected research data in each case study. Details regarding the case studies are provided in the following subchapters.

Table 1 Integration of design methods and collected research data from each design sprint

Location & participants	Short description of design methods used per day in each location					Collected data
	Day 1	Day 2	Day 3	Day 4	Day 5	
Gothenburg, Sweden 18 students 4 nurses	• Presenting previous cases	• Introduction • Team building • Briefing • Ethno station - interviews	• Field research • Collecting & visualising insights & data • Clustering insights & data	• Ideation • Concept development • Testing • Creating videos • Presentations		• 9 research diaries • Field notes • Unstructured interviews
Tallinn, Estonia 19 students 1 nurses	• Introducing five challenges • Creating teams	• Team Canvas: team members and clarifying the topic • Storyboard • Site-visits • Mentoring	• Rough prototyping and role-play through desktop walkthrough • Mentoring	• Mentoring • Testing, evaluating and iterating	• Presentations	• 15 research diaries • Field notes • Unstructured interviews
Rovaniemi, Finland 6 students 0 nurses	• Briefing • Team building • Test journey	• Field research • Mapping down findings • Mentoring	• Clustering insights & data • Ideation	• Clustering ideas • Voting • Storyboard • Prototyping chosen idea • Testing	• Creating videos • Presentations	• 4 research diaries • Field notes • Unstructured interviews

3.3 Case study: Design sprint in Gothenburg

The first four-day design sprint was held in Gothenburg, Sweden in April 2019 with 18 international and multidisciplinary participants, and four hospital representatives (two nurses from Gothenburg and two hospital staff from Tallinn) were included. The participants worked with a design brief from Child Health Centre Services (BVC), where the research focuses included (1) information regarding the different visits during the child's time at BVC, and (2) information related to prepping for a visit from the child's perspective. As an interesting outcome, the teams created different communication tools, such as "Chatbox" and a "Yearbook", for interaction between parents and professionals.

3.4 Case study: Design sprint in Tallinn

The second five-day design sprint was held in Estonia, Tallinn in April 2019 with 19 participants who were also from abroad and from multidisciplinary fields; one participant had a healthcare background. The aim was to investigate and develop patient journeys in five North Estonia Medical Centre clinics by employing design thinking and co-design methods. The design challenges included (1) making the pre-visit process valuable; (2) leading a meaningful life after a stroke; (3) day surgery centre; (4) death with dignity; and (5) emergency department (ED) patients' stress and anxiety. Five conceptual solutions were co-designed to address these challenges in partnership with design sprint participants and

staff from the North Estonia Medical Centre. The design sprint in Tallinn was facilitated by a service design teacher and a hospital representative.

3.5 Case study: Design sprint in Rovaniemi

The last five-day design sprint was held with six participants in Rovaniemi at the beginning of May 2019. The aim was to investigate and develop a care and treatment reservation centre at Lapland Central Hospital by employing design thinking and co-design methods. The challenge was divided into two case studies, including patients who lived far from specialised healthcare institutions and patients who lived near the central hospital, which provides specialised healthcare services in Rovaniemi. Two groups of three participants developed two different concepts for the care and treatment reservation centre. The first group, which focused on a patient living in a remote area, created a LAPP LAB service bus to take healthcare services and e-health solutions into rural areas in Lapland. The second group, which focused on patients living near Lapland Central hospital, created a web-based service system to make the treatment reservation process more flexible by allowing patients to book, change and cancel appointments by themselves.

4. Mapping the findings

We now turn our attention to the analysis of our research, by first considering the findings from the collected research diaries, field notes and interviews. The findings are then considered in the context of key insights associated with certain theoretical frameworks, and as shown in Table 2 below, the collected data were categorised according to recurring themes.

Table 2 Strengths and weaknesses from design sprint participants' perspectives, based on the recurring themes identified in the research diaries.

Strengths	**Weaknesses**
- Learning design thinking and design methods	- Understanding the bigger picture of hospital processes and systems
- Organisational change	- Relevance of the created service concept
- Dialogue between stakeholders associated with different design methods	- Ethical limitations and considerations
- Understanding hospital processes from the end-user's perspective	
- Emphasising stakeholders by employing co-designing	
- Other relevant insights regarding hospital services	

Learning was highlighted as the greatest strength in the design sprints. Learning was strongly linked to design thinking and design methods. This was especially true for the healthcare

professionals who were part of a design sprint team. Participant nurses described their experiences as “Learning how to think innovative” and “Very inspiring sprint and very educational”. The nurses stated their willingness to implement some of the design sprint methods in their everyday practice to make the processes more tangible and gain a better understanding of the holistic experiences of users. In addition, learning occurred inside the design team, which was evident when a nurse was able to immediately communicate how the system or service was working at a given moment. The design sprints were seen as a sample or short introduction to the design field.

Concrete design methods (especially visualisations) helped participants and mentors better perceive service processes and systems. Creating customer journeys as a comic strip or storyboards and playing scenarios through desktop walkthroughs (see Figure 4) played a crucial role in the enhancement of dialogue. Notably, mentors (healthcare professionals) were able to understand the holistic service journey from the user’s (patient’s) perspective. For instance, a doctor acting as a mentor took the user pawn, went through the service from the user’s perspective and perceived the holistic user journey. The research diaries from participants who participated in design sprint teams, our own field notes and feedback from the hospital highlighted that in practice, design thinking and design methods can have a positive effect on organisational changes.

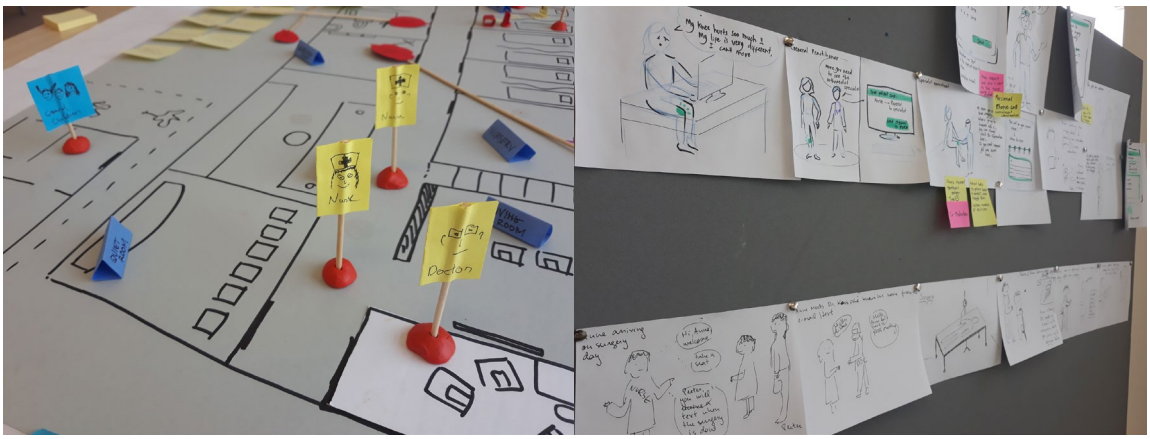

Figure 2 *On the left, a storyboard illustrates the existing service process. On the right, desktop walkthroughs are used as a tangible tool to better understand service flow from a top-down angle*

In this sense, we could also say that participants and mentors empathised with other relevant stakeholders who were the key characters in their specific case study. Participants found that it was important to have a real picture of where the service is delivered. For instance, in Gothenburg, participants visited the clinic and observed and interviewed nurses. Seeing and experiencing services with their own eyes and stepping into the service users’ shoes created a holistic picture of the front-facing services (visible side of the service). In Rovaniemi, participants began their design sprint with a test journey, where they walked through the local hospital using fake ID cards and went through three wards (see Figure 5).

The test journey would have been perfect if the activity had focused more on reservation service, which was the primary subject of the design sprint. Still, it was a good introduction, which improved participants' familiarity with the local hospital and people.

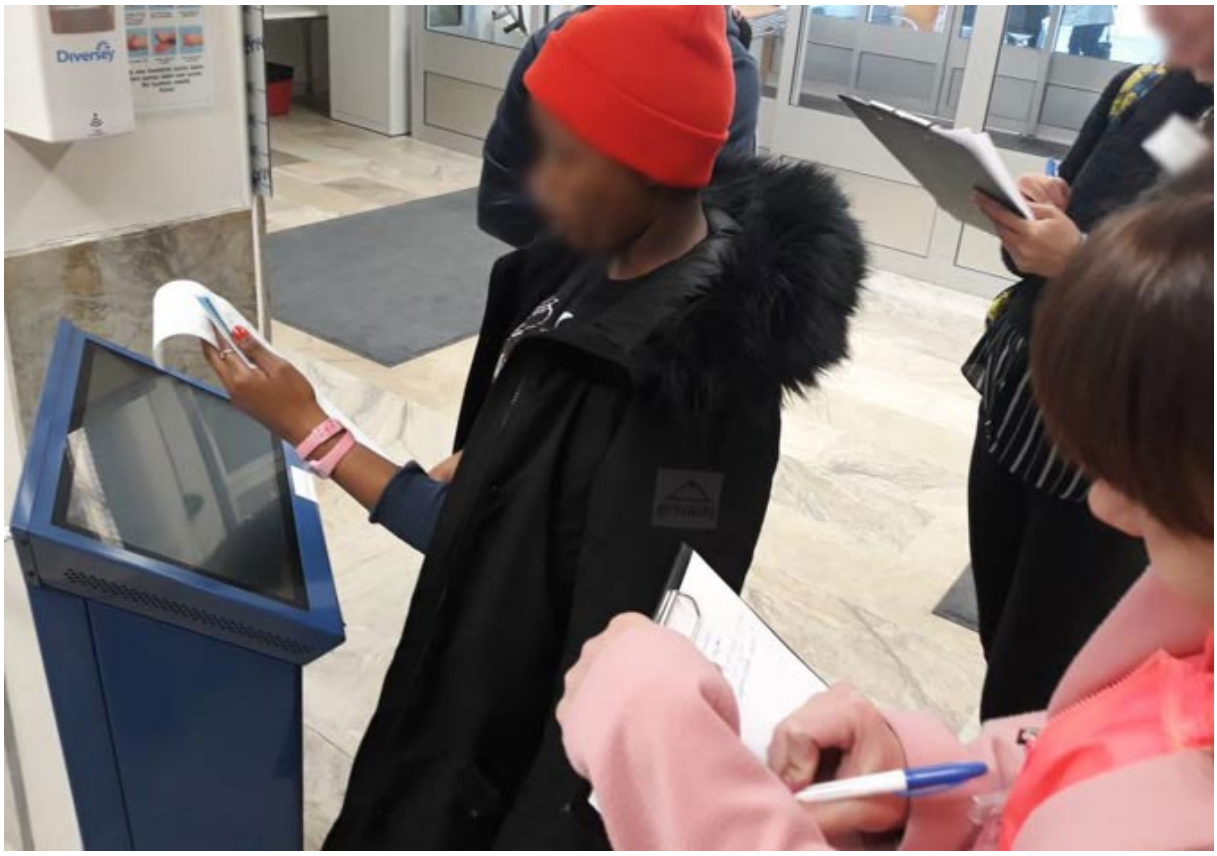

Figure 3 *A test journey in the local hospital helped participants to quickly familiarise themselves with the existing service from the user's perspective.*

Nevertheless, the limited time frame did not allow participants to focus on the entire hospital processes and systems in depth. Certain process gaps were found to be invisible to users: namely, those that occur behind the scenes, which are often complex and multi-layered in the healthcare field. This had a negative effect on concept ideation, trust and the relevance of the final outcome. The most common feedback from participants indicated that the desired end results did not appear fully realised due to gaps between existing service systems and service ecosystems. These weaknesses increased when participants were unfamiliar with local healthcare services.

During the design sprints and design methods used in those, the participants in each team generated a significant amount of valuable information. For instance, through interviews and desktop walkthroughs, many other critical pain points or needs of healthcare services were highlighted or discussed. In health-related topics, the needs and challenges can be multi-dimensional, so different critics were highlighted depending on which ward or position the person is working in. The design sprint teams analysed their gathered information by using

sticky-notes or flip charts, so that everyone in the groups could see the written details and themes. The notes included information outside of the given brief, which were written down, but not considered. In Rovaniemi, the contact person from the hospital was very eager to use hundreds of post-its, pointing out that "there are so many important and relevant findings which need to be highlighted in our other projects". Based on this, participants presented their notes as one additional deliverable to the hospital.

While conducting research in the hospital, ethical limitations and the risk of hearing or seeing something unethical must be considered. In addition, such considerations shed light on what you can ask users in a hospital hallway or on a street while doing field work. These ethical considerations were discussed at the beginning of the design sprints in each location, and participants reported that they felt unsure about what they could do or ask. In this sense, it was easier for the participants to interview mentors because they were hospital professionals. Anyway, during the case studies, members of the wider public were used in field work to gain a wider understanding of the brief. Moreover, in the agile design process, it is difficult to go very deep with one's research, and the deeper data that participants collected were obtained from hospital representatives.

5. Change and achievement through design sprints

The aim of this study was to identify the strengths and weaknesses of health-related design sprints and how to improve synergies among design sprint participants. Based on our experiences from the three design sprints, our key findings (Table 2) from the perspective of health-related service design were presented, and the challenges associated with making changes are discussed in the theoretical framework. We then shared our experiences concerning the synergy among all actors in the health-related service design sprints. These are reflected in the strengths and weaknesses identified in our findings.

5.1 Challenges for change in design sprints

Generally, hierarchy and silo-structured organisations prevent growth (Donetto et al., 2015; Fry, 2019; Radnor, Holweg & Waring, 2012). In our three design sprints, the mentors (healthcare professionals from different healthcare fields) were carefully selected for their open-mindedness and willingness to facilitate changes in healthcare. The mentors shared the best possible knowledge and motivation with design sprint teams. Mentoring rounds helped students go further with the brief and design drivers. In addition, understanding holistic patient journeys that go hand-in-hand with hierarchical struggles was perceived as a strength more than a weakness. Design methods and their visualisations supported the understanding of the holistic service journey from the patient's perspective, as well as from the perspective of the hospital professional's daily work life.

Testing and prototyping through role playing was also conducted in each design sprint. Notably, through concrete examples, it was easier to suggest features and better understand how technology fits in hospital processes to make systems even more suitable for everyday

use. Role playing also further enabled failing in safe environments and iterated service concepts to avoid or manage certain risks and/or costs (Calck & Ellison, 2019; Fry, 2019; Jones, 2013). This is linked to learning design methods, understanding hospital processes in a holistic manner and identifying needed organisational changes.

The results of this study indicated that issues related to governance, strategies, political will and economics were the most difficult to consider. The time-pressured design sprints did not allow participants to delve deeper into these topics. Nevertheless, design sprints were found to be potentially valuable as kick-offs for new hospital projects or as boosters during the middle phase of the project. If the outcomes are implemented later, these topics will be considered more valuable in the hospital development process.

Community engagement, complex and urgent social challenges (Bazzano & Martin, 2017), aging populations, continuous growth, social and healthcare reforms (Clack & Ellison, 2019; Fry, 2019) are areas that can be considered in the service design process. When conducted in an agile manner, a design sprint pressures participants to think about what must be achieved in five days. Narrowing the focus of the challenge might give better and more valuable results, although participation in the design process is important. When managers, various specialists, participants from different backgrounds and designers are included in the design sprint team, the process can be improved and more realistic outcomes can be obtained. This may improve and facilitate changes in hospitals.

5.2 Synergy in agile ways of doing

In this study, synergy was defined as a collaboration among participants and other important stakeholders involved in the design sprint process. We see synergy as an achievement, which design methods and design thinking can support. Design methods such as storyboards, desktop walkthroughs and body storming created a better understanding of services, and this helped people with different backgrounds and knowledge discuss the challenges and potential solutions together. The concrete, tangible tools work as a “common language” among participants in the design sprint teams and healthcare professionals (Rygh & Clatworthy, 2019). Notably, support is also needed from facilitators, who must have skills to guide dialogue and design thinking, while also supporting the usage of design methods. The facilitator’s role is also to boost synergy inside the teams.

We found that through design sprints, it was not possible to achieve finalised service outcomes that can fix existing services or create something totally new. If there is insufficient time for implementation, there is a real risk that outcomes will fail (Fry, 2019; Nilsen et al., 2016). We also found that the synergy and dialogue among all the participants, mentors and facilitators is more important than the end result. Well-facilitated design sprints, open-minded mentors and carefully selected design methods are at the core, which affect synergy and can help overcome challenges associated with making changes in hospitals.

Reflecting on the data of this research, some common themes emerged from our three design sprints. These dominant themes are related to teamwork and the value of having

participants with different backgrounds. In all design sprints, respect for everyone's knowledge, skills and profession was seen as highly important, where design methods worked as a platform to bring out skills. Every skill had a space, and participants found their skills to build the synergy in their team. These skills were, for instance, to ask the right questions or listen to people, visualise or concretise concepts, ideate creative service concepts, lead and support one's group, keeping in time and boosting one's team as they become tired. The professionals who had a deep understanding of their own field (e.g., doctors or nurses of specific hospital wards) should not be forgotten either. Their skills were clearly seen in each design sprint team, highlighting the power of giving space for others' skills to be acknowledged. When the clock is ticking during the intensive design sprint, every group member's skill should be used, and this also generates trust and mutual learning. This creates value inside of the team and generates respect. This is a core element in synergy, while different abilities are found, encouraged and supported inside teams.

6. Conclusion

The design sprints were not only seen as mandatory project contributions from the hospital's point of view but as a great learning opportunity in the healthcare context. As a way of co-designing in the healthcare field, design sprints can be a collaborative approach to bring design thinking into a hospital. It is an effective approach to engaging hospital representatives and concretising design methods in practice. Design sprints pressure design teams to understand the different levels of complexities in hospitals, including its processes, systems, technologies, infrastructures and ecosystems.

Design sprints appear to be an effective approach for kick-off events at the beginning of new development projects or as a booster in the middle of the project. As a kick-off, it gives important tools and a mindset, which are needed to expand and ongoingly explore certain topics, such as how to involve stakeholders and listen to them, how to guide dialogue and give space to express themselves and how to map insights and concretise ideas. Design sprints also provide tools to support synergy among internal teams, design teams and design consultants. Design sprints can be a good starting point to achieve more sustainable services in hospitals. Even so, the pace of the design sprint within a slow-moving organisation, such as those that are so prevalent in the healthcare system, may be just what the design sprint claims to be—a breath of fresh air. The fresh air allows new conversations that can trickle beyond the time-slotted event referred to as a "sprint".

For the next stages of design sprint development in hospitals, engagement and ethical issues must be considered, along with an agile method of going further with time-pressured processes. While the mentors in this study were hospital representatives, the engagement of patients and family members cannot be stressed enough. Their role in effective and efficient healthcare service development is crucial and must be more fully considered in the future.

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Co-designing tools to empower further, independent co-design: collaborating with diverse individuals with lived experience of food poverty

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Abstract: Food poverty is an acute, growing and highly impactful social, political and practical challenge for the UK in 2019. This paper describes collaborative design undertaken by researchers from the Leapfrog project and practitioners from Food Power, a national network tackling food poverty. In this paper we describe 3 elements of a substantial co-design research project. We describe how co-designers from very difference constituencies (in age and location) developed tools and resources that helped the voice of people in food poverty be more clearly heard. The aim of this project is for the clear articulation of the impacts of food poverty to effect policy and policy maker. Helping in the long term to remove the need for food banks and other tactical responses to systemic food poverty challenges. The case studies presented have wider implications for the creation of tools and resources to help co-design, mass creativity and engagement at scale.

Keywords: co-design; tools; engagement at scale; food poverty

1. Introduction

Food poverty is an acute, growing and highly impactful social, political and practical challenge for the UK in 2019. The scale of food insecurity challenges is still being discovered, but recent reports show that nationally 8-10% of UK households experience food insecurity (Sosenko et al., 2019), with 13% of adults experiencing some form of food insecurity (Lambie-Mumford et al., 2019). These national averages values can have huge differences across regional and demographic boundaries. For example, at 52.4% the city of Blackburn has one of the highest levels of child poverty after housing costs are accounted for (Stone and Hirsch, 2019).

This paper describes collaborative design undertaken by researchers from the Leapfrog project and practitioners from Food Power, a national network tackling food poverty. Through a 10-month collaboration with Food Power, starting in November 2018, ‘Tools

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for Empowerment' formed part of 'Scaling Up Leapfrog: Improving a million creative conversations'. This was an Arts and Humanities Research Council project seeking to explore how co-design can enable organisations to reach new scales in their work. Leapfrog researchers worked across sites in Darwen (Lancashire, UK) and Newcastle (Tyne and Wear, UK) with a range of individuals with lived experience of food poverty. Our approach was not to design solutions to food poverty challenges. The practical focus of the collaboration was co-designing reusable, adaptable tools, an approach previously applied by Leapfrog in a range of public sector contexts (Cruickshank et al. 2017, Whitham et al., 2019).

The co-designed tools we describe in this paper respond to the scale of the food poverty challenges across the UK. They centre on enabling individuals to explore, capture and share lived experiences of food poverty and food availability in their localities, and translate these experiences into stories that will be meaningful in local, national and international contexts. The aim of the research presented here was to explore how short-term design research initiatives can empower individuals and catalyse long-term transformations in the scale and impact of existing organisations and networks. The intent is to empower individuals to participate in the public discourse surrounding food poverty and strengthen existing networks and infrastructure that are responding to existing and emerging challenges of food poverty and insecurity. Our approach explicitly responds to the scale and resourcing of the Leapfrog £1.3m AHRC (UK research council) funded project and the scale and strategic intent of Food Power. The tools co-designed through this project are now available freely through the Leapfrog project website alongside over 50 other tools (www.leapfrog.tools), collectively downloaded over 5,000 times.

We firstly review related research literature before introducing the work from the perspective of our collaborating partner Food Power. Three case studies follow this, each exploring a different aspect of the Tools for Empowerment project in relation to collaboration across diverse age and geographic locations, empowerment through embedding new understanding and the ongoing impact of the collaboration on the national Food Power network. The paper concludes with a comparative discussion of the case studies, conclusions and recommendations undertaking collaborative design directed at scales beyond particular projects and localities.

2. Collaborative Design and Scale

Design research has produced an established body of literature engaged with impact beyond the immediate work of the designer. Participatory Design (PD) places the involvement user or beneficiaries as a central concern (Simonsen & Robertson, 2013), providing methods to enable non-designers to participate in design activities (Sanders & Stappers, 2008; Sanders et al., 2010; Bratteteig et al., 2013; Eva et al., 2013). PD and co-design offer a means for designers to open processes and projects to the creative ideas and actions of many people.

In the last decade PD researchers have proposed shifting the focus of PD theory and practice from artefacts and processes (as exemplified in Ehn, 1988) to infrastructures and processes

of infrastructuring (Björgvinsson, 2008; Hillgren et al., 2011). This shift in intent and scale recognises the mutual learning in designers and participants who undertake PD initiatives, and the effects on connectivity and capability within organisations, communities and networks that these initiatives can bring about. By focusing on ongoing and open changes to infrastructures, researchers have proposed framing PD as a means to enable democratised innovation (Björgvinsson et al., 2010), recognising that PD initiatives need not prescribe the goals or intent of collaborative activity.

The shift in scale from artefact to infrastructure accompanies ideas of enabling unpredictable action by design beneficiaries. The concept of Metadesign (Fischer & Giaccardi 2004, 2006) differentiates itself from user-centred or participatory approaches by explicitly seeking to enable the evolution of design outcomes by users. Ehn contrasts Metadesign with PD approaches to designing for 'use before use' (Ehn, 2008), conceptualised by Redström in terms of 'design time' and 'use time' (Redström, 2008). Both Metadesign and concepts such as '*design after design*' point towards enabling unexpected action independent of the designer by looking beyond a particular design project or outcome.

In this paper we draw on ideas of infrastructuring, facilitation and sustainability to position our co-design collaboration with Food Power. As other researchers have found, there is a persistent risk that the initiatives will stagnate when researcher time or project funding ceases (Prost et al. 2019). The interest in sustainability and escaping the scale of particular projects is raised explicitly the work of Prost et al., as they sought to create a Food Hub that could persistent independently from their expertise and resourcing of their research (2017, 2019).

Orienting collaborative design away from particular outcomes and towards networks is one means to address the sustainability challenges (Iversen & Dindler, 2014) of projects and localities. For example, Manzini and Rizzo (2011) describe '*framework projects*', and Britton (2017) describes '*platform organisations*'. Here designers infrastructure and connect as facilitators and activists (Manzini, 2015), acting as mediators and instigators (Björgvinsson et al., 2010; Binder et al., 2015). At this scale the designer is agnostic and open to particular issues as they seek to engage and empower individuals (Cruickshank et al. 2013), trigger further initiatives, and to build capability and resilience across networks and communities.

3. Tools for Empowerment

Food Power is a national 4 year £4 million pound Big Lottery funded programme managed by Church Action on Poverty and Sustain aiming to tackle the root causes of food poverty through people powered change. In 'Tools for Empowerment' Leapfrog worked closely with Food Power's Empowerment officer who supports over sixty local food alliances across the UK to build capacity, with local empowerment at its core. Recruiting and empowering individuals with lived experience of food poverty is central to Food Power's strategy of advocating for long term sustainable solutions. Whilst emergency provision is needed to stop people going hungry, food banks are only a sticking plaster to the underlying issues that

cause food poverty, including low pay, an inadequate benefit system and rising living costs. Through amplifying the voices of those who have been impacted directly, Food Power aim to fully understand the root causes of food poverty and identify sustainable solutions. To pilot this approach, individuals with lived experience of food poverty were recruited into alliances to explore how they could be empowered and involved as experts at a strategic level. Each pilot explored different methods of involving those with lived experience with the intention to share this learning with other alliances across the UK.

When the Leapfrog 'Tools for Empowerment' project began in November 2018 Food Power was working with six pilot areas. Food Power had found that recruiting and supporting individuals within the pilots wasn't without its challenges. Often those experiencing food poverty didn't self-identify as being in poverty. "It *was very much their norm and individuals were hesitant to talk about personal experiences due to risk of stigma or exposing themselves*" (Pearson, 2019). Initiating open conversations where Food Power could draw out an individual's lived experience to influence policy on a local and national level was often difficult. However, it was evident that individuals were so much more than their lived experience. They had assets, knowledge and skills, with stories and expertise to unlock, with intrinsic knowledge of surviving living in food insecurity and knowing from a grassroots level what support helps or hinders.

One of the most difficult things Food Power and their alliances do is talk to people about their experience of food poverty. People often do not realise that their relationship with food is not ideal in terms of quantity and quality. The 'Tools for Empowerment' project aimed to address this by co-designing tools which would help to structure and capture conversations about food and food poverty in a positive, non-confrontational way. The outcome would be a series of tools and resources to engage young people and adults in conversations around food and food poverty, both those with lived experience and keen activists. Food Power also hoped that engaging people in the co-design process (as opposed to just asking them to tell their story) would further empower individuals through giving them confidence. Lobbying or advocating on behalf of yourself or others as an individual with lived experience can be difficult if people don't feel as knowledgeable or powerful as the person or organisation they are communicating with. Leapfrog and Food Power hoped that taking part in the co-design process would increase people's confidence and ability to speak truth to power in future activism or campaigning activities.

4. Co-Design Approach

The ten-month co-design process took place across Darwen and Preston in Lancashire and the Byker Estate in Newcastle. The first co-design workshop developed a narrative around food and storytelling in ways Leapfrog and Food Power hoped would lead to more in depth conversations, but in a dignified, sensitive way. Ten young people came together in an inclusive environment where everyone participated as equals. The facilitation of this first session explored 'What makes a story powerful?' Using their responses, the group looked

at existing Leapfrog Tools and started to adapt them in ways in which would allow them to capture powerful stories about food. The creativity of the young people was evident. In addition to adapting four Leapfrog tools they also had ideas for new tools.

A second workshop later took place in Preston in February 2019 with a wider group of young people who tried out prototypes of the tools and evolved the designs. A third workshop took place at Food Nation in Newcastle in March with four adults with lived experience of food poverty from the Byker estate. They co-designed alongside engagement professionals from Food Nation, a social enterprise aiming to create a healthier food culture in Newcastle upon Tyne. This group were able to refine and adapt the tool prototypes to suit their own locality, something Food Power felt was important as stories were often very localised. Here the group were more confident in talking about their experiences of food poverty. The tool prototypes evolved to respond to their insights and experience of practically supporting their communities and talking to people at the local food bank. New tools were also created through new themes emerging from the group. For example, nostalgia the sharing of recipes such as 'Saturday stew' and buying and cooking food.

Additional co-design workshops were delivered in each locality during April and May 2019, each one building upon the feedback and ideas of the co-designers involved. As individuals became more engaged both the tools and people's confidence further developed. Valuable insights into the issues that affected people around food and food poverty emerged. Food activists, and individuals with lived experience worked alongside Leapfrog, Food Power and Food Nation to co-design tools in an open, inclusive process.

The Tools for Food Stories toolbox was shared at Food Power's national conference in June 2019 to over 100 attendees. The link to the toolbox sits on the new Sustainable Food Cities website, a national programme of nearly 60 Food Partnerships around the UK led by Sustain, The Soil Association and Food Matters. "The *tools have since been used by 35 food alliances across the UK, their adaptability allowing them to be used in numerous ways, from icebreaker and recruitment to activism and campaigning*" (Pearson, 2019). This sits well alongside Food Power's strategic aims as they explore post funding sustainability and the future role those with lived experience can play. The individuals involved in the co-design process have since moved on from developing practical ways to tell their own stories and capture the stories of others in their localities, to having political impact at a national and international level.

5. Introduction to the Case Studies

Drawing from these activities Leapfrog researchers identified 3 areas of insight that make a contribution to wider debates on co-design. The first case study describes the elements and interactions within the co-design process that enabled successful outcomes and embedded a sense of ownership of the tools across multiple localities. The second case study explores how a new understanding of their strategic roles as activists and campaigners was embedded in individuals through repeated use of the tools. The final case study describes how the

instructions for the Tools for Food Stories toolbox were designed to enable independent toolbox use by other alliances through using the contributions and perspectives of individuals with lived experience. "*This has had the result of engaging and empowering far more people nationally than Food Power would have had the capacity to otherwise in a very practical way*" (Pearson, 2019). The paper refers to the following people as actors in the case studies: Ben Pearson, Food Power's Empowerment Officer and Penny and Heather, a mother and daughter with lived experience of food poverty on the Bkyer estate in Newcastle. Penny and Heather have played significant roles as individuals with lived experience of food poverty supporting people in their community in myriad ways. Over time their role with Food Power has grown to advocating for others in food insecurity on a national and international scale.

6. Case study 1: Effective co-design collaboration across diverse ages and geographic locations

This case study demonstrates how tools can be co-designed across different cultures, age groups and locations, without the need to start the process again in each locality. In this case, one of the key elements to effective co-design across diverse locations and ages was creating tools that appealed to a strong sense of intergenerational nostalgia about food. In the co-design workshops in Lancashire and Newcastle many of the co-designer's favourite memories of food were related to nostalgia - the food they ate when they were little or that their grandparents cooked. In the first co-design workshop in Blackburn the young people came up with the idea for two decks of cards. The first was a Local Food Card Deck as shown in Figure 1 below.

In this first co-design workshop in Darwen the young people came up with a list of photos of food they would like to include in the pack. In Newcastle the adults with lived experience looked at the photos in the local Food card Deck so far. Ideas for photos of 'Pease Pudding' and other local 'Geordie' foods were added. Leapfrog provided the group in Newcastle with disposable cameras so Leapfrog could include their photos in the final card deck. Asking the different localities to provide their own photos for the Local Food Card decks was key in creating local ownership over the final card deck in both locations.



Figure 1 *The Local Food Card Deck is a deck of 52 cards with photos of local foods to help break the ice and inspire people to share funny stories and tales about food.*

The second tool that evolved across two locations was the Talking Food Card Deck. A tool the young people originally came up with in the very first co-design workshop. This was a deck of cards with one question per card to help start and structure conversations about food and food poverty. Figure 2 below shows the original questions the young people came up with in the very first co-design workshop.

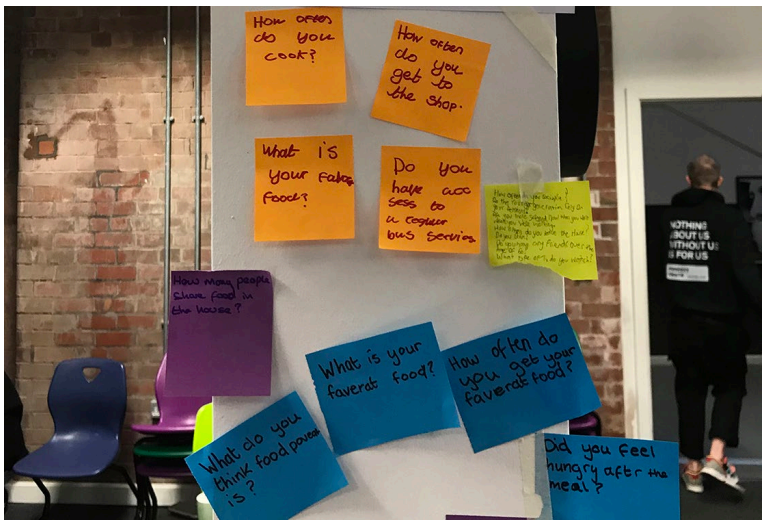

Figure 2 *The initial questions the young people came up with during the first co-design workshop to structure conversations and stories about food and food poverty.*

During the second co-design workshop in Preston the group were invited to try out prototypes of the Talking Food Card Deck. One of the co-designers took the lead in editing the card deck of questions with feedback from the group. New questions that were added brought a sense of fun to the questions in the pack such as '*Do you like red or brown sauce?*'.

Leapfrog presented the Food Card Decks as a work in progress to the adults with lived experience of food poverty on the Byker estate in Newcastle. Their opinions on the young people's questions was direct, insightful and sometimes hilarious. Comments such as "*Well that's just plain rude!"* abounded as they discussed each question in detail. One of the individuals with lived experience called Penny took the lead editing the questions as shown in Figure 3.



Figure 3 *Penny using her experience of supporting communities to refine the wording of some of the young people's questions, so they reflect the friendly, respectful way she talks to people on the Byker estate.*

Throughout the editing process the group took care to respect the original intention of the questions. Penny highlighted which questions you might ask in an initial meeting or conversation and which questions would be considered follow up questions. This informed the development of the final colour coded themed questions in the Talking Food Card Deck which the Newcastle group named: Building Trust, Exploring Food and Talking Food Poverty.

Food Power and food alliances across the UK have found the Local Food Cards and the Talking Food Card Deck to be a quick and easy way to break the ice and share stories about food. Despite the design, photographs and wording evolving at each workshop, each locality contributed to the tools at every stage. This diversity of authorship (and the capability to modify the cards locally) have proved to make the use of the cards more robust and more widely applicable than working directly with one specific group or location. This improved and strengthened the concept of the card decks, rather than taking away previous contributions or starting again. Having something practical to design enabled people from different ages, groups and backgrounds to come together to discuss their experience and come up with ideas in an inclusive process. This process both instilled confidence and helped

to empower individuals in their roles as food activists. The co-designers continue to use the Card Decks. Through their involvement in the co-design process they have ownership of the tools and are confident adapting them to work in different contexts.

7. Case study 2: Using tools to embed new understanding

This case study explores how the Food Safari and Caterpillar tools embedded a new understanding of their role as food activists campaigning for change. The young co-designers wanted to explore what food young people can afford and how healthy or otherwise it is in their hometown of Darwen.

As shown in Figure 4 a '*Food Safari*' tool was co-designed to give the young people a menu of twelve mini food related research challenges.



Figure 4 *Image showing a section of the 'Food Safari' tool. Like a real menu the 'Starters' are simple activities to get people warmed up. Before printing people can add a map of their area inside.*

For example, the popular '£2 Healthy Food Challenge' showed how difficult it was to buy cheap healthy food. Several of the challenges involved interviewing shopkeepers and their customers which visibly increased young people's confidence in talking to people they didn't know. The Food Safari "*felt ground breaking*" to Food Power's Empowerment Officer. "*It empowered the young people to use the tool in a real-life setting, to choose their own challenges (or create their own) and find their own routes through the town in teams of activists, experts and allies"* (Pearson, 2019). The tool took people on a journey which allowed them to see how local food scenes link to access, affordability and choice.

Two of the young co-designers that day were ambassadors for Children's Future Food Enquiry whose findings were due to be presented at Westminster. To bring the news report to life a Channel 4 News crew filmed parts of the Food Safari. Later the crew went to one

of the young people's home for an interview about her family's experience of living in food insecurity. The 16-year-old girl gave a confident and articulate interview to Channel 4 about her experience. "*A salad was £4.50 and a bacon butty was £2 so unhealthy food always the main option for everyone*" (Channel 4 News, 2019). The Food Safari tool, though she was not using it at the time helped to frame her findings into food provision locally. It enabled her to tell her story in the context of wider food provision of her hometown.

Later in the project, Ben and Penny visited ImaginationLancaster to co-design a tool which would help capture learning, structure conversations and understand people's journeys as individuals with lived experience, or those involved in activism and campaigning. The tool was used on a trip to the US in September 2019, firstly to the '*Closing the Hunger Gap*' Conference in North Carolina, and then in New York on field visits with Why Hunger. In under two hours a tool emerged, a colourful fold out caterpillar, playful yet practical, and something that could neatly sit in the back of notebooks. Once in the US, the tool as shown in Figure 5 became so much more than something to capture learning. It gently reminded the Food power team amongst all the activity and excitement of the trip what they were there to capture and learn.

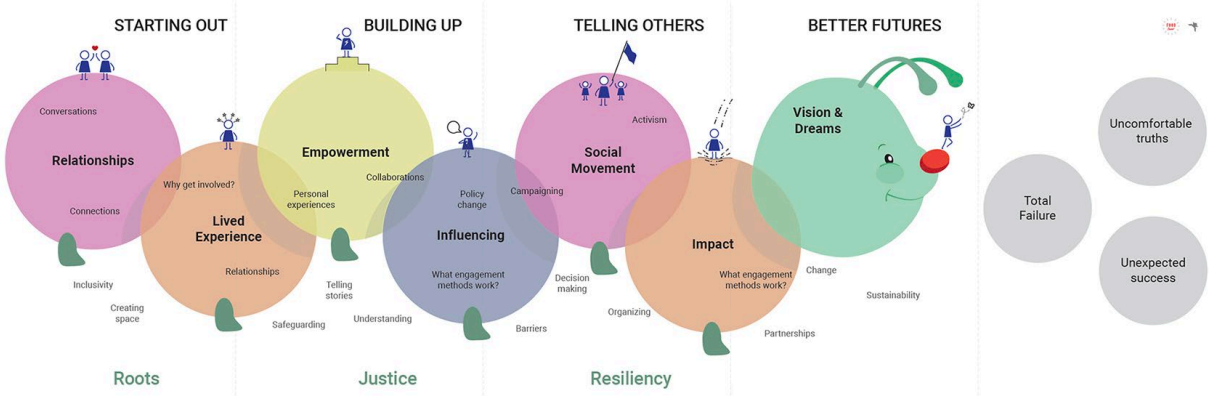

Figure 5 *The Caterpillar tool breaks the journey of an individual with lived experience of food poverty into small steps such as policy change, activism and campaigning, speaking truth to power and what it looks like to have influence.*

Whilst in the US, the Caterpillar tool was used by Penny and Heather to reflect on conversations and note key findings. This helped them understand how some of the root causes of food poverty can be addressed through grassroots engagement as well as the actions and the outcomes they are working towards. "*This confidence and structure are still with Penny and Heather even when they're not using the tool" (Pearson, 2019)*.
In *'Tools for Empowerment'* Food Power wanted to explore ways the power balance between engagement professionals, activists and campaigners could be more equal and enable individuals to have a more meaningful role. Participating in the co-design process and using the Leapfrog tools to embed a new understanding has helped to equal out the power balance when individuals with lived experience are working alongside engagement professionals. Some participants are now active and independent co-designers.

> "They can now see and talk confidently about the bigger picture beyond helping somebody day to day. They understand where systems and policies might need to change, how they can engage effectively with authority figures and have influence when speaking truth to power" (Pearson, 2019).

8. Case study 3: Co-designing instructions using the voice of individuals with lived experience enabling independent toolbox use

A key component of co-designing tools is creating instructions for use. They need to be simple and clear so that anyone can adapt and use them. The instructions, which suggest multiple ways each tool can be used have proved critical when engaging and empowering people to use the Tools for Food Stories toolbox on a national scale. This case study recounts the process the Leapfrog team undertook to successfully co-design instructions which acknowledge the contribution and perspective of the co-design team. The toolbox which can be downloaded from (http://leapfrog.tools/) was co-designed to not only support conversations about food and food poverty but to be used in many different ways. For example, there are tools that can be used to structure conversations about shopping and cooking habits, a scribble on High Street and a Canteen tool. The co-design team's challenge was to create instructions that inspire the user to adapt the tools to achieve their specific facilitation initiatives.

To co-design the instructions, Leapfrog and Food Power captured quotes and stories during the co-design workshops. These insights proved useful as a reminder of the original intention behind each tool. In the final co-design workshop in Newcastle in May 2019 Leapfrog focussed on co-designing instructions and suggestions for use for each of the eight tools. The group of twelve people was split into two and invited to develop examples of use for each of the tools from the perspective of the individuals by experience and engagement professionals. Each group was asked to complete a pro forma with the following three questions: 1) Who are using the tool with? 2) What are you trying to do? 3) How would it work? These examples revealed different stories around the tools that provided powerful insights and resulted in multiple mini case studies for how each tool can be used. Leapfrog drew on these examples to create the instructions for each tool. Leapfrog deliberately selected suggestions for use that were diverse and interesting to show a wide range of potential uses and inspire the user to come up with ideas of their own. The tool instructions reflect the multiple voices of the participants that co-designed and tested the tools. As shown in Figure 6 the co-designers were represented by three groups of personas: young activists, engagement professionals and individuals by experience.



Figure 6 *The co-designers were illustrated in cartoons that provided, with their own voices, the context of the tools and recommendations of how the tools could be used. Using this approach to create the instructions gave this toolbox a unique character.*

The tools are contextualised in the fields of activism and campaigning and are designed to open up conversations and capture stories about affordability and access to food. On the other hand, having three different voices on the instructions serve as an example of the versatility of the tools since they can be used by young people, experts and professionals. Featuring their voices in this way conveyed the power balance of the co-design process, in which each co-designer was equal, no matter the role they played. The instructions included two or three suggestions of different ways the tool could be used along with facilitation tips about the structure and mechanics of adapting and using each tool. To help people see the range of tools within the comprehensive toolbox Leapfrog co-designed a Toolbox Menu as shown in Figure 7.



Figure 7 *The menu for the Toolbox for Food Stories gives a clear overview of the tools within it as well as acknowledging through cartoon illustrations of the co-designers how the toolbox was created.*

Using cartoons of individuals in this way has given the participants a sense of ownership. The illustrations of key participants made them feel that the tools belonged to them. The way that the instructions were written, acknowledging and giving voices to the co-designers of this project gave them a sense of empowerment and pride in what they had created. Penny recently requested that 300 copies of each tool were printed and posted to her so she can run her own tool sharing workshops with a ready supply of the tools and Card Decks to hand. The impact of providing these clear, colourful instructions has enabled up to 69 Food Alliances across the UK who wish to engage and empower individuals with lived experience in conversations to do so without the need for face-to-face support or training from Food Power's Empowerment Officer.

9. Conclusion

In this paper Leapfrog describe 3 elements of a substantial co-design research project, and how co-designers from very difference constituencies (in age and location) developed tools and resources that helped the voice of people in food poverty be more clearly heard. The aim of this project is for the clear articulation of the impacts of food poverty to effect policy and policy maker. Helping in the long term to remove the need for food banks and other tactical responses to systemic food poverty challenges. The case studies presented here have wider implications for the creation of tools and resources to help co-design, mass creativity and engagement at scale.

The research team have established that it's possible to co-design with very distinctive hyper-local groups to meet their needs but further than this we have strong indicators that there are advantages in cross pollinating between these local groups. This was achieved through the sharing of co-design materials and tools between groups but also in bringing together co-designers with lived experience of food poverty with very different experiences to collaborate together.

Leapfrog at scale has also recognised that people with no prior co-design experience can become self-actualising, independent co-design practitioners. Co-Design participants have the potential to take ownership of the tools and resources they helped develop and apply them in their own way independent of professional designers or design researchers.

Finally, Leapfrog have established an approach to the creation of instructions (often more important that the tools themselves) that places the voice of co-design experts through experience at the centre of this communication. At a local level this has given a further layer of ownership and pride in their co-design work to participants who use the tools day in day out. Also (the researchers believe) giving the instructions an authentic voice and look of co-designers by experience makes the tools and resources more accessible and usable to all citizens outside academia.

10. Recommendations for future research

The impacts and effectiveness of this approach is still emerging. For example, some of the young people involved in 'Tools for Empowerment' were also involved in working with a young local film-maker to produce a powerful short film called 'Edgelands'. The film creatively amplifies the voices of young people telling their truth and stories in their language. In Edgelands, a land of forgotten estates, the film demonstrates the grim reality of issues surrounding food poverty, homelessness, and welfare. Food Power ran a workshop in December 2019 that brought a small group of people together including young people and individuals with lived experience to co-produce a resource that will sit alongside the 'Edgelands' short film. The resource will act as a catalyst for conversation around the themes within the film for use in schools, youth settings, community and faith groups. In the workshop the group adapted the Leapfrog Food Card Decks and created the 'Edgelands Discussion Card Deck' - 41 cards of questions to spark discussion on the issues raised in the film. The film has already been screened at a number of events nationwide and this resource will be used widely as they further promote the film (https://www.church-poverty.org.uk/edgelands/).

The research team are seeking other projects that have adopted a similar multi-participant group collaborative approach to corollate our findings. They are developing an extension of this work as part of the £13.2m Beyond Imagination project at Lancaster University. The team will co-design with experts through experience of activism, responding to activism in policy and service design across the spectrum, from national policy creation (Policy Lab) to regional government to community groups and activated citizens. Working directly with them but

crossing boundaries between issues. The team would like to research how to create a model of ethical activism that effectively engages with those in power positions.

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Under construction: Reimagining health and safety communication for multilingual workers in Qatar

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Abstract: As Qatar races to complete development projects in advance of the 2022 FIFA World Cup, the country's construction sector continues to face criticisms regarding its treatment of migrant workers. This criticism is compounded by nominal safety legislation at the national level and the need for accessible occupational health and safety (OHS) media on worksites. Adding to these concerns, there is currently no comprehensive approach to ensure the effective communication of vital health and safety information to workers with limited English/Arabic proficiency or low literacy skills. In light of these concerns, this paper describes a pilot study that brings together the disciplines of safety management and communication design to resolve communication inequities embedded in the nation's construction industry. Through a three-part workshop series, the study explores the synergistic potentials of design research and creative action to generate inclusive OHS media in Qatar.

Keywords: occupational health and safety; migrant rights; action research; social change

1. Introduction and context of the study

The complex relationship between labour and development bears witness to humanity's relentless desire for expansion and progress. Throughout history, powerful empires have risen from desolate lands, built on the backs of men toiling under the gaze of an unforgiving sun. Few countries can escape the dark side of socioeconomic growth, with the remnants of decades of intense labour embedded into the bricks and mortar of most great nations. In recent decades, the discovery of oil in Gulf Cooperation Council (GCC) countries has fuelled development efforts in the region with billion-dollar construction projects supported by the recruitment of workers from South and Southeast Asia (GLMM, 2019). Within this context, GCC citizens maintain strict structural power relations between themselves and foreign workers tied to notions of nationalism and citizenship (Diop et al., 2012; Kapiszewski, 2006).

As one of the six Middle Eastern countries that comprise the GCC, Qatar has received extensive media coverage regarding its sponsorship laws and treatment of foreign workers

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(Amnesty International, 2019; ILO, 2018; ITUC, 2011). Rajai Ray Jureidini (2017) outlines some of the structural mechanisms impacting the workforce, including the tendering process and workers paying large sums of money to recruitment agencies in their home countries. Moreover, the 'highly privileged position' of nationals is reinforced and maintained through *kafala*, a sponsorship system which regulates residency duration, immigration opportunities, and ties temporary work visas to employers or "sponsors" (Jureidini, 2017; Zahra, 2015).

Comprising nearly 85% of Qatar's total population, the majority of foreign workers come from Bangladesh, India, Indonesia, Nepal, Pakistan, the Philippines and Sri Lanka (Snoj, 2019; Crépeau, 2014). With an estimated 100+ languages shared amongst this diverse community, many blue-collar workers do not read or speak the two primary languages of the country's leading contractors: Arabic and English (Gardner et al., 2013). Language is not only an essential cultural tool needed for communication and social cohesion (Everett, 2012), but linguistic barriers can also distance people from public discourse and contribute to socio-cultural marginalization (Lo, 2014). In workplace scenarios such as the construction industry, addressing communication inequities is arguably a "matter of life and death" for marginalised communities (Lee, 2009).

According to Amnesty International, construction workers in Qatar consistently face above-average rates of injury or death due to poor working conditions and limited access to healthcare services (2019; 2014). Umesh Upadhyaya from the General Federation of Nepalese Trade Unions, further references the harsh climate of Qatar, stating, "everyone is talking about the effect of Qatar's extreme heat on a few hundred footballers, but they are ignoring the hardships, blood and sweat of thousands of migrant workers, who will be building the World Cup stadiums in shifts that can last eight times the length of a football match" (qtd. in Pattison, 2013). The linguistic and cultural diversity of Qatar's foreign workforce, along with insufficient health and safety materials to support these needs, may offer evidence pertaining to the high number of safety-related incidents within the country.

In response to these complex socio-cultural challenges, several local design initiatives have emerged in recent years to investigate how designers can contribute to positive social change in Qatar. For example, the need for temporary labour accommodations for construction workers spurred Maja Kinnemark to create an adaptive innovation plan for communal living spaces that use portable modules as a solution to the shifting worksites across the country (VCUarts Qatar, 2014). Alia Khairat focused on enhancement-oriented innovation to improve upon construction worker's clothing in response to the extreme temperatures in which people often work (Khairat & Modeen, 2014). Together, these projects highlight an opportunity for design research to actively contribute to improving the lives of people working in the construction industry as a form of social change in Qatar.

2. Communication inequities in the construction sector

Over the past two centuries, the imperative to communicate safety information across language barriers has increased due to industrialization and economic development, but

also because of international gatherings such as the World's Fair, the Olympic Games, and the FIFA World Cup. The development of universal visual language systems have also greatly impacted how people understand visual information, particularly when the meaning of certain information is not always self-explanatory to international audiences (Adams & Foster, 2013). One often overlooked aspect of international standardization, however, is the potential sexist and nationalist values embedded in the creation of these visual systems.

In the case of the transportation symbols developed by AIGA in 1973, for instance, it is noteworthy to mention that these signs were designed by an all-male cohort, with only two women mentioned in the list of credits as "project coordinators" (Landa, 2011. p. 15). Rarely questioned, these sign-systems conceal possible cultural meaning and power relations that exist below the surface of their so-called universality. In "Queering the Universal Rhetoric of Objects," Bruce King Shey examines Henry Dreyfuss's "Measure of Man and Woman" to question the narrative and myth surrounding the notion of universality:

> "[t]hrough the ability to see these ruptures in the industrial design narrative as points of tension between the idealized universal and the politics of difference, the determinacy of the narrative can be subverted" (2005, p. 32).

Extending Shey's argument to graphic forms, bathroom symbols have recently come to represent a "prejudicial and pigeonholed" use of visual language in many American cities (Dobson & Dobson, 2016, p. 80). Indeed, the intentions of designers who developed the original set of transportation symbols were effective in providing people with information about how to locate a bathroom or elevator. Yet, the opportunity to reimagine restroom signage as inclusive spaces for transgender community members is a necessary reminder about the need to continually question and evaluate seemingly benign design practices (Dobson & Dobson, 2016). This involves surpassing ingrained gender inequalities, social hierarchies, and stereotypical labelling embedded in notions of objectivity and neutrality.

The need to increase accessibility is especially critical with consideration to the international dimension of workplace health and safety in Qatar. In this context, safety inspectors can sometimes overlook how cultural and social differences can influence the way viewers interpret visual information. Miscommunication can arise from representational, linguistic, or formal barriers. Meaning that, the standardization of safety signs does not necessarily equate to understanding across cultures. Moreover, the hazards of cultural mismatches in the communication of safety information remains largely uncontested and provides an opportunity to investigate strategies for improving occupational health and safety (OHS) communication to workers from a range of linguistic and cultural backgrounds. This study responds by questioning how OHS media is created, disseminated, and evaluated in Qatar.

3. Design research and social change

Across the scope of scholarly literature, design research and methods are fundamentally concerned with *change* (Bardzell & Bardzell, 2013; Simon, 1996; Jones, 1963). One of the early pioneers of design research, Chris Jones, referred to the methods of design as "the

initiation of change in man-made things" (1992, p. 6). Nobel prize winner Herbert Simon conceived of design research as an action, in which "everyone designs who devises a course of action aimed at changing existing situations into preferred ones" (1996, p. 112). Years later, Peter Lloyd (2017) described design research as the "active engagement in shaping future forms by suggestion, prototype, speculation, practice, and intervention" (p. v). Fatina Saikaly describes this kind of practice-based approach to research as a "designerly mode of inquiry," a concept first proposed by Bruce Archer in 1981 (2005, p. 4). Former president of the International Council of Design, Jorge Frascara, specifies some of the ways in which design can modify, reinforce, or facilitate change in behaviours, attitudes, or abilities:

> "This modification can be a change, as in switching from one product to another or in quitting smoking; a reinforcement, as in the case of exercising more, giving more money to charities, or drinking more milk; or a facilitation, as in the case of reducing the complexity of reading, operating a machine, or orienting oneself in a new place" (1998, p. 51).

In addition to these conceptions of design research, there is an increasing range of definitions, theoretical concepts, and debates expanding the field to include critical frameworks and autonomous methods (Escobar, 2018; Clarke, 2017). The expansion of disciplinary boundaries now includes design anthropology (Tunstall, 2012), transition design (Irwin, 2018), and social design (Kolko, 2012), among others. But, while design scholars contend that research has radically transformed across the field in recent years, the need for conscious, equitable, and responsible design must continue to forefront scholarship. Scholars make a case for the ongoing need to develop both theoretical and practical strategies for social change as conceptualized as policy-oriented, systematic, and radical.

Critical scholars contend that what is often missing from the rhetoric surrounding human-centred design and design thinking is the concept of reciprocity, justice, and systems of oppression. Sadie Red Wing makes a call for designers to evaluate the responsibilities embedded in processes dedicated to problem-solving and communication, warning of design's ability to abuse individuals and populations (AIGA, 2018). These systems affect and exclude "some humans from being considered human" (Platoniq, 2019). For instance, the design of digital technologies and consumer goods have emboldened global consumerism and colonialist ideals (Clarke, 2017). Moreover, the visual propaganda of MAGA (Make America Great Again) in the form of hats and other wearable objects serve to communicate ideological values, ethnic heterogeneity, and political systems that threaten many groups. Reaching back even further, German propaganda posters during World War II celebrated the Nazi regime and spread hateful messages to malignant ends (Bachrach & Luckert, 2009).

As part of the theoretical lens for this study, critical theory offers a way to study language as a social practice and investigate its social-theoretical implications using the term discourse. *Discourse* primarily refers to written or spoken communication but also includes semiotic modalities such as visual images and photography (Machin & Mayr, 2012; Lassen et al., 2006; Kress & van Leeuwen, 2006). In a pilot study such as this, moreover, the goal is to analyse the causality and determination between discursive practices (Fairclough, 2010, 1993), historical structures (Wodak, 2009), and socio-cultural cognition (van Dijk, 2001, 1993). In

doing so, critical theory serves to propel design research towards the creation of equitable and inclusive OHS media for multilingual workers, while concurrently respecting the social development space of Qatar.

4. Methodology

Design scholar Cal Swann suggests *design research* is an interpretive and reflective process, where "reflection 'in action' and reflection 'on action' lead to "action research" (2002, p. 50). According to Swann, "action research and the action of designing are so close that it would require only a few words to be substituted for the theoretical frameworks of action research to make it applicable to design" (p. 56). Much like *action research*, designers seek out practical and creative resolutions to problems rather than prediction or explanation alone. This practical purpose is important because while many other disciplines focus on the scientific, technological, and social impacts of research topics, *creative action* is verified through praxis. Design researchers Sandeep Purao, Matti Rossi and Maung Sein describe an overlapping methodology that integrates creative action with action research as identification/definition, intervention, evaluation, and reflection/learning (2010). The basic principles of this approach is to test ideas through real-time collaboration and feedback so as to produce practical knowledge rooted in the experience of those involved (Reason & Bradbury-Huan, 2007; Maguire, 1987).

Within this study, however, the protection of vulnerable community members foregrounded traditional notions of participatory creative action to account for the strict socio-political barriers embedded within Qatar's context. As mentioned earlier, the topic of migrant rights and inequities remains a highly contentious topic in the GCC region. It requires researchers to account for governmental policies and practices, first and foremost. For example, foreign journalists from the BBC and WDR were arrested in 2015 for reporting on the conditions of low-paid migrant labourers in Qatar's construction sector (Akkoc, 2015; Lobel, 2015). Therefore, a core feature of IRB approval necessitated the exclusion of migrant workers from data collection processes to mitigate any unintended negative consequences associated with the research. An alternative method of data collection involved semi-structured interviews with Doha-based safety experts. This group of people works closely with migrant workers, with their professional responsibilities focused specifically on OHS. In addition to this interview data, the study drew from a content analysis of observational and visual data collected from construction sites in Doha over a two-year period.

The collection of interview, visual, and observational data informed the final stage of the pilot study, wherein 15 Doha-based communication designers came together in a three-part workshop series to creatively respond to the need for inclusive OHS media. Hailing from nine different countries, each possessing a range of multilingual acuities, the group of designers encompassed professionals, faculty, staff, alumnae, and students. Using the aforementioned collected data to drive their creative process, the designers worked together in weekly workshop-sessions to devise strategies to cross language barriers and increase

communication around OHS topics. The resulting workshop data includes three workshop surveys, photographic documentation, and three OHS proposals.

5. Workshop series: Reimagining health and safety communication

5.1 General workshop structure

As a form of knowledge-sharing, the setup for the workshop series introduced participants to health and safety themes raised during interviews with the Doha-based safety experts. The workshop space was designed to feel like an experiential mood-board, expanding from the pin-up walls to the tables. At each table, materials were provided for participants to use during the series of design-based activities including coloured sticky-notes, sticker-dots, pens, pencils, and index cards. Participants were asked to walk around the full workshop space and ground themselves in the gathered data, including: safety messaging, and visual data collected from worksites (Figure 1). In addition to these materials, the presentation of interview data collected from safety experts provided the participants with key OHS insights in alignment with three overarching questions:

- What are some ways that you think construction workers in Qatar could be better supported in terms of health, safety, and communication?
- What are constraints or boundaries to inclusive and accessible communication?
- How would you like to see things changed?



Figure 1 *The setup for the workshop series "Reimagining Health & Safety Communication for Multilingual Workers in Qatar" included safety messaging, visual data collected from worksites, and interview data collected from Doha-based safety experts.*

The principles of design for inclusion and universal design served as the primary backdrop for large and small-scale group discussions during the workshop series. *Design for inclusion* offers a creative-practice checklist to consider the "physical, visual, auditory, financial, and other factors as well as an individual's temporary or permanent limitations to accessing each" (Axios, 2018). The principles of *universal design* provide a framework to increase usability by embedding "economic, engineering, cultural, gender, and environmental concerns" into the process, practice, and mindset of designers (The Center for Universal Design, 1997). Together, these two underlying strategies helped participants to better

understand how to broaden their perspectives, design for equitable use, and build inclusion into their processes (Axios, 2018; The Center for Universal Design, 1997).

5.2 Knowledge-sharing workshop activities

Over the series of three workshop sessions, participants creatively responded to the viewpoints of safety experts by engaging in brainstorming and small group activities. The workshop activities were designed to spark creativity and connect participants with the opinions of stakeholders who work with construction workers on a daily basis. The *Reimagining Safety Card Game*, for example, invited teams to work together to reimagine strategies for communicating OHS concerns to workers (Figure 2). The card deck contains 72 cards with three equally distributed categories, each related to a certain aspect of the study. These three categories correspond to the themes: 1) health and safety concerns; 2) type of visual media; and 3) emotional reaction the design should spark in the viewer.

During gameplay, for example, one participant proposed revising the information that appears on workers' water bottles in response to the three cards: *dehydration*, *packaging*, and *personalized needs*. Instead of branding on the label, the bottle showcased the amount of water a person should drink during heavy labour or in extreme heat. The proposal featured a sketch of a water bottle with digital markings and accompanying text that prefaced the idea with the statement "this requires programming." The designer went on to describe how a construction worker drinking from the bottle would receive positive and individualized messages recorded by co-workers and approved by a mental health expert. "By drinking the water, the worker also lessens fatigue caused by dehydration" explained the designer.

In a second round of gameplay, another designer focused on the development of an app to help people manage depression in response to the three cards: *depression*, *app*, and *comfort*. By connecting people to counselling services, the proposed app could become a lifeline to people suffering from depression or those feeling suicidal. This idea emerged in response to an interview statement from a safety expert that explained: "many people feel depressed when they are separated from their families and living in a different country." According to the designer, the app could provide people with motivational quotes, Bollywood soundtracks, or funny videos in multilingual formats.



Figure 2 *Recruitment flyer for the workshop series (left) and the "Reimagining Safety Card Game" materials and group gameplay (right).*

5.3 Consolidating ideas

Following the series of brainstorming activities, participants were broken into three distinct teams based on their shared or overlapping interests in OHS. Rather than forcing a particular prescribed creative outcome on the designers, the small groups were asked to discuss how to either focus or expand upon "favourite" proposals developed during gameplay. The groups brainstormed how to communicate their concepts, determining which ideas could be rough and which needed to be well-defined (Knapp, 2016). Some concepts required abstraction, for instance, while others lent themselves to narrative solutions. Each group was then asked to develop a story-map to outline all of the necessary action steps required for a construction worker to engage with the concept (Figure 3).

The aim of developing a story-map is to drive more in-depth thinking about a chosen concept and make it actionable by outlining a step-by-step plan for a potential prototype (Knapp, 2016). For example, an opening scene might begin with a construction worker receiving a private message on their mobile phone. In this case, the first scene would include the text "a worker reads the message and clicks on the link." Other examples for opening scenes include when a boss shares a booklet with an employee, a friend sends a text message, or someone watches a video in their workplace cafeteria.



Figure 3 This series of photos shows the story-map and action steps phase of the workshop series.

Following the story-mapping process, each team was asked to determine their preferred and chosen "answer" by exploring various aspects of OHS and participating in the "construction of possibilities" (McCoy, Triggs, & Van Toorn, 2002, p. 331). In-depth discussions were geared towards building a consensus about the actionable steps of their plan and deciding which idea(s) to execute individually or as a team (Brown, 2009; Brown & Katz, 2009). During this time, the group also considered how to eliminate ideas that were either impractical or outside the skillset of the group. To reach a final consensus, workshop participants used sticky notes to anonymously vote, engage in dialogue, and determine a timeline to achieve their goals. The next section of this paper shares the results of this process and highlights how participants conceived of designs' role in improving OHS communication in Qatar's construction industry.

6. OHS proposals

The workshop series' anticipated output was a collection of new safety media, inclusive of multilingual translations and accessible iconography. However, the OHS proposals generated during the workshop moved well beyond the initial goal of using visual language and graphic forms to improve workplace safety. Instead, the participating designers approached the topic of safety more holistically, perhaps due to their familiarity with Qatar's socio-cultural complexities or due to their collective interest in resolving inequities past traditional forms of communication design. In either case, the proposals engage with a broader understanding of community needs and recognize critical gaps in OHS as related to workers' wellbeing. Thus, the following workshop proposals provide a glimpse into the synergistic potentials of both design research and creative action as an avenue towards social change in Qatar.

To begin, the "Rest-and-Relax Tent" aims to improve workers' day-to-day lives by minimizing the impacts of heat stress and focusing on positive strategies to help people relax during their breaks (Figure 4). The team behind this idea based their concept on interview data collected from Doha-based safety experts who suggest that a "welcoming environment" could encourage people to take preventative measures to mitigate heat stress. The resulting OHS proposal invites employees to take regular breaks by supplying worksites with large tents furnished with items such as radio, sink, fridge, water, fan system, and medical kits. The team went on to recommend that the shelters should employ colourful visuals inspired by the Bollywood industry to ensure workers identify with safety messaging embedded within the tent.

The second concept developed during the workshop aims to celebrate construction workers' achievements using a badge reward system (Figure 5). After interacting with interview data from safety experts, this group of designers became inspired by the suggestion to address workers' mental wellbeing as a core component of health and safety in Qatar. The team responded by conceptualizing a system for recognition, much like those employed by organisations such as the Boy Scouts of America. The designers explained that a similar achievement system could be used in the construction industry by adding permanent badges, semi-permanent removable patches, and optional stickers to people's helmets, vests, and uniforms. The resulting "Employee Achievement Program" highlights the importance of recognising a worker's accomplishments and the emotional benefit of supervisors acknowledging a "job well done."

The final OHS proposal produced during this pilot study responds to the need for workers to seek relief from the sun throughout the workday. This team observed that workers on construction sites often sit under the scorching summer sun without shelter when their bodies should be recovering from the intense heat. This excessive exposure to the sun can have an adverse effect on employees' mental health, physical health, and productivity. "Mi.Pod" aims to combat this occurrence with a simple, easy-to-assemble shelter that is compact, portable, sustainable, and cost-efficient (Figure 6). Mi.Pod would be made from polypropylene foam, a sturdy and lightweight material that is flexible in a wide range of temperatures and is moisture-resistant and chemical-resistant. The panels would be equipped with industrial Velcro to connect the different panels, creating a folding frame mechanism to provide shade and comfort to the user.

Overall, the purpose of generating the collection of OHS proposals during the workshop series was to add to a recommendation packet developed for government agencies and construction companies in Qatar. While only designers were involved in the workshop series, safety experts' viewpoints play an equally prominent role within the recommendations packet, without overshadowing the proposed creative interventions. By sharing these cumulative ideas with various stakeholders, the aim is to increase awareness about practical and actionable areas to support workers' welfare.



Figure 4 *Workshop Proposal 1: Rest-and-Relax Tent. This proposal uses images found online to help justify the need for increased preventative measures to protect workers from heat stress in Qatar's harsh desert climate. Within the proposal, the team highlighted examples of other cities with multilingual construction environments that provide workers with inviting spaces to take regular breaks (as shown in the image on the right).*

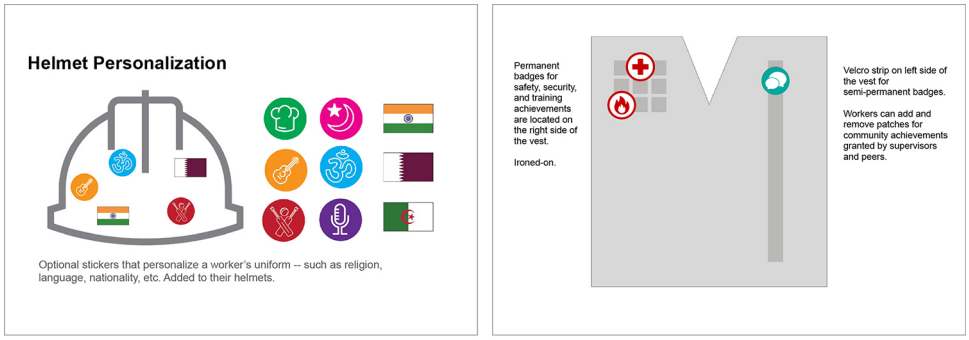

Figure 5 *Workshop Proposal 2: Employee Achievement Program. This proposal aims to celebrate construction workers' achievements using a badge reward system. The system would include permanent badges, semi-permanent removable patches, and optional stickers to adhere to people's uniforms, vests, and helmets.*

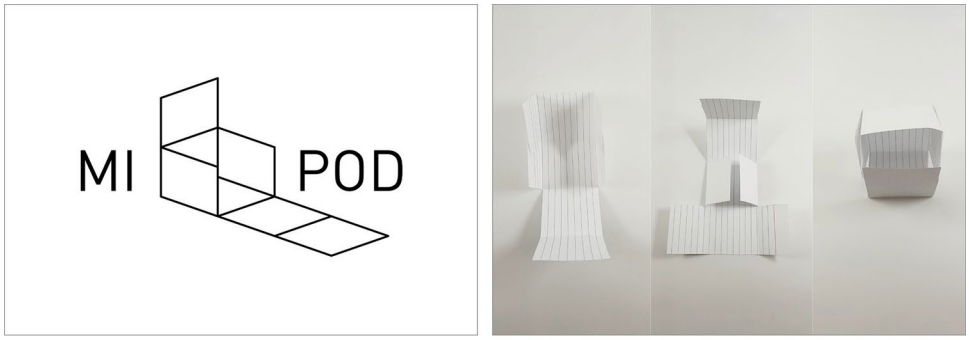

Figure 6 *Workshop Proposal 3: Mi.Pod. This proposal suggests that an easy-to-assemble shelter can help provide workers with relief from heat stress in a compact, portable, and cost-efficient manner.*

The recommendation packet makes a case for needed improvements in the dissemination of OHS information and shares critical insights from the following collected data:

1. Visual analysis of OHS graphic forms collected from construction worksites
2. Interview data from Doha-based safety experts
3. Survey data from participating communication designers
4. OHS proposals presented in this section

The visual analysis reveals, “there is a critical need to provide clear, accessible, and detailed safety information in the workplace.” The interview data adds to this finding by providing a glimpse into the ways in which language barriers can hinder how safety topics are understood. Safety experts suggest a crucial component of educating people about OHS is through a combination of static, experiential, and interactive media. The proposals developed during the workshop series similarly indicate a need to move beyond merely identifying hazards or presenting adequate warnings to construction workers. Altogether, these collective findings expose an obligation to provide richly informed design strategies to communicate vital health, safety, and wellbeing information to construction workers from various linguistic and cultural backgrounds.

7. Implications and next steps

This study reveals a shared enthusiasm from the two fields of safety management and communication design to promote policy-level change in Qatar’s construction sector through focused and care-filled collaborative efforts. While the study was limited by socio-political restrictions related to migrant rights in the region, it also expands notions of creative action to account for closed contexts with strict authoritarian governments. By correlating OHS communication with the productivity and wellbeing of workers, there is an opportunity to place positive pressure on contractors to improve worksite health and safety practices.

Perhaps one of the most exciting and unexpected results of this study was the creation of OHS proposals that bypass linguistic or semiotic communication with other artefacts that, in and of themselves, provide health and safety. This outcome may be a result of exposing the participating designers to interview data from safety experts, participants’ familiarity with OHS complexities in Qatar, or the integration of *design for inclusion* and *universal design* in the workshop dialogue. To understand this phenomenon more explicitly, the next steps of this study will investigate 1) how the workshop methodologies impacted the OHS proposals and 2) how this strategy might inform future design research in Qatar and across the GCC.

Additionally, the next phase of the study will involve an exhibition of the OHS proposals as a strategy to promote dialogue between government officials, safety experts, and communication designers. A public display dedicated to the topic of worksite OHS could bring awareness to the need for safety legislation at the national level and accessible media on the ground level. Bringing the voices of construction workers into the study at this stage of the process is also a strategy to seek reciprocity between the research findings and the intended audience. Initiating an open dialogue with all stakeholders has the potential to mitigate some of the tensions around the topic of migrant rights in Qatar and encourage other researchers to build on this initial pilot study. In turn, an informed and educated public

can urge policymakers and governmental entities to account for the long-term health, safety, and wellbeing of the country's indispensable workforce.

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Critical and Collaborative Making with augmented technical tools

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Abstract: Our research practices a critical approach to collaborative design making and speculates how present technologies shift future possibilities where interactions and exchanges are limited to those mediated by technological devices. Through a series of investigations, a collaborative, critical making process is prioritized over the final artifacts. The investigations consider and address the social and technological implications of how remote collaborative-making, mediated by augmented technical tools, might (1) foster new ways of thinking and making through play and experimentation (2) affect social interactions and empower people to become producers (3) affect relationships between collaborators and the technologies in use through transparent processes. This paper shares the outcomes of our investigations, based on participant data collected through qualitative and quantitative measures.

Keywords: collaboration; critical making; socio-technical systems; drawing robots

1. Introduction

The relationship between technology, collaboration, and ways of making continue to evolve as new digital tools (and systems of tools) enable transformative and unique working methodologies that drive and shape the discipline of design. Our research examines the socio-technical systems that influence and shape interactions between people and technologies through the use of present technologies that challenge people to make collaboratively in remote scenarios in unfamiliar ways. The act of making collaboratively fosters critical thought and inspires new ways of thinking and making. The present technologies are the digital tools (and systems of tools) that include multiple drawing robots as augmented technical tools in remote collaborative making processes.

Our research practices a critical approach to collaborative design making and speculates how

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present technologies shift future possibilities where interactions and exchanges are limited to those mediated by technological devices. Further, the research investigates how the use of present technologies support remote collaborative making that takes place off the screen and occurs in a physical environment. Through a series of investigations, a collaborative, critical making process is prioritized over the final artifacts. The investigations consider and address the social and technological implications of how remote collaborative-making, mediated by augmented technical tools, might (1) foster new ways of thinking and making through play and experimentation (2) affect social interactions and empower people to become producers (3) affect relationships between collaborators and the technologies in use through transparent processes. This paper shares the outcomes of our investigations, based on participant data collected through qualitative and quantitative measures.

2. Literature Review

A socio-technical system can be defined as a system of working, often realized as a complex phenomenon, that recognizes and responds to the interactions between people and technology in a working environment. Our research examines what socio-technical systems are in order to address how our work relates to this phenomenon. We examine the social interactions that occur through the use of, and restriction of, certain technologies for communicating and working. This system affects how participants work and make together in certain collaborative experiences. Matt Ratto (2011) emphasizes that the act of critical making should "signal a deep research commitment to the co-constructed nature of our socio-technical world" (p. 206).

We examine socio-technical systems through a critical making process. Critical making, as defined by Ratto is a process in which the "material and conceptual work is interwoven" (2011, p. 205). He explains that critical *thinking* and *making* are often thought of as different. Critical *thinking* is often conceptual and articulated through writing while *making* is understood purely as "goal-based material work" (p. 205). He suggests that '*critical making'* creates insightful understandings of processes, not necessarily objects, artifacts, or services, and shares these making experiences to research and understand socio-technical phenomenon for others. In our research, 'critical making' is the method for framing and planning the design processes and procedures that initiate and foster critical thinking among participants. Through the use of materials and processes in the investigations, an emphasis is placed on working with one's hands to think and learn. Rosanne Sommerson (2013) defines critical making as "process-oriented and scholarship-oriented." She argues that critical making emphasizes "the shared acts of making rather than the evocative object" (p. 19). With an emphasis on making, it is important to note that critical making is not *critical* if the conceptual is not interwoven into the process. John Dunnigan in his article, "Thingking" explains, "critical making requires critical thinking and social consciousness along with embodied knowledge if it is to be distinguished from making in general [...] In critical making, the very process itself opens up new possibilities for deep, expansive thinking and the serious inquiry that stimulates discovery" (2013, p. 98).

Critical making is not an act of production, which is often considered the execution of a preconceived concept. In production, the thinking happens before the making. Ellen Lupton (2011) writes, "production is rooted in the material world. It values things over ideas, making over imagining, practice over theory" (p. 12). In our research, we consider the thinking and making simultaneously. We are not producers, but rather empower others to be producers through a critical making process. We consider participants to be producers of their own experiences and that they engage and explore ideas with materials and processes. By providing open-ended prompts for participants, we observe how they can be creative and critical simultaneously.

Critical making draws on Seymour Papert's learning theory of constructionism[1], which advocates student-centered, discovery learning where students construct models for learning through materials and processes. In Papert's seminal book, Mindstorms (1980, 1993), he describes learning as an "intellectual activity that does not progress by going step-by-step from one clearly stated and well-confirmed truth to the next. On the contrary, the constant need for course corrections, which he calls 'debugging' is the essence of intellectual activity" (1993, p. xiii). In this statement, Papert surmises his central theme which is that the acquisition of knowledge requires learners to think through making and to 'figure things out', which is directly in opposition with learning models that emphasize the memorization of abstract theories. He believes that thinking and making (and the human connection and enjoyment of those actions) are interrelated and discusses how the use of computers can be used as "objects-to-think-with" (p. 23). In our research, we consider how augmented technical tools and design processes can be "objects-to-think-with," as Papert dictates, to explore concepts and materials simultaneously and to learn and understand socio-technical systems of working in design. In our investigations, each robot is the augmented technical tool designed for participants to explore collaborative making across different scenarios.

The objects that we "think with and through" are simple drawing robots constructed from open and available present technologies. We refer to these robots and the digital systems in which they function as our augmented technical tools. David Rose (2015), defines 'enchanted objects' as augmented technical tools that are "enhanced through the use of emerging technologies—sensors, actuators, wireless connection, and embedded processing—so that it becomes extraordinary" (p. 47). He describes them as ordinary objects that 'come alive' to "become more useful, delightful, informative, connected, and more engaging than it was in the first place" (p. 47). Rose discusses how enchanted objects are the future of computational tools as they are much more likely to connect with people in an emotional way (beyond the dry and detached future of digital screens). He describes them as objects enhanced by technology with a "humanistic approach to computing that is not about fanciful, ephemeral wishes, but rather persistent, essential human ones" (p. 8). Rose makes this connection with enchanted objects, but designers have been recognizing and

1 Constructionism is connected with experiential learning and builds on Jean Piaget's theory of constructivism.

articulating this emotional connectivity with designed objects long before computational tools were as ubiquitous as they are today. Don Norman writes in Emotional Design (2004) that “technology should bring more to our lives than the improved performance of tasks: it should add richness and enjoyment” (p. 101). He argues that “beauty, fun, and pleasure all work together to produce enjoyment, a state of positive affect [...] positive emotions trigger many benefits essential to people’s curiosity and ability to learn” (p. 103). Norman values function and usability but writes extensively about the designer’s roles and responsibilities to merge the fun and pleasurable with the practical. Designed objects should connect emotionally with people and attempt or contribute to improving people’s experiences in the process. We use our augmented technical tools to facilitate fun, delight, and play. Rose further connects enchanted objects with ways in which people express themselves creatively. He discusses how tools and technologies can enable the exploration of creative-making and self-expression. He says, “we often look to technology to enhance our skills and enable us to express ourselves” (p. 146). In our research, we attempt to foster and support people’s innate desire to create with augmented technical tools, and to challenge participants to work in unfamiliar ways.

3. Research Methodology

Our research responds to these ideas through three unique investigations that were designed and implemented to test how people respond to activities conducted with and through augmented technical tools. Each investigation utilizes a digital system made up of drawing robots constructed with present technologies and a collaborative working environment. The ways in which these augmented tools are controlled vary from investigation to investigation and the people involved range from being passive users to active participants.

Our primary research questions are:

- In what ways can augmented technical tools & design processes foster play and experimentation through new forms, meeting the fundamental human desire to create?
- In what ways can augmented technical tools & design processes affect social interactions and empower people to become producers within a collaborative online context?
- How can augmented technical tools & design processes support new ways of making, thinking, and learning about technology for the collaborators?

Each of the investigations consider and address the social and technological implications of how remote collaborative-making, mediated by augmented technical tools, might (1) foster new ways of thinking and making through play and experimentation (2) affect social interactions and empower people to become producers (3) affect relationships between collaborators and the technologies in use through transparent processes.

The first investigation demonstrates how collaboration and social interactions may take

place through one system of augmented technical tools in one physical location. It sought to (1) foster play and experimentation among many participants and (2) empower people to become producers within a collaborative context by inviting people into an open collaborative making process via their smart-phone devices.

The second investigation demonstrates how two participants collaborated from two remote locations to (1) experiment through and with new forms that were unfamiliar to the participants in order to (2) support new ways of making, thinking, and learning about technology for the collaborators. This also sought to (3) empower the participant to become producers within a collaborative online context by planning and implementing a series of designed drawings with the robots.

The third investigation demonstrates how teams of participants worked collaboratively to build and construct their own technical tools for making activities. Through the process of building and working with the drawing robots and digital system, participants were able to (1) learn about the technologies in use and how it can foster collaboration, (2) manipulate and develop the technologies to engage more deeply with the material and concepts to foster new ways of thinking and making and (3) empower further making, with a deeper understanding of project capabilities and future possibilities.

To capture findings from these interventions, we collected data through qualitative and quantitative research methods including observation, surveys, personal testimonials, digital data, and making activities. Each investigation articulates which research methods and data collection techniques were utilized for measuring, collecting and concluding on the outcomes. Qualitative and quantitative data was analyzed across all three of the investigations resulting in conclusive themes and insights such as unexpected patterns of use, considerations for other possible augmented tools, and how the experiences created the conditions for thinking more about artistic making and collaboration.

4. Investigation #1: An Exhibition Experience with Open Participation

The first investigation demonstrates how collaboration and social interactions may take place through one system of augmented technical tools in one physical location. It sought to (1) foster play and experimentation among many participants and (2) empower people to become producers within a collaborative context by inviting people into an open collaborative making process via their smart-phone devices. Based on these goals, an exhibition experience was designed in a museum space as a participatory installation that utilized a single robot with a drawing surface. Participants of this investigation included visitors to The Eli and Edythe Broad Art Museum, a contemporary art museum at Michigan State University in East Lansing, Michigan. These visitors could easily interact with the robot to draw contributing to a shared, collaborative outcome, which was a series of physical drawings. Individuals with access to a smart phone with texting capabilities were able to participate by sending directional commands to the robot (Figure 1).

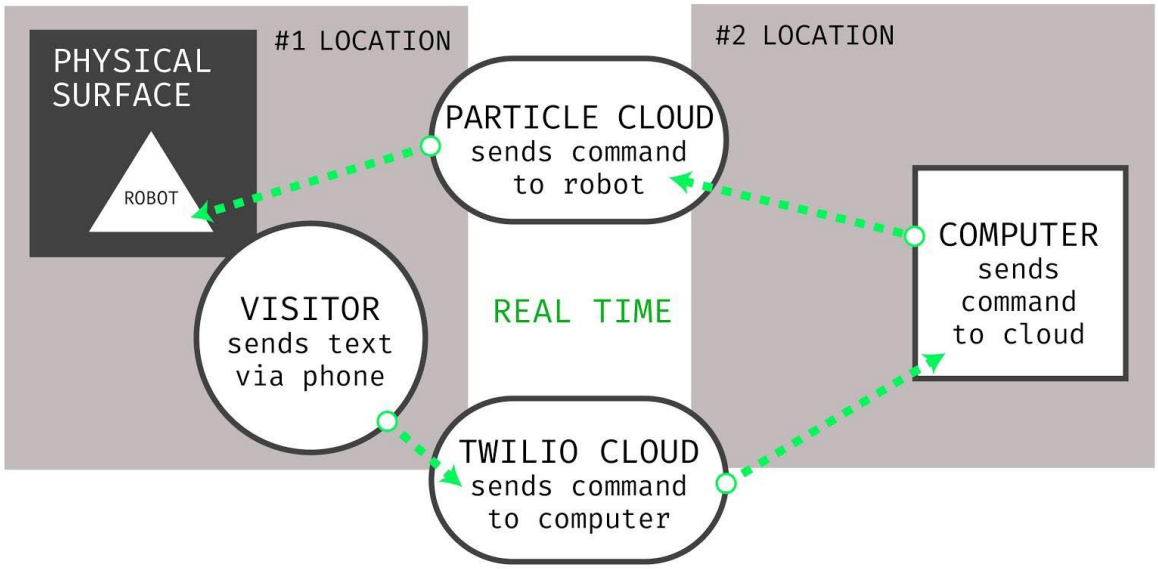

Figure 1 *Once a directional text message is sent, the message was delivered to the Twilio cloud. Twilio was the communication platform used to manage the text messages. The text command was communicated to a computer off site, which connected to the Electron on the robot, prompting the robot to respond.*

Visitors were invited to engage with the installation through simple, instructional signage. The research population sample included visitors of this public museum who visited the exhibition over the course of two months and who had access to a smart phone with texting capabilities (Figure 2).

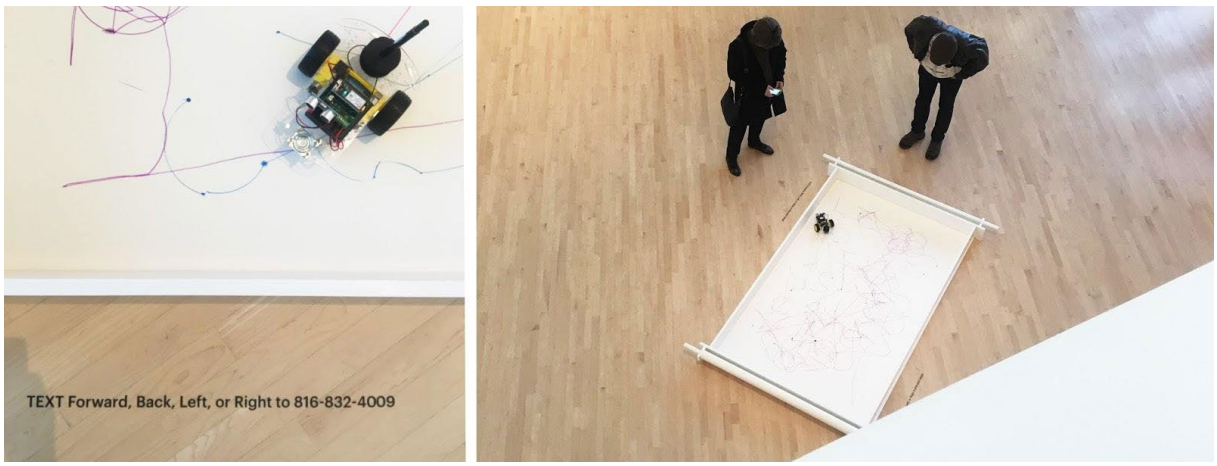

Figure 2 *Museum visitors were prompted to control/draw with the robot via vinyl text adhered to the floor beside the drawing frame. Any device that sends a text could be used from any location.*

The goal of this investigation was to set up a digital system in which open participation was possible to foster play and experimentation (meeting the fundamental human desire to create). This investigation allowed anyone to draw with the robot and contributed to a

shared (collaborative) outcome. The museum as a setting for this investigation offered the optimal space in which to test an installation with multiple users (Figure 3). The single robot functioned within a drawing space which consisted of a simple rectangular 8’ x 5’ frame that was constructed out of wood and painted white. At each end of the frame a dowel rod held the paper and functioned as a feed for the paper, enabling a weekly “roll up” of the paper. The height of the frame was about 5 inches tall.

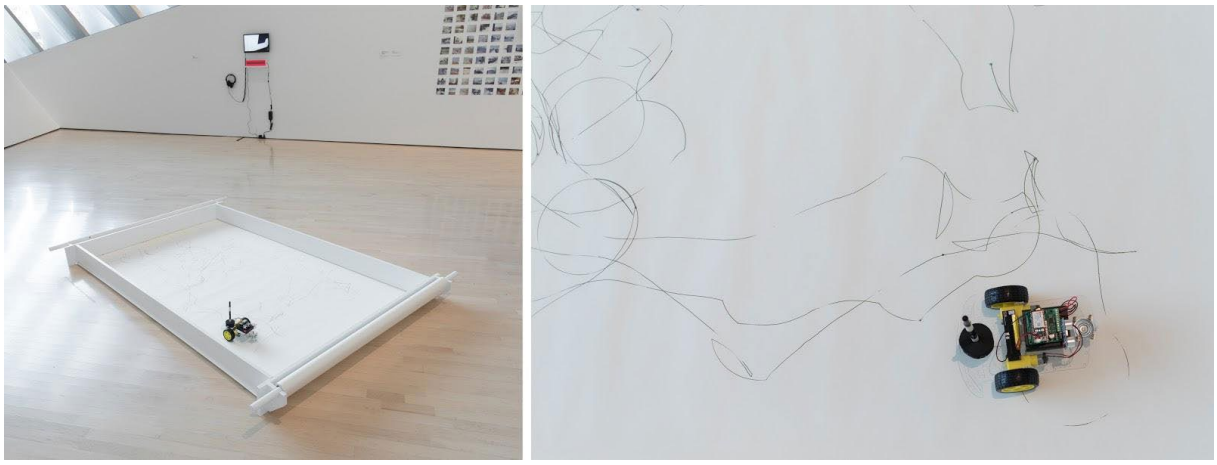

Figure 3 *Installation view at the Eli and Edythe Broad Art Museum at Michigan State University, 2018. Photo: Eat Pomegranate Photography*

This exhibition experience was focused on initiating play among the participants, as visitors experimented with the tools and technology to become producers and makers. To design this participatory installation, a collaborative drawing surface was created that could change over time as the outcomes developed and expanded through participant interaction with the tools. Over the duration, drawings were ‘completed’ after a dictated amount of time and new paper was rolled out. The finished drawings recorded the activities of the space and drawing parameters such as color marker designations documented the dates and times participants interacted with the tools.

4.1 Data Collection Methods + Analysis Process

The research instruments for analysis of the successes and short-comings of the installation employed public observation during the two-month exhibition period, the physical artifact created as a result of robot drawing by the visitors, and the digital data collected through the text messages sent. The digital data revealed an unexpected pattern of use by the participants, people texted the robot outside of the typical museum hours and beyond the physical space of the museum. Prior to the installation of the exhibition, process documentation of the planning phases (prototyping and testing) were recorded to capture insights on the development of the augmented tools and the objectives specific to working in a public space.

4.2 Results

Due to this investigation taking place in a public space, there were limitations in setting up our technical tools with open networking capabilities. Previous uses of a Raspberry Pi would not be feasible in the museum based on the need to connect the Raspberry Pi to an open WIFI network in order for it to be remotely controlled. Additionally, the space was assigned by the museum as this installation was part of a larger group exhibition and requesting the optimal space was not an option. The final space assigned by the museum did not allow for any wall or electrical outlet opportunities and was situated in the middle of the room occupying roughly a 9' x 9' space on the floor. Finally, the duration of the exhibition was a two-month period of time (every day of the week except Mondays), determining a system that could sustain use for this long period of time was necessary.

Specific objectives and considerations arose throughout the planning process in response to the multiple challenges brought on by the public museum as a setting. Three distinct challenges in the museum prompted the working objectives and working considerations; *networking limitations, space assignment,* and *exhibition duration.*

Networking limitations: The digital system in which all the technology (but the robot) needed to be invisible to the viewer. The need for transparent technology in this investigation enabled the ease of use of the tools for the visitors/participants.

Space assignment: The drawing surface would require spatial boundaries for the robot in order for it to not be physically disturbed and to protect the museum floor surface. The tool needed to account for these boundaries via motion sensors on the robot.

Exhibition duration: This investigation needed to consider tools that offered minimal maintenance for the museum staff and functioned in an open network in a public space for a long period.

In order to solve for the networking limitations, the exploration of the technical capabilities of the robot led to the use of an Electron Board from Particle, a hardware company and software company that produces a platform for Internet of Things products. The Electron Board is a 3G cellular-connected electronic board with a SIM card and is programmed via the Particle cloud programming platform. (Figure 4). This enabled the robot to have its own phone number and be controlled via a cellular network, eliminating the need for a WIFI connected network. The device needed to be charged nightly and during the day it was powered by a cell battery.

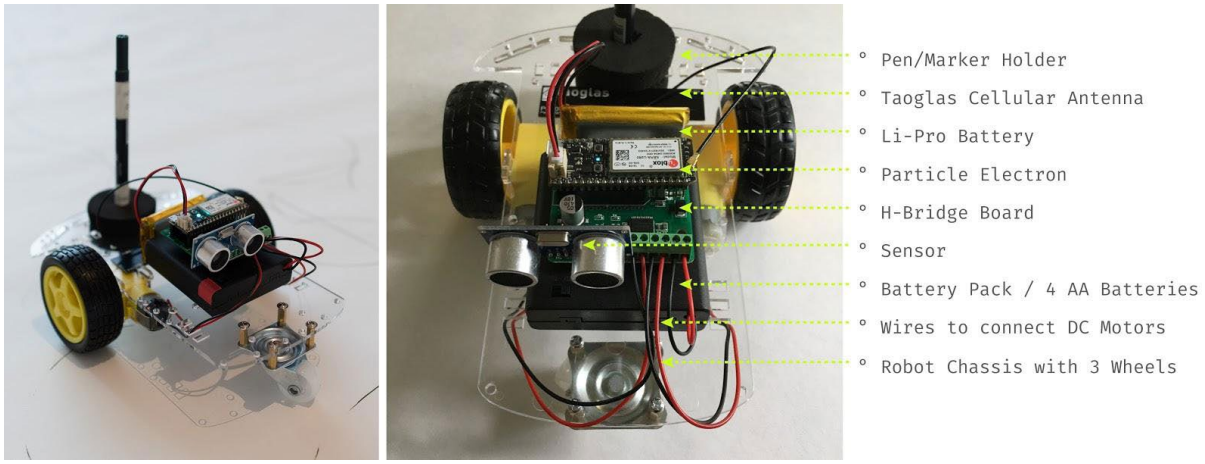

Figure 4 Drawing robot on the drawing surface and the robot with components labeled.

Decisions for how the robot could be controlled informed the technical capabilities of the robot, thus informing the design of the drawing surface and space. Controlling mechanisms for the robot were explored and considered given that the WIFI network would not be an option for various WIFI connected controllers. What tools were readily available was then considered leading to the decision to explore and augment smart phones with texting capabilities as the controlling mechanism. This is a device in which we could assume that all or at least most visitors would have access to during their museum visit. In addition to the facility and technical parameters that directed design decisions of the robot, we also considered how these tools would be "objects-to-think-with" for museum goers.

Observations during the use of the robot evoked a sense of delight; visitors were intrigued by the robot and often stayed longer than expected to test their drawing capabilities. As Papert argued, the robots allowed museum goers to explore concepts and materials simultaneously by participating with this particular socio-technical system. The feedback from notetaking and photo-documentation suggest that the digital system in the exhibition/ installation format fostered play and experimentation among participants, meeting the fundamental human desire to create. Visitors were eager to create with the robots and the ways in which some tried to push the limitations indicated a strong desire to explore the tools given to them. An unexpected outcome was that several visitors attempted to control their drawing outcome by making a pattern or writing a word. It is possible that the collaborative nature of the installation was lost on some of the participants. Perhaps the process-driven, abstracted drawing wasn't enough for some visitors and prompted their desire to create a familiar literal form. Nevertheless, this does suggest that participants wanted to play and experiment with the tools, and that the technologies in use empowered participants to be active makers and producers, regardless of whether they wanted to interact and collaborate with one another or if they preferred to interact only with the tools and space of the exhibition.

After the completion of the exhibition experience, the physical drawing resulted in 36 ft of paper that was drawn upon over the span of 58 days. Each week the color of the marker was changed, revealing a pattern of use from week to week. The physical drawings became

collaborative recordings or data visualizations of the activity and interactions of every participant with the robot over the course of the exhibition. Additionally, the data cumulated from Twilio revealed a timestamp of the texts as well as the phone numbers and the messages sent for every command sent to the robot. Frequency of the texts indicated that in the first weekend alone over 2000 text messages were sent to the robot and over time the texts were being sent at all hours of the night despite the museum being closed and visitors not being present at the installation. Another unexpected outcome was the sheer number of participants engaged with this collaboration and the reach beyond the exhibition space to include others via word of mouth and social media sharing of the project. Finally, we learned from the data, that commands other than “Left”, “Right”, “Forward”, and “Back” were tried (although failed) such as “Dance”. This indicated that participants understood how to think and make through the use of the robot by making assumptions about other commands the robot may recognize. Papert discusses a similar type of interaction between student and computer as an indication that participants are considering more in-depth concepts about the tools through their use. This further implies that the participants were seeking more opportunities to be delighted by the experience as visitors found alternative ways to interact with the installation.

4.3 Conclusions

The goal of this investigation was to set up a digital system in which open participation was possible to foster play and experimentation. This investigation allowed anyone to draw with the robot and contributed to a shared (collaborative) outcome. It was focused on initiating play among many participants, as visitors experimented with the tools and technology to become producers and makers. It surpassed our expectations of how many people participated during their visit to the museum and remotely, after their experience with the installation. The reach also expanded to people who had not visited the installation yet participated remotely. Future iterations of this investigation could consider alternative outcomes such as exploring other artifacts from participant interactions with the experience, incorporating more directions enabling better control of the tool, and facilitating a system that enables participation in both a digital and physical environment to better support collaboration.

5. Investigation #2: A Remote Experience with two Participants

The second investigation demonstrates how two participants collaborated from two remote locations to (1) experiment through and with new forms that were unfamiliar to the participants in order to (2) support new ways of making, thinking, and learning about technology for the collaborators. This also sought to (3) empower the participant to become producers within a collaborative online context by planning and implementing a series of designed drawings with the robots. The investigation involved two participants who often collaborate and reside in different parts of the United States. Each participant was given a robot with an online interface and making tools, together both participants experimented

with prompts for making collaboratively through four working sessions across the span of one month (Figure 5).

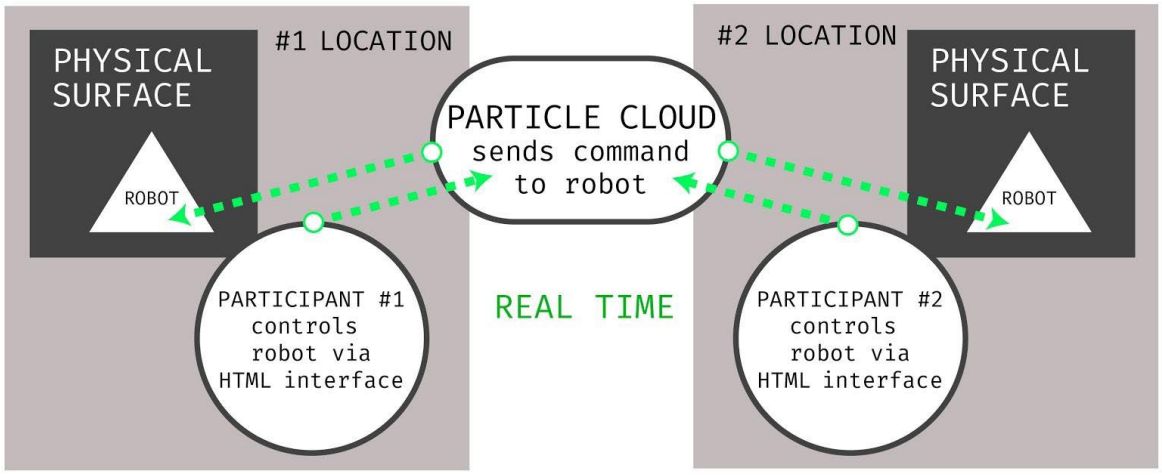

Figure 5 *When directional commands were made via the online control panel by the participants, the commands were sent to the Particle cloud which then relayed the directions to the robot.*

The main goal of this remote experience between two participants was to invite other like-minded design collaborators into a remote collaborative making process that was unfamiliar to them to see if they might engage with the tools and/or a design process in unexpected ways through experimentation and play. With very little direction for how to interact with the robots and digital systems provided, this investigation attempted to test for unforeseen outcomes, challenges, and considerations that had not yet been revealed to us[2].

Additionally, this investigation sought to find ways in which augmented technical tools and design processes affect social interactions and empower people to become producers within a collaborative online context. By providing the tools and digital system for working, the participants could experiment through new forms and potentially provide insight to consider for future iterations.

Each participant was sent a robot kit and was given an HTML control panel link for the robot that resided with the other collaborator. The kits each included a drawing robot, a set of markers, a roll of paper, and an instruction sheet (Figure 6). How and when the participants decided to draw with the robots was determined by them over the course of one month. Additionally, how they chose to use additional technical tools was up to them, i.e. live video chat platforms and use of cameras for live streaming. Participants were encouraged

2 For more on authors' previously published research, see: Normoyle, C., & Tegtmeyer, R. (2017). Speculating the Possibilities for Remote Collaborative Design Research: The Experimentations of a Drawing Robot, The Design Journal, 20(1), S4038-S4051, DOI: 10.1080/14606925.2017.1352906

to experiment and test alternative solutions to making. Some example prompts included considering alternative drawing surfaces and spaces, media and mark-making tools, and/or processes and methods.

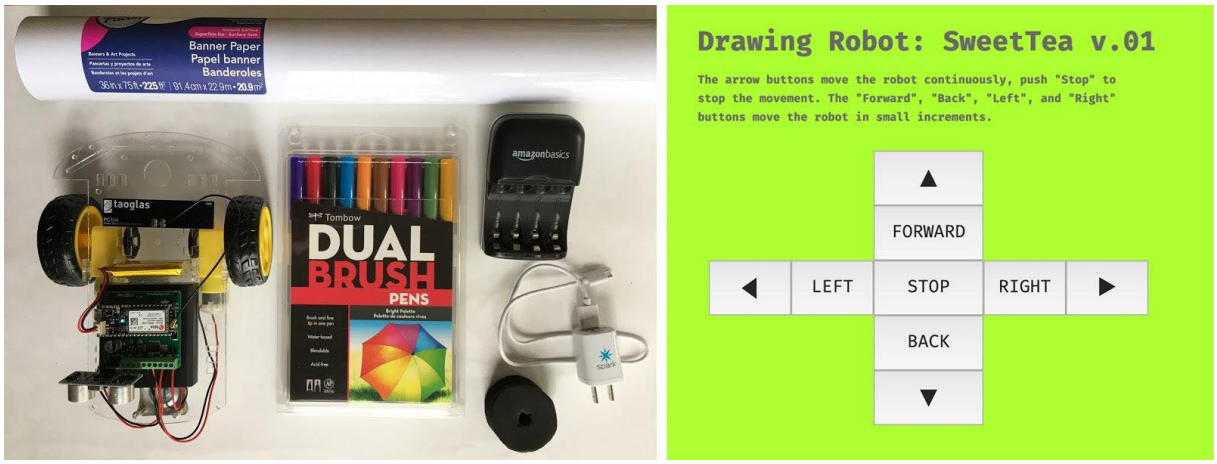

Figure 6 Drawing Robot kit of components, the Drawing Robot online interface/control panel

5.1 Data Collection Methods + Analysis Process

The research instruments chosen for this investigation included a pre and post survey. The pre-survey sought to gain insight prior to the participants beginning their workshop sessions and asked about their previous remote collaborative experiences and what technical tools mediated these collaborations. The post survey asked the participants to reflect on their collaborative experience. Additionally, the participants kept a process journal via a Google document file which outlined the goals and conclusions for each working session. Photographs and video captured in process documentation as well. The journals were analyzed for themes and insights into how the participant's approached the experience. The findings from the surveys led us to question what other tools and processes have not yet been considered, relevant for future research.

5.2 Results

Developing the kits for the participants required technical considerations for the drawing robots and the digital system. Several challenges needed to be solved prior to engaging the participants involving the robots and the control mechanisms. It was necessary to provide robots, directions, and a control panel that was easy to use and understand. This investigation required the development of robot kits that contained directions for use, robots that could connect easily to a network, and battery mechanisms for charging the robots efficiently.

The kits included robots that were informed by the robot used in the first investigation. A robot, that operated via a cellular network rather than a WIFI network, would eliminate any possible connecting issues within a closed WIFI network. These robots however, were

controlled by the use of an online interface rather than texting. Drawing with the robots through an HTML interface was best for this configuration since the collaborators also utilized web video chat platform (Google Hangouts) while working remotely (Figure 7). The control panel included buttons for moving the robot forward, backward, left, and right. There were two options for each direction, a continuous movement and a shorter movement.

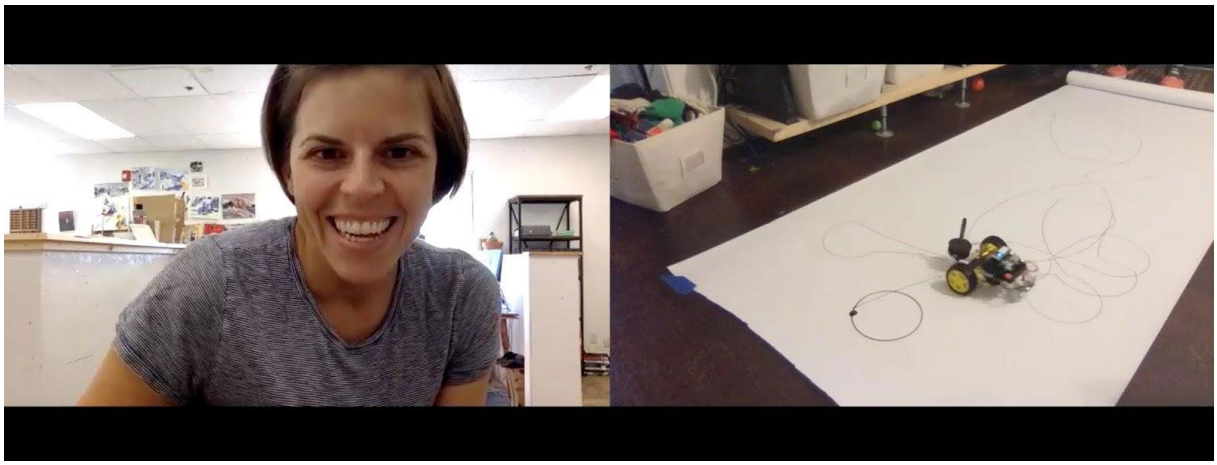

Figure 7 Screen captures of participants collaboratively working via Google Hangouts.

Once the kits were in the hands of the participants, the rest of the working process was up to them. The augmented tools provided a way for them to test a systematic approach that pushed the limitations and affordances of how the robots were controlled and how they functioned. Together they determined a system by which they controlled the robots, using mapping as the common idea. One of the participants used a series of bike routes connecting time as it relates to distance. These moments of time were translated to the buttons controlling the robots. The other participant used their daily route via a geographic map. This way of working supports a facet of 'critical making' as defined by Sommerson—the way the tools were used was prioritized over the objects and the outcomes.

After testing this system numerous times via their collaborative working session, it became evident that using a systematic approach might not work as well as a more organic approach due to the limited control and abilities of the robots (Figure 8). A few factors that prohibited the systematic approach was due to the limited capabilities of the robots. The robots don't move in a straight line nor make turns at a 90-degree angle. This limited any accurate representation in the physical drawing outcomes. Also, the stationery mark making tool limited the natural ability to pick it up and reposition easily. In realizing the challenges with a systematic approach, the participants imagined a future scenario in which the robots are controlled via a behavioral process. For example, having the robots move in response to participants' actions or behaviors in the physical environment. This discovery and future experiments would not have been realized without the robots contributing to the systematic process, a factor Norman and Rose state as important for designed objects to connect on an emotional-level with people and support their curiosity and ability to learn.

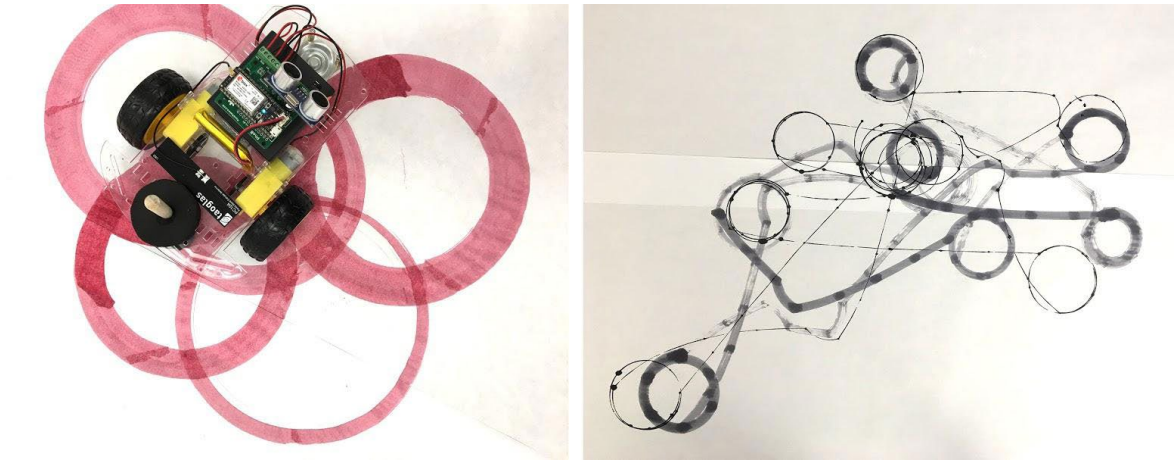

Figure 8 The participants experimented with controlling the robot using bike route times.

5.3 Conclusions

This investigation sought to find ways in which augmented technical tools and design processes affected social interactions and empowered people to become producers within a collaborative online context. It invited other like-minded design collaborators into a remote collaborative making process that was unfamiliar to them to see how they might work with the tools. The results brought forth insight into our participants (across all investigations) and the expectations that come with using digital tools when one has previous expertise in making digitally and collaboratively. In this case, the participants, who are experts in design making, were more interested in the outcomes of the artifact than the experimental process of working with the tools. This caused a conflict between prioritizing a process-oriented approach versus an artifact-oriented approach.

Additionally, the working process became the most collaborative part of the experience between the participants, experimenting with the robots as a tool was less collaborative than they expected it to be. The experience did empower them to think in alternative ways about the possibilities as well as the limitations of collaborating in the digital space. Based on post-survey responses, this investigation led to further inquiries about remote collaborative making such as what other possible augmented tools, aside from the robots, should/could be considered. Additionally, it was considered how creative remote collaborative making activities might expand on existing systems i.e. commercial/industry settings, academic/ research, educational, healthcare, manufacturing, etc., which could facilitate visual thinking artifacts created in the digital space.

6. Investigation #3: A Workshop Experience with Invited Participants

The third investigation demonstrates how teams of participants worked collaboratively to build and construct their own technical tools for making activities. Through the process of building and working with the drawing robots and digital system, participants were able to

(1) learn about the technologies in use and how it can foster collaboration, (2) manipulate and develop the technologies to engage more deeply with the material and concepts to foster new ways of thinking and making and (3) empower further making, with a deeper understanding of project capabilities and future possibilities.

To investigate these ideas, we planned and implemented a two-day workshop. Participants were invited from the Pitt Pirates Robotics team (http://www.pittpiratesrobotics.com/) of Pitt County, North Carolina to reflect a sample population of people that were directly interested in robotics and technology, in contrast to the previous two investigations, which aligned more directly with art and design interests.

The first day of the workshop was focused on building the augmented technical tools and setting up the digital drawing environment which controlled the drawing robots. The second day was focused on drawing activities, which helped to understand more deeply how the tools functioned, how the analog and digital experiences inter-related, and how the digital system worked as a whole. Through this process, they were encouraged to build beyond the steps provided to construct and contribute their own ideas.

The digital system included a drawing robot with mark-making tools that drew on a physical canvas on the floor in the space. The robots, programmed using a Raspberry Pi, were controlled via a web browser interface. The web browser interface has two drawing modes, a driver mode, which allows you to control movement via navigational buttons and distance increment values and a follow mode, which allows you to control movement via a trace function. You can also enter direct commands via a command line in the driver mode, and both modes include a graphic rendering, which can then be compared with the physical drawings (Figure 9).

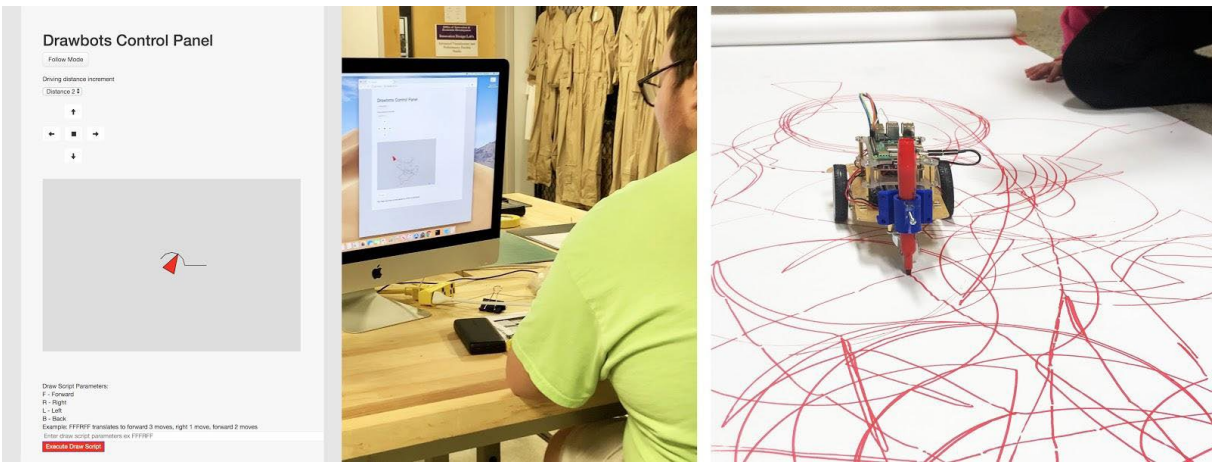

Figure 9 The digital system and physical drawing environment

Participants broke up into three teams and built three robots. Each robot was constructed as its own unique digital system, and participants worked adjacent to each other throughout the process. Teams worked with the digital systems independently as well as all together (Figure 10).

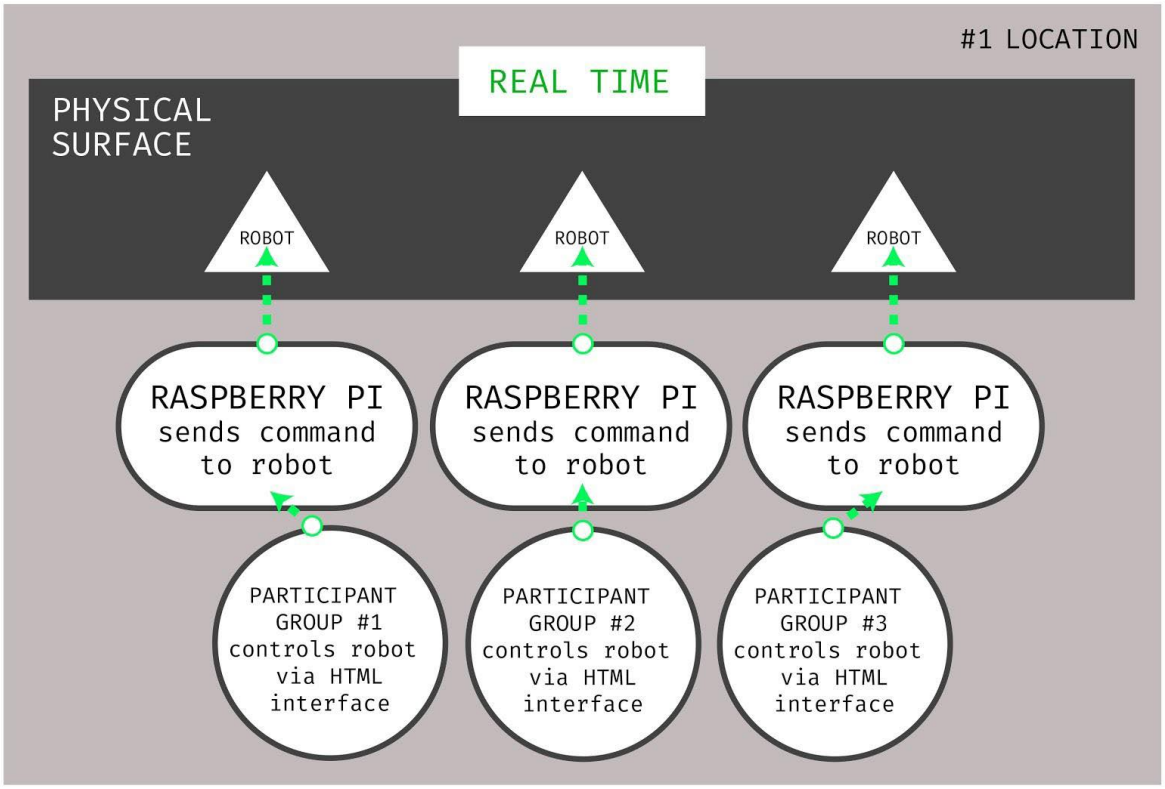

Figure 10 *Participants logged into their robots via the pi, which had already been flashed with our drawbots software package that is available via github. They used terminal to access their robot via its IP address, which was assigned by our access point/network for the workshop*

6.1 Data Collection Methods + Analysis Process

To capture findings from the workshop, research team members conducted observations during the experience through fieldnotes and photo-documentation. The fieldnotes were analyzed for themes and insights relevant to how participants engaged with the technology in use to collaborate and how they considered materials and processes as instruments for learning. A post-survey was also conducted to record details about our population sample as well as to provide quantitative feedback on the workshop experience and possibilities for future investigations. Once analyzed, the feedback indicated that the workshop experience did lead to the participants thinking more about the connections between art and collaboration through technology.

6.2 Results

The kit enabled intuitive development of technical tools and empowered participants to learn complex concepts through design processes, collaborative making, and analog materials. Participants responded well to the written instructions in the kit for building and assembling the robots versus following an instructor-led verbal demonstration/intervention.

The kit allowed participants to work intuitively through procedures and processes, at their own pace, in their own way (Figure 11). Because of this, participants engaged with one another to determine how they wanted to move through the steps to interpret the instructions before seeking answers directly from the instructor. This prompted groups to designate roles and responsibilities amongst themselves. For example, one group designated "readers" versus "finders" versus "builders."



Figure 11 Students working with the kit to assemble the robots collaboratively.

In observation it was seen that all the groups were comfortable with allowing the process and materials to direct their making. While they followed the instructions, they were thinking critically about the process, thinking ahead, and having foresight into crafting their robot tools. By working collaboratively, their critical thinking through making was made evident through their questions and discussions between each other throughout the process. If they made mistakes in the process, they did not dwell on them and instead, re-examined the instructions and worked with one another to solve the problem. Participants preferred to ask questions after they tried something versus over-thinking the procedures. They worked through trial and error and fell back on the instructions if they needed clarification.

To learn and understand how the tools functioned, participants worked through a series of drawing activities to experiment with the robot's capabilities. One drawing activity prompted participants to compare digital and analog drawings. As a result, teams noticed discrepancies between the digital controls and the physical outcomes and attempted to make modifications to their robots to increase its accuracy. In response, they discussed ideas for refining their tools such as loosening or tightening certain screws to check the integrity of their machinery.

To learn about the technologies in use and how they can foster collaboration, participants worked through a series of prompts to create collaborative drawings. Comparatively, each team worked collaboratively with the tools in slightly different ways (Figure 12). Team 1 was very interested in how their tools functioned to create patterns and repetition in their drawings. They relied heavily on the command line functionality on the driver interface to set

parameters and watched how their robot responded to these commands. They considered collaboration be creating design parameters and then as individuals, created a range of work that followed said parameters. Team 2 was more engaged with collaboration as a process. They responded to each other's work by adding color and linework to the drawing spontaneously, in a more intuitive and organic way. They were more interested in making the robot move versus making the robots move to create a specific drawing. They were less outcome-oriented. Team 3 was very interested in collaboration as a group composition and narrative in their drawing. They thought about an overarching theme, Star Wars and each member drew different parts (pod fighter, Death Star, Millennium Falcon) of a larger composition.

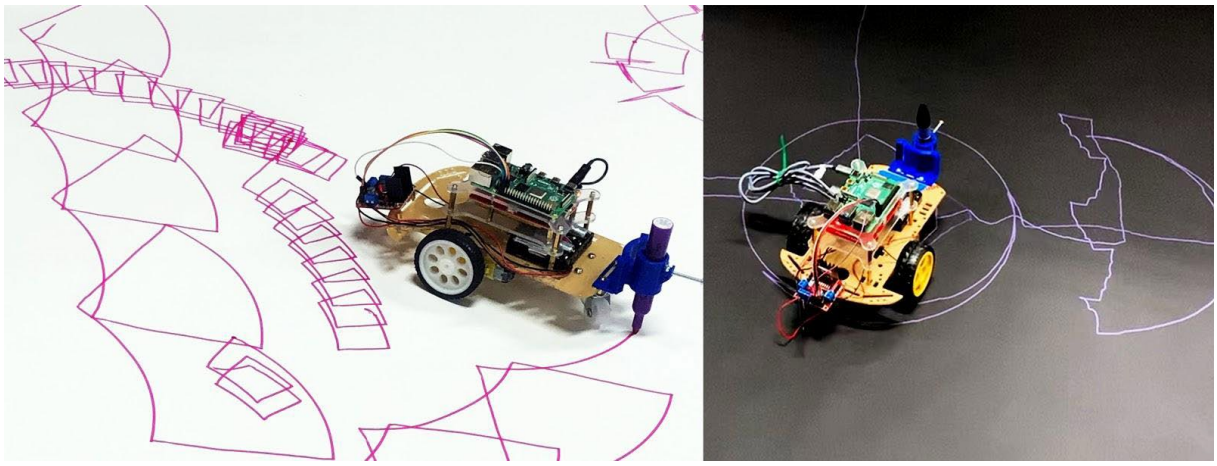

Figure 12 *Team 1 exploring pattern and repetition through the command line function and Team 3 exploring narrative by drawing representational compositions.*

Further modifications of the tools were implemented by teams during the final drawing activity, which prompted them to hack their robots to customize them for mark-making in one collective collaboration (Figure 13). After some initial movement and drawing exploration, participants competed in a drawing obstacle race where each robot was challenged to reach multiple check points on the paper. One team modified the pen holder by adding multiple marker holders and another team placed different objects on their robot to try and balance weight distribution. In the end all the groups modified their robots in similar ways as inspired by each other.

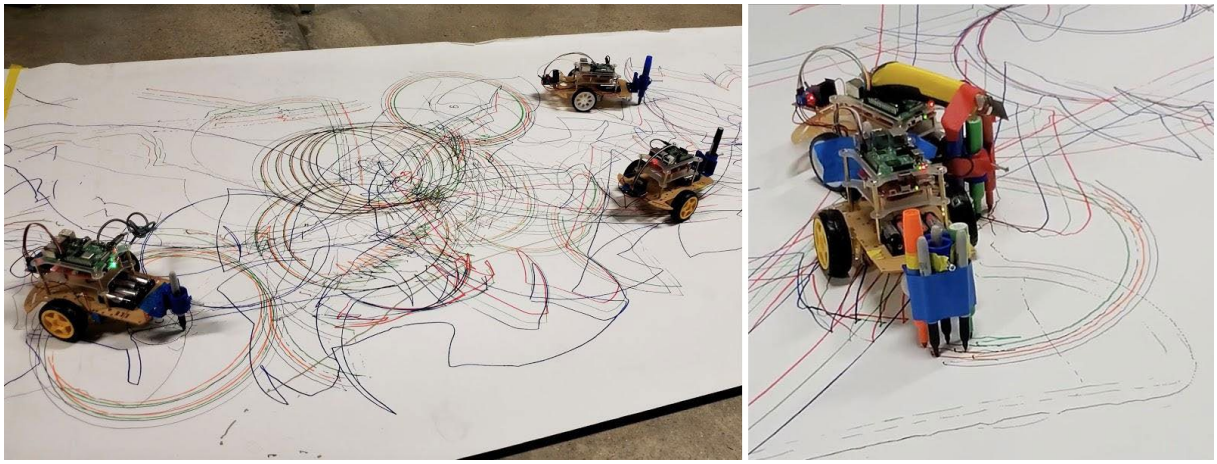

Figure 13 *Each group's modified/hacked robot was placed on one, single sheet of paper for a final drawing activity.*

6.3 Conclusions

Through the process of building the robots and then working with them as drawing tools, participants were able to understand the underlying mechanics and programming of the technical tools and therefore engage with and learn the capabilities and future possibilities of the robots in more depth. We were also interested in understanding how the technologies under investigation encouraged and facilitated collaborative making. As this was a primary goal of the investigation, the participants were able to find agency through working with the tools, and thus use the technology for their benefit.

In this investigation, the participants were highly engaged with the technology and system of tools under investigation. They collaborated well to find and solve problems related to the mechanics of the robots and were very interested in experimenting and playing with the modification and hacking of the robots. The participants became producers of the tools, and as Papert taught us, the tools and processes became "objects-to-think-with". These objects empowered the participants to explore concepts and materials simultaneously and to learn and understand socio-technical design systems. Although these participants did not consider themselves particularly creative, they were incredibly imaginative with the technology and processes introduced. Many of them discussed in the post-survey how their passion for robotics made them think more intently about art and collaboration, an insight not previously discussed in either of the investigations prior. Rose defines 'enchanted objects' as the tools and technologies for exploring creative-making and self-expression. In this investigation, we sought to foster and support the participants innate desire to create with augmented technical tools, and to challenge participants to work in unfamiliar ways.

7. Conclusions

By these investigations, we attempt to address the socio-technical systems that emerge when people work collaboratively through and with augmented technical tools in a design making

process. We consider how augmented technical tools and design processes can be "objects-to-think-with," as Semour Papert dictates, to explore concepts and materials simultaneously. We practice a critical approach to collaborative design making and speculate how present technologies shift future possibilities where interactions and exchanges are limited to those mediated by technological devices. The objects that we "think with and through" are basic drawing robots constructed from open and available present technologies that shift the way we work with one another in collaborative contexts. The conclusions from each investigation yield different insights, yet all intend to (1) foster new ways of thinking and making through play and experimentation (2) affect social interactions and empower people to become producers (3) affect relationships between collaborators and the technologies in use through transparent processes. Through the use of these augmented technical tools and the digital systems introduced in each investigation, we examine how participants engage with and in collaboration differently and to what end.

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Behaviours in design collaborations: Insights from a team learning perspective

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Abstract: This paper proposes that designers can improve their collaboration effectiveness by foster team learning behaviours. Most of the design collaboration literature is on how to effectively transmit information between members. Team learning literature, however, covers how to effectively transmit, understand, refine and retransmit information between members. Despite the extant literature on design collaboration, there has been little to no research that examines the model and effects of team learning behaviours on delivering collaborative designs. This paper provides a literature overview of design collaboration, which has predominantly studied design activities through a social lens. It then provides the growing body of team learning literature from organisational science, which focuses on the learning processes of teams collaborating on a project. The paper then synthesises both strands of research, before proposing that team learning behaviours are more explicit in indicating effective design collaborations than our existing research on communicating practices.

Keywords: design collaboration; team learning; collaborative behaviours

1. Introduction

A popular stance in the design collaboration literature is the idea that communication is the key to effective collaboration. This common perspective has been widely observed and documented, evident from the large bodies of work that examines design collaboration through either a social lens or a communication theory lens (Bucciarelli, 2003; Carlile, 2004; Pikas et al., 2016). However, **how** the team members contribute to the group (communication) is as important as **what** they provide to the group (knowledge). In fact, **why** the team wants to contribute back to the team after listening to each other (team learning) is even more critical. So researching through a social or communication theory lens may not be sufficient in understanding how to foster effective design collaborations. While there is increasing attention on understanding how team learning behaviours foster effective collaboration in organisational learning discipline, this attention is absent in the design

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collaboration discipline.

Is the designer learning from team members' experiences, and responding accordingly? Do arguments occur not only to bring attention to differences but to value-add to the project? Does the team co-construct a synthesised body of knowledge (transdisciplinary knowledge) for the collaboration? Or does the team simply place their siloed expertise together (multidisciplinary knowledge)? Here lies the distinction between the current social and communication perspectives used to examine design collaboration and team learning perspective used to discuss effective collaborations. The former seeks to strengthen communication between members occurs, and the latter seeks to ensure members receive and respond accordingly to the communication.

The motivation of this paper arose from the need for additional explicit mechanisms that will help foster effective design collaborations. Existing research focuses on increasing collaboration efficiency by discovering and promoting different forms of communication. However, this array of communication does not necessarily mean more effective collaborations. Therefore, the objective of this paper is to compare the research on effective collaborations in the design literature with research on team learning from organisational science, then identify the gaps in the literature on design collaboration. The purpose is to broaden the research focus on *how to facilitate communication between team members* to *how to ensure communication is received and acted upon accordingly*.

This paper contributes by: (1) charting the current research on fostering design collaborations using communication methods, (2) reporting the team learning behaviours of effective collaborations from organisational science literature, (3) cross-referencing both strands of research, and (4) identifying the gap in the design collaboration literature that require further research. Based on these conclusions, the author recommends designers working in teams to also focus on how they learn as a team, on top of how they communicate in the team behaviours.

2. Background

One of the ways a team of architects deliver a design proposal to clients is to interpret the clients' brief, come up with an idea, turn it into a concept and materialise the concept into a design. Apart from sketches and conversations, they also employ digital models, physical prototypes and technical drawings to communicate amongst themselves. However, it is very common, for architects to work with a range of experts outside their discipline during this process. Such experts may include paying stakeholders, end users, engineers, builders, construction managers, landscape architects and financial planners. Whether these experts are considered part of or external to the team of architects, there is no denying that they each bring their own disciplinary expertise to the project. The challenge architects face here is communicating with these experts effectively to incorporate their knowledge into the design project.

With digital technologies, architects can increase collaboration amongst themselves by

using virtual design studios (Achten, 2002) to organise asynchronous communication and information exchange effectively. Since the architects receive similar education and professional training, they can use industry-specific software to improve information flow between themselves (Svalestuen et al., 2017). To communicate with the experts outside their discipline, they can use basic software such as Wikis (websites for users to edit and contribute) for everyone to record ideas, design changes and decisions (Burry et al., 2005).

To further understand the role of communication in a multidisciplinary design team, three guiding questions were used to frame the following literature review:

- **What** does a designer communicate with the team in a design collaboration?
- **How** does a designer communicate with the team in a design collaboration?
- **Why** do designers communicate what they communicate in a design collaboration?

2.1 What does a designer communicate with the team in a design collaboration?

In a simple team arrangement involving only designers, an individual designer contributes to the team by describing ideas and designs to respond to the brief and the team's ongoing discussions. This arrangement is rare. Even in an all-designer team, each member has their perspective and their way of responding to the brief.

When team members come from different disciplines, collaboration becomes even more complicated and challenging. This complexity arises because each member gets to contribute their disciplinary expertise to the team. They will also bring to the table different opinions, even conflicting views, on the project. In such an arrangement, the designer takes on more responsibilities. From someone who produces a design, the designer now must mediate the different perspectives of the team to create a design. As such, what the designer communicates with the team will depend on the role the designer performs in the team. As the demand for multidisciplinary collaborations increases, the need to adopt different roles are becoming more common for the designer (Inns, 2010).

The designer's role may be of an inquirer (Johansson-Sköldberg et al., 2013), who asks critical questions to extract insights from different team members. Designers may also be of a problematiser, who re-present given problems as ill-defined problems (Cross, 2007). This action emphasises the importance of unpacking the problem, invites richer discussions of the problem and highlights the dangers of assuming a single perspective to solve the problem. Designers may also be a facilitator that steers the exchange of ideas between team members. Whether members discover ideas through team conversations (Johansson-Sköldberg & Woodilla, 2014) or toolkits (Liedtka, & Ogilvie, 2011), design facilitators help the team diverge in thinking to reveal more creative ideas (Minder & Heidemann Lassen, 2018). Designers can also be coaches, who bring team members of diverse backgrounds together and guide them through the process of exploring the problem and delivering solutions as a group. The impact of designers as coaches were studied in both education settings (Ledsome

& Dowlen, 2007; Powers & Summers, 2009) and professional settings (Reich et al., 2007; Styger & Ellis, 2013).

In multidisciplinary teams, the designer often oscillates between these roles. It is also unsurprising if a designer performs these roles simultaneously. These examples show a glimpse of the value a designer brings to the team. More importantly, it reveals that there are many ways to elicit the varying knowledge, perspectives and insights from the team members.

2.2 How does a designer communicate with the team in a design collaboration?

How designers communicate with their team is another area of considerable research interest. Over the last few decades, information communication technology has enabled designers to communicate digitally. This advancement has made communication more convenient for designers. They can initiate and continue conversations without the presence of the receiver – asynchronous communication. However, this technology has also introduced greater complexity on how designers communicate in collaborative design projects by giving us more modes of communication.

Today, designers have a diversity of ways to communicate with their team. Designers still have the traditional option of communicating verbally, through face-to-face discussions or phone calls. For information that cannot be thoroughly captured through verbal methods, designers use artefacts as a communication device. Artefacts may be two-dimensional drawings, aimed at turning intangible ideas into concrete yet evolving ideas (Henderson, 1998). The artefacts may also be a series of scaled models used to represent the design development process (Schmidt & Wagner, 2004) or even a simple and tangible mock-up, to trigger a discussion of ideas amongst the team (Brandt, 2007).

With information communication technology, designers can, to an extent, replicate the tradition methods digitally. For example, using video conferencing to meet with team members instead of gathering in a room to discuss. In fact, designers have the option of communicating synchronously (real-time, e.g. conference calls), asynchronously (delayed e.g. wiki discussion threads) or a mix of both. To transmit information that cannot be captured in words, designers can share analogue drawings online synchronously (Everitt et al., 2003). They can also broadcast and share their artefacts online synchronously (Gumienny et al., 2011) and even work together on a digital file simultaneously (Paavola & Miettinen, 2019). While online communication can increase idea generation in collaborative designs (Rahman et al., 2013) and indirectly increase the stimulation of creative ideas (Ocker, 2005), it still cannot match the performance of teams that collaborated in person (Andres, 2002; De Pillis & Furumo, 2006).

Again the designer oscillates between the different ways of communication with the team members and will employ a combination of communication modes as required by different situations or task. These modes attempt to elicit different forms of knowledge, perspective and insights from the team.

2.3 Why do designers communicate what they communicate in a design collaboration?

Despite the various ways to extract and transfer information, the need to communicate remains the same. In design, it is used mainly to negotiate ideas and manage conflicts (Cross & Cross, 1995) to arrive at decisions and progress towards a design outcome (Bucciarelli, 1994; Henderson, 1998).

A key indicator of successful communication is the presence of a shared understanding, which allows members to make important decisions that progresses the project together (Valkenburg, 1998). It is also this shared understanding that avoids unnecessary re-questioning of decisions that hamper progress (Valkenburg & Dorst, 1998). When teams cannot achieve a shared understanding of the project, collaboration becomes challenging, tricky (Cross, 2011; Maher et al., 1996) and may even become destructive to the project.

In practice, it is highly unlikely that all team members are present for every exchange of ideas or to even understand ideas exactly as intended. This is because everyone frames their understanding differently (Schön, 1983). However, sharedness in understanding can be achieved through dialogue (Møller & Tollestrup, 2013) so that team members learn how to frame their ideas similar to one another (Stumpf & McDonnell, 2002). Since it's impossible to guarantee the singularity of an overlapping understanding, Smart et al. (2009) proposed to define shared understanding as an ability to draw information from different members to complete tasks that help achieve a common goal. This suggests that shared understanding exists as a dynamic state (Bittner & Leimeister, 2013), which surfaces depending on how it needs to be used in its context.

Whether it's a state of shared understanding, or a sharedness in understanding, the goal of a designer when communicating with the team is to extract, exchange and amalgamate knowledge into a team body of knowledge, so as to then deliver a design outcome. In fact, some researchers even argue that collaborative design is about communicating and integrating knowledge from different members to attain shared understanding (Kleinsmann et al., 2007) and that shared understanding is the foundation of collaborative design (Gomes et al., 2016).

2.4 Author's critique: Is communication behaviour the only way to achieve shared understanding?

It is unarguable that there is extensive research on collaboration between designers and evidence that effective communication leads to successful design collaborations. However, does facilitating communication behaviours always achieve shared understanding and ultimately a successful collaboration? Shared understanding may be an outcome of successful communication, but effective communication does not guarantee shared understanding. It can only increase the likelihood of achieving shared understanding.

Some researchers even say that communication is not the answer to effective collaboration (Jowers et al., 2016). In other words, socialising processes, that is to say, how people

communicate, may not be a suitable lens to examine design collaboration effectiveness. So, are there other factors aside from communication behaviours that can be used to achieve shared understanding and ultimately, effective collaborations?

If communication in a design collaboration environment is to elicit and integrate knowledge into a team knowledge, shouldn't the team's ability to learn from and adapt to each other's knowledge also be a vital characteristic of shared understanding? Hence, an alternative lens, which this paper proposes, is to examine design collaborations from a team learning perspective. After all, one of the benefits of working in a team is access to a range of expertise from every team member. To not learn from these available experts is not to take advantage of the team's strength.

3. Team Learning

This section explains why the author chose to examine team learning behaviours from organisational science as alternative indicators of effective collaboration.

3.1 Design and learning

Every design process involves learning. What we have learnt from previous experience influences the way we design and what we design (and are designing) influences what we have learnt (Duffy, 1997). When we learn, we use past and current experiences to frame and change how we perceive our situations. When we design, we create artefacts to change our current and future conditions. Both these actions, learning and designing, share a similar objective - to change our experience of situations. The act of designing is filled with learning activities, which are visible and invisible (Lawson, 1997; Schön, 1983). Whether it is learning from the current design task to understand what we are designing, or using the experience to determine how we approach a design project, learning in design is inevitable.

The outcomes of design learning in the literature are described in terms of design cognition, rationale and knowing (Cross, 2007, 2011; Lawson, 1997; Schön, 1983). In comparison, the act of design learning has received less attention, both in design education (Eastman et al., 2001) and in professional practice (Dall'Alba & Sandberg, 2006). In this context, the presence of motivation differentiates design learning from design knowing. Design knowing is the process of becoming aware of the design and its situation whereas design learning is the process of intentionally trying to understand the design and its situation.

If shared understanding is necessary to create effective design collaborations, and that it is achieved after teams elicit, transfer and amalgamate each other's knowledge, design learning is a necessary action in the route to creating shared understanding.

3.2 Why not individual learning

While individual learning affects how shared understanding is nurtured within the team, the author does not elaborate on it because it does not capture the reciprocal interactions

between team members. Yes, the practice of design in professional setting activates learning in the individual (Schön, 1983), and that experiential learning is the foundation of creating meaningful understanding (Dewey, 1986; Kolb, 1984). However, there are many other factors within the individuals that influence how they perform in teams. Some factors include their character (Birdi et al., 2016), their cognitive style (Peeters et al., 2008; Sonalkar et al., 2017), how they interpret the task (Eisentraut, 1999), and even their adaptability to different approaches to the task (Kirton, 2003). To consider individual learning as a factor of fostering effective design collaboration will require the coupled examination of these additional factors. Since these issues apply to every individual of the team, the severity of how each member learns from and performs with each other through collaboration is compounded.

3.3 Cultural difference and its affordances

The author acknowledges that cultural differences between individuals influence team performance. However, cultural differences do not affect team performance directly. The presence of cultural differences increases the likelihood of interpersonal conflicts (Ayub & Jehn, 2010) and influences how each member addresses these conflicts (Paletz et al., 2014). As Stahl et al. (2010) pointed out, cultural differences can be a positive and negative asset to the team. Their study showed that when conflicts triggered by cultural differences end poorly, it can lead to further task conflicts and a decrease in social integration. When the team managed their conflicts appropriately, their differences increased the team's creativity. For example, Gray and Boling (2018) highlighted that translators were introduced into a co-creation workshop to mediate the conversations between Scandinavian and Chinese team members. Therefore, the author does not elaborate on the impact of cultural differences on team performance but examines the management of conflict as a team learning behaviour (Constructive conflict) in the section below.

3.4 Organisational science

In organisation science, where team learning literature emerged from, research is focused on how individual behaviours benefit or disadvantage the development of organisations. Early authors include Argyris and Schön (1978), who described how employees in organisations learn from their experience to either correct their mistakes (single-loop learning) or change policies to prevent future mistakes from occurring (double-loop learning). Since organisational learning aims to improve the performance of organisations, the discipline observes and describes effective teamwork methods based on how individuals and teams learning independently and interdependently.

In the organisational learning literature, research on team learning is focused on how team behaviours impact the way a team achieves a common goal by through shared understanding. The seminal work by Edmonson (1999) identified team learning as a behavioural and cyclical process that involves gathering information, discussing information and seeking feedback. Individuals gather information by asking their team members questions. They discuss the information to identify errors in understanding and seek

feedback to ascertain that information is accurate within the group.

Based on the previous section on design collaboration, team learning shares many similarities to what, how and why a designer communicates in a collaboration. The key difference is that team learning behaviours can indicate that teams are developing a collective knowledge (Ellis et al., 2003) whereas communication behaviours can only suggest that teams are using methods that help build collective knowledge.

4. Findings

There are four basic team learning behaviours from the team learning literature that may help examine the effectiveness of design collaboration more accurately. These four primary behaviours are 1) sharing, 2) co-construction, 3) constructive conflict and 4) error management. The following explains these concepts and evaluates them against concepts found in design collaboration literature.

4.1 Sharing and Co-construction

When individuals share meaning with the team, they share their understanding of the project with other members. The distinction between sharing meaning and co-constructing meaning is that the former involves aggregating meaning whereas the latter is amalgamating meaning that converges into an idea. Without the construction of meaning by team members, it is impossible for team learning to occur. That is because the individual needs first to contribute their knowledge to the team so that the team can then receive and learn (Van den Bossche et al., 2006). When individuals share meaning in the team, they are then able to co-construct meaning with the team.

When individuals co-construct meaning with the team, they listen to, add on and build upon each other's ideas. As mentioned previously, the difference here is that members are not merely 'piling on' but are 'mixing in' ideas to achieve a shared understanding of the project. This process helps teams unlock collective meanings that could not have been achieved purely through the construction of meaning (Van den Bossche et al., 2011). Some researchers argue that this co-construction process is repetitive (i.e. iterative and not a linear process) (Decuyper et al., 2010) to align team members' cognitive behaviour with each other (London et al., 2005). Ultimately, it is to achieve a shared knowledge amongst team members, which could not exist without collaboration (Van den Bossche et al., 2006).

Co-construction, in the team learning literature, is the joint effort of the team to create a shared body of knowledge by discussing with each other. Co-creation, from a design perspective, is the collective effort of turning ideas into creations (Sanders & Stappers, 2008). However, it originated from a business perspective and referred to the act of creating value together (Prahalad & Ramaswamy, 2004), especially with different stakeholders to capture their expertise within the outcome. When these two perspectives are combined, co-creation represents the creation of a design outcome through consultations with various stakeholders. While co-construction and co-creation may share similar qualities, their

objectives are different. The former focuses on creating a shared understanding with the team, whereas the latter focuses on delivering an outcome.

4.2 Constructive conflict

When team members debate over meanings, ideas or processes, they enter a conflict. When conflict is constructive, it reveals differences in opinions and can initiate greater elaboration of ideas. Through this elaboration, hidden meanings associated with the proposed ideas come to light (Van den Bossche et al., 2006). However, this conflict can be destructive to the project as well. Instead of using the conflict as an opportunity to investigate ideas further, these conflicts may end when an individual ignores the comment or rejects the opposing party (De Dreu & Weingart, 2003).

Surprisingly, there has been little research that looks at the impacts of constructive conflicts on creating a shared understanding in design collaborations. Only recently did design researchers looked at the positive influences of conflicts on the design outcome. McDonnell (2009, 2012) found that conflicts within conversations between team members help advance the design, and Paletz et al. (2017) discovered that micro-conflicts reduced the uncertainty of the design task. However, most of the existing research focused on the impacts of conflicts on team cohesion. For example, how different cognitive background can lead to conflicts (Kilker, 1999), how to resolve disputes in design collaborations (Lauche, 2007) and how to avoid conflicts (Hsu, 2017).

In the team learning literature, conflict is recognised as a potential driving force that can increase shared understanding. Here, the challenges are to differentiate constructive and destructive conflicts and to encourage constructive conflict. However, the design literature suggests that conflict is a negative influence on team cohesion and should be avoided.

4.3 Error management

How the team treats a reported error have direct consequences on how subsequent errors are identified. With proper error management, mistakes can be fruitful learning opportunities that initiate discussions (Frese & Keith, 2015) and even instigate problem-solving activities (Edmondson & Lei, 2014). Despite the considerable learning potential that comes with making a mistake (Tjosvold et al., 2004; Weinzimmer & Esken, 2017), research also shows that organisations still gravitate towards blaming and punishing employees when mistakes occur (Edmondson, 2004). Since admitting a mistake has almost become synonymous with taking the blame for failure (Edmondson, 2011), this faulting practice tends to obstruct individuals from sharing their mistakes. In more severe situations, the lack of proper error management may even lead individuals to deny or blame the mistake on others (van Dyck et al., 2005).

Despite the learning benefits an error management process brings to a collaboration, there is no research on the benefits of making errors in design collaborations. In fact, existing literature on error management in design shows errors as undesirable. For example, Love

et al. (2014) report that fixing errors in the late stages of design can cost up to a third of the valuation of the project. Lopez et al. (2010) attempted to classify errors to prevent them. Love et al (2011) proposed a framework to use digital communication tools to identify and reduce errors in the design process.

Like the perspective on conflict, team learning literature recognises the benefits and disadvantages of making errors in a collaborative environment. In contrast, design literature only recognises the negative implications making an error has on the project.

5. Discussions

From the review above, the significant difference between the two research disciplines is in the purpose of communication. The design literature focuses on understanding and improving communication methods to make collaboration more efficient. On the other hand, the team learning literature focuses on encouraging learning behaviours associated with the creation of a shared understanding. Even though learning behaviours (sharing, co-construction, constructive conflict and error management) require communication with the team, it also involves individual and team learning processes. This additional attribute makes team learning distinct from the existing design research scope on communication methods.

These team learning concepts, though mostly still in its early stages within the design context, already has some theoretical implications. These concepts, coupled with the growing research on team learning in the organisational learning literature, prompt researchers to step back and re-examine if communication methods between team members should be the key identifier of effective collaborations. Instead of describing how communication is executed in design collaborations, more attention could be paid on how the content of communications changes as it passes through different team members.

5.1 Measuring our current state

This model of team learning behaviour has been tested in a variety of context such as military teams (Veestraeten et al., 2014), teacher teams (Vangrieken et al., 2016), student teams (Van den Bossche et al., 2006) and engineering teams (Cauwelier et al., 2019). Now, empirical studies are needed to validate these concepts with design teams. The first step would be to use Savelsbergh's (2009) measurement instrument on team learning behaviours to examine if team learning behaviours do foster effective design collaborations.

Savelsbergh's measurement instrument is an empirically validated multidimensional questionnaire used to measure a team's reflection, feedback, and communication behaviours. These dimensions were built from previous questionnaires that measured co-construction (Van den Bossche et al., 2006), reflection (Schippers et al. 2003), error management (van Dyck, 2000) and feedback behaviour (Edmondson, 1999; van Offenbeek and Koopman 1996; Schippers et al. 2003). The objective of measuring these qualities is to identify the relationship between team learning behaviours and team performance. The questionnaire was tested with 19 customer service teams (approximately 180 individuals

holding various positions) in a Dutch banking organisation and yielded a positive relationship between team learning behaviours and team performance.

5.2 Implementing these conditions

These team learning behaviours offer a new way of examining design collaborations. The validated instrument also allows researchers to empirically measure the impact of these concepts. But the ultimate question is, how can designers put these concepts into practice and benefit from it?

Teams can adopt specific processes to cultivate team learning behaviours. These facilitating processes help teams transcend from simply a group of individuals to a team (Decuyper et al., 2010). One of these facilitating processes is *Team Activity* (Kinny et al., 1994). This involves team members of different expertise share the responsibility of producing the same outcome. For example, an architect and landscape architect working to design a zoo where the boundaries of building and landscape are blurred. A second process is *Boundary Crossing* (Kasl et al., 1997). This involves team members actively seeking information outside their team of expertise. In the same example, the architect asking advice from a zoologist, who is not in the design team but still able to contribute to the design. A third process is *Team Reflexivity* (West, 2000), which involves the team reflecting collectively on what was done and needs to be done to achieve their shared goals. This is more than a just a discussion of works to be done. In the same example, it is an opportunity for the architect to learn from the working experience of the landscape architect. These three processes have been found to cultivate team learning behaviours (Decuyper et al. 2010).

6. Conclusions

This paper has only introduced the four basic team learning behaviours into the design discipline. Yet organisational learning discipline contains an array of literature on other types of learning behaviours, methods to facilitate such behaviours effectively and research on conditions to support such behaviours. Since these research focus on explaining what makes collaboration effective, the concepts should also be tested with the design discipline to further understand how communication and learning impacts design collaborations.

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Designing Six Dimensions of Intercultural Teamwork: A next-gen challenge in co-creation processes

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Abstract: By examining remote collaboration as a design problem, this paper provides a rationale for the Six Dimensions of Intercultural Teamwork, a new framework to help teammates understand various differences such as how they build trust, exchange information, and cope with creative abrasion. Collaborative work intensifies when teammates are diverse in mindsets, cultural backgrounds, disciplines, and approaches to problems and projects. Stumbling blocks can also grow when teammates work remotely or are working with each other for the first time. Design processes can help remote teams improve the way they work together by introducing systemic thinking, promoting physical and iterative processes, and making the invisible visible. The COVID-19 pandemic thrust design education and workplace activities into new virtual spaces, amplifying some of the challenges associated with teamwork. Videoconferencing tools and cloud-based software alone cannot build the necessary interpersonal skills for effective communication and relationship-building, nor can they address other challenges inherent in teamwork.

Keywords: diverse collaboration; intercultural learning; design process; wicked problems

1. Introduction and study context

Design educators have begun to recognize the need to teach collaborative skills, as evidenced by the recent publication of Intercultural Collaboration by Design: Drawing from Differences, Distances, and Disciplines through Visual Thinking (Murdoch-Kitt & Emans, 2020) and Collaboration in Design Education (Lane & Tegtmeyer, eds., 2020). These publications suggest that working effectively with teammates—especially across national borders—is now more critical than ever. Likewise, the design discipline has been moving increasingly toward addressing intractable systemic challenges, or wicked problems, a term coined by Horst Rittel in 1973 (Buchanan, 1992; Rittel & Webber, 1973). These complex problems are best tackled by diverse teams—with constituents from various disciplinary and cultural backgrounds working synergistically together (Emans & Murdoch-Kitt, 2017). Because collaborating

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remotely is an added challenge, it is essential to confront the process and system of collaboration and co-creation as a complex design problem in and of itself. Designers are prepared to improve the problems inherent in remote collaboration because their working processes enable them to understand a problem from many different angles (Frankel & Racine, 2010). Thereby, designers can integrate "signs, things, actions, and thoughts" (Buchanan, 1992, p. 12–15) from a variety of disciplines and cultural perspectives into new online environments and virtual teamwork scenarios. The study responds to this challenge by proposing a framework to address common issues for all types of teams, regardless of the relative diversity of their membership.

1.1 Innovation and co-creation

Various forms of co-creative practice (Sanders, 2000; Stappers & Sanders, 2012) can positively affect teamwork, bringing together contrasting viewpoints, methods for understanding and solving problems, and domain knowledge (Leonard-Barton, 1995). This combination, when managed well within a diverse collaborative team, can lead to more interesting and innovative design outcomes than any individual in the group would have developed working alone (Hill et al., 2014). Approaching problems from new perspectives can lead to innovative outcomes that create value for organizations and society as a whole (Patton & Downs, 2003; Rosen, 2009).

According to the Observatory of Public Sector Innovation (OPSI), "Innovation involves introducing entirely new approaches or the application of existing approaches to new contexts" (Roberts & Tõnurist, 2018). In order to arrive at new ideas, innovation is often brought about by teams that are diverse in their thinking and approaches to problem-solving—and who give time and space to learn from each other's differences (Leonard-Barton, 1995). Though diversity does not guarantee critical thinking or superior outcomes, studies such as these show that when constituents of collaborative teams are diverse across many different characteristics, they often do better work (Rock & Grant, 2016).

At the same time, assembling a team and then working together—not just in a perfunctory way—but deeply and innovatively, can be an enormous challenge. For instance, a study of 200 Canadian-based firms conducted by De Clercq, Thongpapanl, Dimov revealed that successful product innovation requires managers to establish fair and mutual respect amongst intra-organizational interactions (2013). To achieve high levels of product innovation, moreover, managers themselves must "go out of their way to integrate their viewpoints with others', rather than to avoid them, when conflict situations arise" (De Clercq, Thongpapanl, Dimov, 2013, p. 67). While issues of equity, fairness, and respect are critical to teamwork, building these skills takes time and experience, particularly when team members hail from different cultural or social backgrounds (Hill et al, 2014; Meyer, 2014). Teammates' differences could include work or educational backgrounds, country or language of origin, approaches to problem-solving, and any number of demographic differences (age, race, gender identity, and so on).

Improving the teamwork experience for diverse collaborators in both education and practice is an intricate design challenge. By employing lateral thinking (de Bono, 2010), designers can connect disciplines and integrate ideas from them together into something new. The ways in which designers focus on making and visual thinking is also a differentiator. As Nigel Cross writes, “design offers opportunities for development of a wide range of abilities in nonverbal thought and communication” (Cross, 1982, p. 226). With this in mind, visual thinking (embodied in activities such as sketching, collaging, creating diagrams, and so on) can provide an opportunity to improve upon and clarify typical approaches to collaboration by offering alternatives to typical communication styles and exchanges. Therefore, visual thinking can be particularly useful in intercultural collaborations wherein linguistic and cultural differences often create barriers to mutual understanding and teamwork.

To better equip diverse teams to take on multifaceted problems together, the study introduces the Six Dimensions of Intercultural Teamwork, a framework developed from design thinking and research methodologies. While this research was developed specifically from studying newly formed, remote intercultural design teams in a learning context, the framework developed from its findings is transferable to a range of remote learning and working scenarios that involve some kind of teamwork.

1.2 Collaboration in remote learning environments

Keeping in mind the benefits and challenges of innovation and teamwork, this paper focuses primarily on the need to effectively incorporate collaboration in remote learning environments. The authors discuss the challenges of diverse and remote collaboration and how these parallel patterns for active learning (Anderson & Krathwohl, 2001; Bloom, 1956) and the design process (Design Council, 2015a, 2015b). The study brings together literature on intercultural learning (Mansilla & Jackson, 2013), intercultural communication (Martin, Nakayama, & Flores, 2002) and collaboration (Hill et al., 2014; Rosen, 2009; Patton & Downs, 2003; Kirkman, 2002) to understand key characteristics of successful diverse design teams.

The result of this research is a framework called the Six Dimensions of Intercultural Teamwork, an organizing structure which acknowledges the flexibility and adaptability within each person. Each dimension encompasses a range of contrasting characteristics to help teammates understand their differences in working styles, unpack stereotypes and biases, learn to trust each other, explore topics of mutual interest together, and work more productively on design challenges together (Table 1). The framework is introduced in this paper as a way to inspire other design faculty and practitioners to facilitate and engage with these concepts as part of evolving remote collaborative practice and diverse teamwork.

Table 1 The Six Dimensions of Intercultural Teamwork, described in relationship to the design process and the revised Bloom's Taxonomy of Educational Objectives.

Dimension	**Description**
Discover Work Styles	To what extent is your working style: • Independent? • Interdependent? This dimension runs parallel to the stages of **discovery** (Design) and **remembering** (Bloom's) in that it asks teammates to learn about their working preferences and to recall their self-discovery as they learn about their teammates. Activities in this dimension are designed to help build an individual's self-awareness and use that as a basis for conversation about productivity and guidelines for team operations.
Understanding Core Beliefs	To what extent do you value: • Individualism? • Collectivism? This dimension relates to **empathizing** (Design) and **comprehending** (Bloom's). When individuals comprehend their own biases and values, it sets the stage for empathy and the ability to understand their teammates' beliefs, even if different from their own. Activities in the second dimension aim to help individuals become aware of implicit biases, stereotypes, and values, and how these might play a role in their work. From a basis of self-reflection and analysis, individuals prepare sensitive questions to begin engaging with remote teammates.
Establishing Trust	To what extent do you rely upon: • Substantiated trust? • Relational Trust? This dimension entails teammates acknowledging, accepting, and learning to work with each other's strengths and weaknesses, and prepares teams to begin projects together, which they do by **defining a problem** (Design) to explore. This relates to **applying knowledge** (Bloom's) in that teammates are able to build trust by applying what they know about themselves and each other. Activities in the third dimension are focused around exchanging personal narratives and co-creating new narratives as low-stakes productive activities between new teammates. In the process of learning about each other and initiating some small collaborations, teammates begin to build trust while also learning about how technology affects communication and identity.

Assessing Information	To what extent do you look for information from: • Objective sources? • Subjective sources? This dimension prepares teams for **ideation** (Design), which involves creating many different ideas, opportunities, or other responses to the defined problem. Understanding how to **analyze** (Bloom's) information, objects, or ideas is essential to both. Activities in this dimension help teammates explore topics using subjective and objective means of researching, gathering, and portraying data, with the goal of reaching a topic that teammates are excited to explore together. This is the phase in which teammates often identify a wicked problem to pursue together.
Decoding communication styles	To what extent is your communication: • Direct? • Indirect? This dimension is essential for **critique** (Design), which encourages constructive feedback, and **evaluation** (Bloom's) of self, teammates, and outcomes. Activities in the fifth dimension guide teams in giving and receiving information in ways that all teammates can receive and understand, based on an understanding of indirect and direct communication styles and a format for delivering constructive feedback.
Designing shared goals	To what extent do you set goals that are: • Attainable? • Challenging? This dimension naturally leads to teams being able to **prototype** (Design), which brings ideas to life and enables them to **create** (Bloom's) new ideas by combining different prototypes together. This process synthesizes what teams have learned and also produces new knowledge. Activities in this dimension help teammates develop attainable as well as challenging goals, break longer projects into manageable phases, assign roles matched to skills and learning interests, and engage in creative work together. This dimension guides teams in how to begin addressing the wicked problem they would like to explore.

1.3 Diverse teams: Challenges and benefits in remote collaborations

In setting the stage for the complexities of working in teams, it is important to note the distinction between the terms *collaboration*, *cooperation*, and other different ways people can work together. "Collaboration is the process of two or more people, i.e. collaborators, working together to co-create something through joint decision-making, in which everyone takes part in the process and responsibility for the outcomes" (Murdoch-Kitt & Emans, 2020). Remote collaboration engages teams or small groups of people in working together using online or virtual tools. More specifically, remote learning in higher education involves undergraduate and graduate students in using online or virtual tools for educational purposes. Remote learning does not necessarily include collaboration, however, and collaboration can occur in other online contexts outside of remote learning scenarios. While collaboration strives to be more equitable, cooperative learning and working generally involves structured and hierarchical roles and an emphasis on completing a provided learning activity versus cultivating a project and outcome together.

In the context of this research, participants engage in both remote collaboration and remote learning to improve students' readiness for professional practice. This is because today's professional workplaces require students to hone interpersonal skills and experience prior to entering the workforce. In higher education, this process involves learning about collaboration in order to address the gap that exists between classrooms and the workplace; evolving students' mindsets in order to effectively work with collaborators' different perspectives; and doing team-based activities online in order to practice and refine collaborative skills and develop innovative team projects.

1.4 Learning: The need to prepare for workplace collaboration

Even in courses or workplaces that are not typically collaborative, encouraging peer-to-peer learning and support is critical to forging interpersonal communication skills across a range of platforms. Cultivating interpersonal connections in these spaces helps participants feel less disconnected and solitary in their experience, particularly in the context of emergency remote teaching. However, one issue affecting the efficacy of collaboration is the measurable gap between the amount of collaboration preparation students gain during higher education and the importance employers place on being able to work well with teammates and people who think differently.

A survey conducted by Hart Research Associates for the Association of American Colleges and Universities (2015) underscores the need to explicitly teach collaboration skills in higher education. As many as 83% of the employers surveyed consider the ability to work in teams as one of the most important skills for new graduates (and that only 37% of new graduates are adequately prepared in this area). Furthermore, 96% of employer respondents believe that "all college students should have experiences that teach them how to solve problems with people whose views are different from their own" (Hart Research Associates, 2015). The unpreparedness of students to work in teams is not unique to American culture. In a

study conducted at a university in Vietnam, the lack of collaborative skills was considered the largest obstacle for collaborative learning. All students and almost all professors agreed that students did not demonstrate effective collaboration skills (Le, Janssen & Wubbels, 2017).

As professional settings are highly collaborative, a lack of collaboration skills can become a challenge later in designers' careers. In a survey of 1,087 design professionals conducted by Magoulas & King (2017), 97% of respondents reported working with professionals in different roles, such as programmers, product managers, and sales people. The Enterprise UX Industry Report (2017-2018) conducted by UXPin (2017) also reveals that collaboration between professional design teams is also a significant challenge. Given the need for collaboration that designers encounter and the lack of collaboration skills development in design education, problems inevitably arise.

There are obstacles to collaboration other than building the requisite interpersonal skills and experience prior to entering the workforce. Teams that work together in-person, remotely (purely digital), or in hybrid form (both in-person and remotely) have different needs, dynamics, benefits, and challenges. For example, Kirkman et al. (2002), conducted a study with members and leaders of mostly virtual teams within a travel organization. Building trust within virtual teams and clarifying and sustaining team processes, such as goals and operating norms were two of the primary challenges. Other major obstacles were the ability to create an inclusive virtual environment, considering individual needs and preferences; finding team members that balance each other's technical and interpersonal skills; and developing approaches for feedback, assessment, and support of team members. The authors' own study, which revealed the same types of issues among long-distance teams of design students from different cultural backgrounds, seeks to address these challenges through the implementation of the Six Dimensions of Intercultural Teamwork (Table 1).

1.5 Evolving: Creative abrasion necessitates adaptation

In collaborative scenarios, creative abrasion is a sort of pressure that necessitates evolution in individuals' mindsets and ideas. It is the struggle or discomfort that comes from people challenging each other's contrasting ideas en route to reaching the team's shared goal. The term is attributed to Gerald Hirshberg, who was director of Nissan Design International at the time (Leonard-Barton, 1995). Creative abrasion is not about consensus—it is about creating the space for drastically different ways of thinking to encounter and interact with each other in a synergistic way (Leonard-Barton, 1995; Hill et al., 2014). Ultimately, it is about shifting from working individually as the sole creator and "evolving" to embrace the different perspectives in the group to cultivate mutual understanding.

While individuals—and entire organizations—often cling to similarity and familiarity (Nemeth, 2018), business success is increasingly attributed to individuals' adaptability to different cultural settings, contexts, and viewpoints, and in demonstrating respect for other people (British Council, Booz Allen Hamilton, & Ipsos, 2013; Daniel, Xie, & Kedia 2014; Rock & Grant, 2016). Research suggests that experiencing creative abrasion, although not always

pleasant, is an essential ingredient for teams who wish to do innovative work (Hill et al., 2014). Diverse teams boost their collective cognitive performance as a result of learning from members' unique perspectives and challenging one another to think differently (Rock & Grant, 2016).

Novel ideas and outcomes are the result of seeing problems from new angles or having a teammate challenge one's sense of status quo. Teammates from different cultural backgrounds are likely to consider very different types of solutions or approaches to the issue at hand. Differences in ideas, opinions, working styles, and perception of the problem itself can lead to challenging communications and struggles. At times, these varied perspectives can sometimes cause communications to shut down completely, as teammates struggle to voice contrasting opinions or conflicting ideas. Often, teammates want to prioritize preserving the interpersonal relationships within the team over finding a creative solution to the problem at hand.

Ultimately, creative abrasion in a diverse collaboration provides a valuable and rare opportunity to learn how to think very differently about something, that is, evolve. Working through all of this complexity means that teammates may need to work harder than they would work alone, but investing the time results in better outcomes. In addition, teammates must preserve open lines of communication. Harnessing the potential of creative abrasion relies on teammates' expanding their empathic horizons.

1.6 Doing: Collaboration vs cooperation

Both collaboration and its close relative, cooperation, require skills such as analysing, evaluating, and creating, which, according to the cognitive domains of learning, are examples of "higher-order" thinking and learning (Anderson & Krathwohl, 2001). Matthews et al. (1995) further discuss the dissimilarities and commonalities between cooperative and collaborative modes of learning. Both approaches promote more active learning and working, and involve practicing social and team skills. Both can be accomplished in various settings: online, in person, or a mix of the two.

Collaboration—particularly involving constituents from diverse backgrounds—is required with greater frequency in academia and professional design practice. Therefore, there is an increasing need to address the actual experience and process of collaboration. Collaboration is itself a complex and systemic design problem. Its complexities are magnified and may even feel insurmountable when teammates have different backgrounds and work together remotely. This can result in high levels of frustration, even when people receive some training or preparation before meeting their teammates (Baker & Clark, 2010). Designers must embrace the opportunity to create new approaches to improve the experience and efficacy of diverse collaborations.

Approaching collaboration as a set of interconnected learning experiences that build upon each other stands in marked contrast to teamwork approaches in which individuals work independently and later combine work, which does not equate to a "real team" or a real

collaboration in terms of the team's performance and outcomes. Even worse, a "pseudo-team" can have a poorer performance than simply combining together individual work (Katzenback & Smith, 2015). Moving beyond a cooperative perspective empowers each team member to feel like an equal contributor to the process and outcomes of a shared project. In point of fact, simply because people work together does not necessarily mean that they are a "real team," as Katzenback and Smith (2015) point out: "A real team has a small number of people with a common and meaningful purpose, specific goals related to that purpose, have complementary skills, an approach with a set of rules, and mutual accountability."

The "think-pair-share" strategy is a ubiquitous cooperative learning strategy used at all educational levels (A. Goldman, personal communication, July 21, 2019; Kaddoura, 2013; Big Heart Media, 2010; Cortright, Collins, & DiCarlo, 2005). Individuals are asked to first think about something on their own, then are assigned to pair up with someone. Students are usually provided with instructions at this stage in terms of how to discuss their individual thoughts and summarize them, how to apply their individual thinking to an assignment or activity, and so on. Finally, the pair shares what they accomplished together with the group. The think-pair-share strategy also has parallels in professional practice. Because this is such a common pedagogical approach, cooperative learning is often mistaken by students as a form of collaboration. However, it is important to distinguish that collaborative learning more closely resembles the collaborative scenarios students will encounter in the workplace. Collaboration is less formally structured by a party outside of the collaborative team (such as an instructor or team lead). Instructors or team leads assume that individuals already possess the necessary interpersonal capabilities to work together successfully and place the responsibility on the group to determine their own course of action and outcomes. As this responsibility belongs to the group, teams cannot rely on software and must reach beyond such tools to work effectively together.

2. Methods of Inquiry

Since the study began in 2012, the Six Dimensions of Intercultural Teamwork have been developed and refined using a grounded theory analysis of observational and survey data. Over 230 participants in long-distance intercultural collaborations between North America and the Gulf Arab region have contributed to this study to date. As a strategy to bring together the concepts of collaborative learning and professional practice, this multi-phase study began by analysing survey data collected from 20 academic and professional designers working in visual communication design. The study also integrates secondary literature regarding the benefits and challenges of collaboration in pedagogy and professional practice. Finally, the study involved testing, iterating, and observing activities based on the Six Dimensions of Intercultural Teamwork with cohorts of design students based in North America and the Middle East who worked collaboratively online.

2.1 A grounded theory approach

The data from this ongoing study is analysed through a grounded theory approach in order to understand the efficacy of visual thinking activities in the relationships, working processes, and outcomes of intercultural design collaborations in higher education. Charmaz states that researchers can use this approach to gain a "conceptual handle on the studied experience" through comparatively analysing quantitative and qualitative data; analysing the findings from a theoretical standpoint; applying inductive logic; and utilizing informed practice (Charmaz, 2014; Sarker, Lau, & Sahay, 2000). In this study, the authors derived insights by comparing their analysis of the collaborative cohorts over time (Glaser, 1978; 2010), enabling the analysis of study participant experiences and the development of a new theory, offered in the following section.

2.2 Initial survey

The study began with interviews and survey data collected from a purposive sample of 20 communication design faculty and professionals living in the United States. The authors took care to select participants to achieve a high level of demographic variation (such as age, gender, geographic location, education level) within the small sample of respondents and ensure the respondents' background knowledge of the research topics. Participants were selected from a variety of different design workplaces and higher education contexts, ranging from individual freelancers to large design studios and small private art schools to large public universities. Three themes emerged from the survey data, including: 1) the importance of collaboration skills; 2) the intersection of design and sustainability; and 3) ability to work with people from different backgrounds.

The first theme relates to the ways in which respondents articulated a need for contemporary designers to function well in collaborative settings utilizing skills like conversing, active listening, exchanging constructive feedback, empathizing, and asking questions. The second theme pertains to the need for designers to comprehend complex problems in order to help others better understand them. The third and final theme discovered in the collected survey data suggest a need to incorporate global perspectives into design practice, especially as it relates to wicked problems.

2.3 Critique of secondary literature

Cultural anthropology, organisational studies, and theorists from other disciplines offer some frameworks for understanding cultural similarities and differences, such as Edward T. Hall's (1989) high-context and low-context cultural continuum. Others are organized around communication patterns according to differences in nationality (Trompenaars & Hampden-Turner, 2011) or cultural values (Hofstede, 2011). In the context of research dedicated to online communities, these frameworks are commonly referenced to explicate how different cultures express information and "exhibit different behaviors online" (Gallagher & Savage, 2013, p. 1030). But while Hoefstede's model of national culture is widely referenced in

organizational studies, it is also criticized as “profoundly problematic” (McSweeney, 2002, p. 13). Signorini, Wiesemes and Murphy pinpoint these problematic aspects as inconsistent, oversimplified, and static. Perhaps most critical in an educational setting is the notion that Hoefstede’s model lacks “empirical evidence” and, therefore, the authors encourage educators to embrace a more holistic view of culture that is both dynamic and flexible (2009, p. 253).

Building on these criticisms, this study similarly found that, using these models as a basis for participant self-assessment and subsequent team analysis in earlier phases of this study creates a false sense of cultural absolutes. Based on participants’ self-assessments, many participants positioned themselves along the continuum in locations very different from those prescribed to their culture in the literature. In their written reflections following the activity, many of these participants reported a sense of frustration, injustice, or inadequacy of anthropological or cognitive frameworks for the purposes of the group analysis. Some reported that they felt these existing frameworks reinforced stereotypes, and that they felt a need to express themselves as a blend of various characteristics instead of absolute terms. Furthermore, in the context of collaboration, these frameworks did not offer insight into specific preferences or habits that are especially relevant to the success of diverse teams.

2.4 Observations of collaborative online intercultural learning

Based on respondent feedback from the initial survey of professional designers and design educators, the authors initiated an ongoing study of long-distance intercultural collaborations between their respective design classrooms. To date, the study has involved 14 cohorts of design students, located in the United States and the Middle East. Each group is tasked with addressing a particular wicked problem, usually related to environmental sustainability or social justice issues. The students work together remotely in small intercultural teams. These classroom collaborations provided the foundation for developing visual activities to facilitate different aspects of the teams’ working process and interpersonal experience.

Drawing from these ongoing observations and analysis of data collected from study participants, the findings reveal that the Six Dimensions of Intercultural Teamwork is an effective strategy for working across international borders and remote environments. This theory emerged from the patterns observed in the needs and behaviours of the collaborators, which also serves as a framework for organizing and understanding the visual activities as a progressive sequence.

The Six Dimensions align with the processes for learning, evolving, and doing. It does this by introducing the integrated ideas of learning in relation to an interrogation of the concepts of collaboration vs cooperation; doing as a pedagogical strategy that employs the cognitive learning domains from Bloom’s Revised Taxonomy; and evolving education and professional practice to respond to students’ lack of preparation for workplace collaboration (Figure 1).

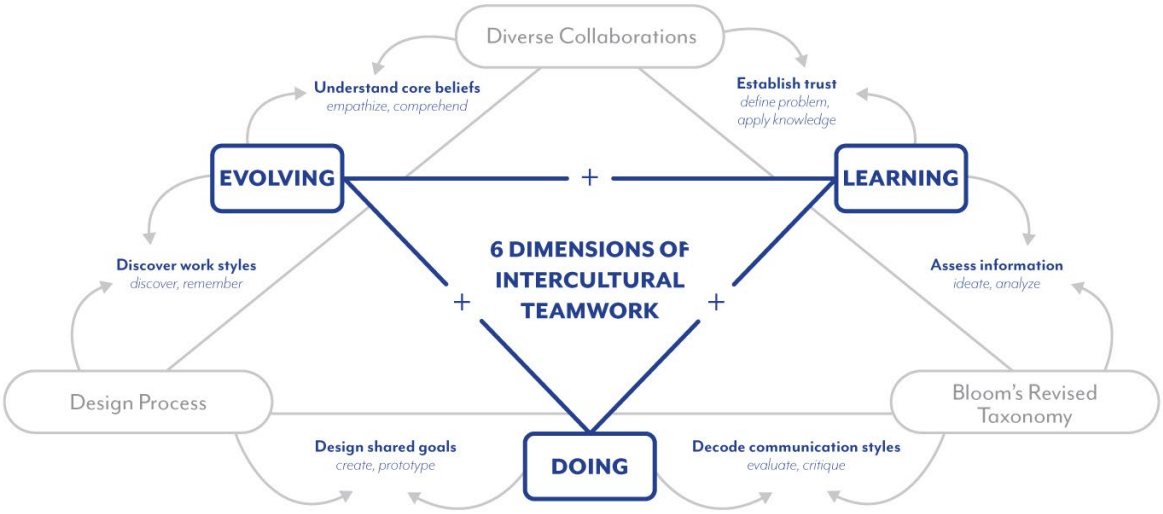

Figure 1 *Convergent frameworks: The Six Dimensions of Intercultural Teamwork combine ideas from learning theory with the design process to support teams of diverse collaborators in learning, doing, and evolving together.*

2.5 Methods in practise

In response to comparative observations of these student cohorts over time, the authors developed a series of more than thirty visual activities to address some of the typical problems inherent in diverse collaborations. These have been tried, tested, and refined by the authors in the context of remote intercultural design collaborations as well as other collaborative contexts to promote evolving, learning, and doing. These activities are categorized based on the Six Dimensions which include 1) discovering work styles, 2) understanding core beliefs, 3) establishing trust, 4) assessing information, 5) decoding communication styles, and 6) designing shared goals (Murdoch-Kitt & Emans, 2020). The activities are grouped based on each Dimension to help teammates further understand and build relevant skills. The visual activities take into consideration how to apply active learning and multisensory exploration to both the processes of cultural learning and engaging in teamwork.

One example of this strategy is a visual thinking activity called the Teamthink Constellation. This is a self-assessment tool that puts the Six Dimensions of Intercultural Teamwork to use by helping teammates see and compare their different working and communication preferences. This method is known as a Teamthink Constellation because it results in a series of six scattergrams that often resemble constellations. During the activity, teammates individually assess themselves, and then all responses are combined together into six different scattergrams, which correspond to each dimension. The aim of this approach is to introduce participants to the six overarching dimensions which define the Six Dimensions and how their preferences differ with their teammates.

To develop the Teamthink Constellation, several cohorts within this study have used different versions of the self-assessment tool over time to create various types of visualizations from their results. Because the authors have first-hand experience in applying Hall's high- and low-context model as a team assessment mechanism, the model evolved to embrace a more holistic view of culture. Observing the gaps, shortcomings, and limitations of the aforementioned cultural models lead to the creation of the Six Dimensions framework (Murdoch-Kitt & Emans, 2015). The final Teamthink Constellation pulls from and integrates the most successful elements of this and other earlier iterations of team assessment activities.

Teamthink Constellations are usually created with physical materials, although some participants re-create their scattergrams digitally or document them in digital formats to share with long-distance teammates. For example, oftentimes, an individual will use all of their team's self-assessment results to create team scattergrams using sticky notes on a whiteboard (Figure 2), then photograph and share the results with remote teammates. For example, the dimension "Understanding Core Beliefs" asks participants to plot themselves using two axes based on the degree to which they related to the following statements:

- I feel that I have the ability to influence or change things that affect me. My personal values, principles, and their roots contribute to a sense of self-efficacy or ownership. I feel a responsibility to myself above others.
- I feel that my actions can directly contribute to or detract from team harmony. My personal values, principles, and their roots contribute to how I see my role in the community. I feel a responsibility to my community above myself.

The results of the class self-assessment activity using the Six Dimensions (shown photographically in Figure 2) can be translated into digital form (as in Figure 4) so that the individuals, teams, and the larger group can continue to reflect on their similarities, differences, and how to overcome gaps that might cause challenges in work behaviours or communication patterns.



Figure 2 *The Teamthink Constellation is one visual activity that utilizes the results of the Six Dimensions self-assessment, enabling teammates to see each other's characteristics and preferences in relationship to each other. Here, a class that comprises six teams engaged in this visual activity in order to better understand themselves, their small teams, and their large group in relationship to each other. Each team is represented by different colors of sticky notes. This image shows the outcomes of the six scattergrams, one for each of the Six Dimensions.*

3. Results: A new actionable framework

The results of this study indicate that the Six Dimensions of Intercultural Teamwork enable teams to visualize important differences in their working and communication preferences. Feedback gathered from teams who engaged in this process reported higher satisfaction in the collaborative experiences and outcomes than those who did not utilize the activities associated with the Six Dimensions. In particular, this was due to the fact that the visualizations prompted the teams to engage in conversations about how to leverage their differences early in their process, rather than seeing them as areas of division. This reframing of differences as a way to support positive and productive collaborations is a pivotal finding of the study.

In developing, utilizing, and studying participant self-assessments over time, alongside other visual thinking activities and their outcomes, a larger pattern emerged. Prior to the integration of the Six Dimensions into team-based activities, participants consistently experienced similar hurdles at similar points in their collaborations. Some examples include coordinating schedules and time differences; thinking about how their own biases and stereotypes affect how they might approach their partner and the collaboration; trying to connect with each other on a personal level; understanding each other's differing viewpoints; offering feedback; and attempting to tackle projects together. The introduction of the Six Dimensions of Intercultural Teamwork helped address these barriers to collaboration by enabling participants to engage with six critical areas for teammates to understand about themselves— and each other.

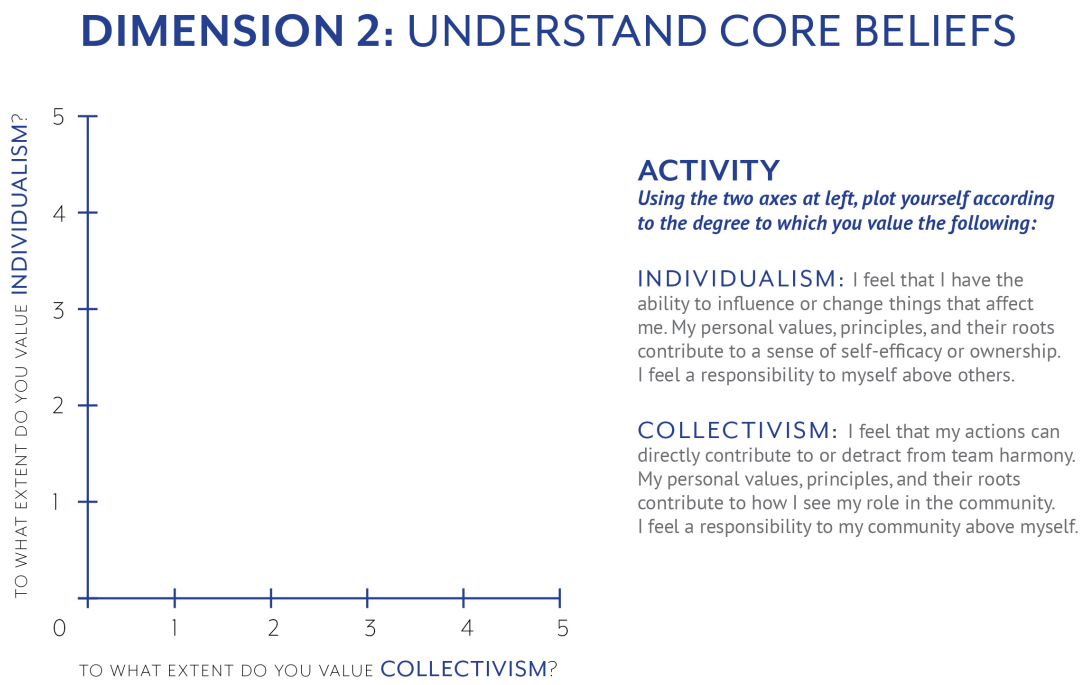

Figure 3 *Understand Core Beliefs: Activity. This is a blank scattergram with descriptions for each of the axes. Respondents can choose to what extent they are individual or collective in their work or daily actions. Being able to select from each of the two options acknowledges the blend of characteristics embodied in most people, instead of forcing them to choose one characteristic over another, which may reinforce stereotyping and cultural biases among teammates. This is just one example from the full activity, which invites teams to create these scattergrams for each of the Six Dimensions.*

Incidentally, many teammates who engaged in these hands-on activities (away from the screen) and later shared results with their remote teammates reported a stronger sense of engagement and connection to their team. In courses that include many different teams, visualizing the scattergrams can be done as a large group activity. The approach provided the best of both worlds: hands-on interaction with the Six Dimensions data, and a common point of reference that the team could easily return to when working through challenges. By working with all of these different areas, teams became much more well-equipped to manage some of the challenges highlighted earlier in this paper, such as explaining how teammates express information or different behaviours online. This self- and team-assessment method also enabled participants to get a sense of the whole group in addition to their smaller (in-person or remote) teams within the larger group. Physical displays of the scattergrams can also be digitized and saved in the cloud for quick reference throughout the collaboration.

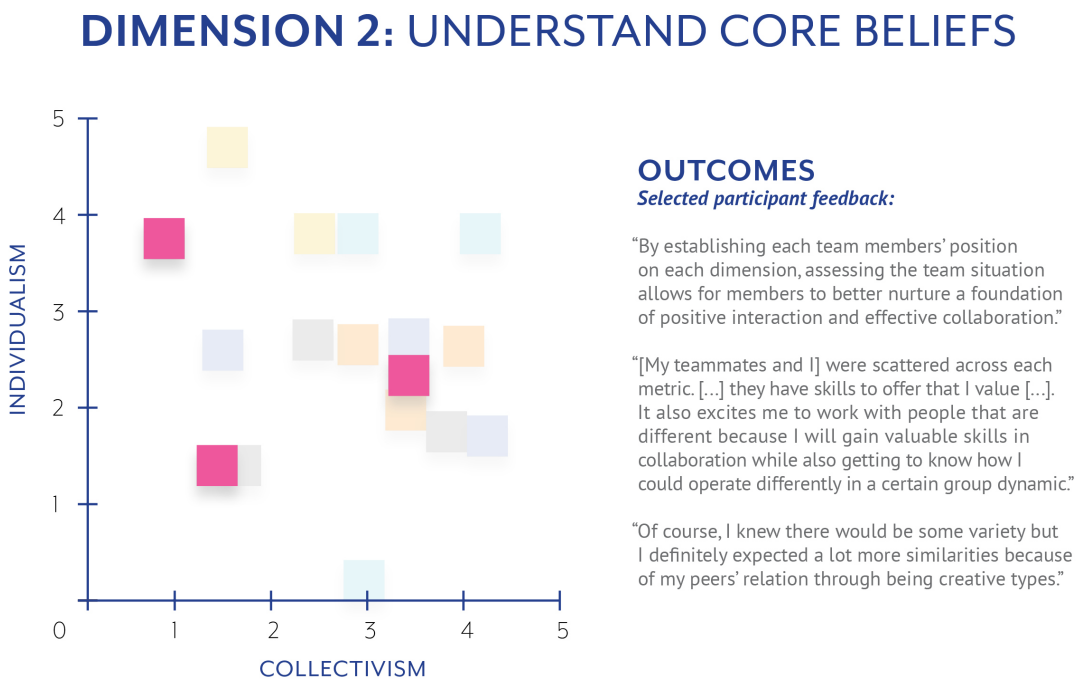

Figure 4 *Understand Core Beliefs: Outcomes. In this example scattergram, Understand Core Beliefs, each team used a different colour sticky note to plot themselves and each other relative to the two axes. The design of the scattergrams enables each team to discover and discuss teammates' characteristics. One team is highlighted here (pink squares) to illustrate the wide range of results that can manifest between individuals. Quotes at left illustrate the value participants saw in this activity.*

In addition to serving as a self-assessment for individuals and their diverse teams, the Six Dimensions of Intercultural Teamwork catalyse critical conversations among teammates while providing an organizational framework for their working process. In the context of a collaborative team, visualizing individual inclinations and work habits enable teammates to proactively discuss differences as assets and to anticipate ways to productively utilise or work through them together.

4. Analysis & Discussion

This section discusses and analyses both theoretical and applied outcomes in terms of the significance of the Six Dimensions of Intercultural Teamwork. In comparing the outcomes of cohorts who applied some aspects of the Six Dimensions framework before embarking on project work to cohorts who did not utilise the Six Dimensions, those who engaged with the framework self-reported better outcomes in terms of team cohesion and satisfaction, and were more likely to deliver finished products on time. The majority of participants who utilise some or all aspects of the Six Dimensions describe their team's final product as including multiple perspectives and / or moving beyond any idea they would have had if working alone.

The Six Dimensions of Intercultural Teamwork work in parallel to the design process, which describes a methodology for evolving an idea. This correspondence is significant because effective learning about teammates is essential to supporting intercultural collaboration, and effective learning about a topic is necessary for the design process to have an effective outcome. The design process itself is action-oriented, with progressive phases that overlap. The Six Dimensions also encompass a progressive evolution that addresses the problem of building interpersonal connections between teammates alongside the issue of helping teams figure out how to approach a project together.

The conversations prompted by the Six Dimensions scattergrams are a hallmark of their efficacy. Perhaps one reason teams can more easily discuss their scattergrams is because assessing oneself along the Six Dimensions of Intercultural Teamwork is not about defining individuals in absolute terms. The framework is flexible in order to accommodate the nuances and apparent contradictions inherent to human nature. For example, an individual may simultaneously embody feelings of independence and interdependence, may practice both indirect and direct communication depending on the situation, or could place equal significance on objective and subjective information. An important component of understanding these dichotomies, however, are an individual's preferences for working in group settings.

5. Conclusion

As higher education continues to respond to COVID-19 by transitioning to remote working and learning environments, communication and collaboration in remote teams have become essential parts of the classroom experience for many. As such, the Six Dimensions of Intercultural Teamwork are transferable. Diverse teams and collaboration opportunities exist beyond design, creative disciplines, and the classroom. The authors therefore hypothesize that this framework will have wider applications across many disciplines and contexts. Designing optimal collaborative experiences is particularly pressing in this moment when the need to create resilient plans for continuity of education at all levels is paramount.

International and diverse teams are essential as designers and non-designers unite across disciplines to improve wicked problems (Emans & Murdoch-Kitt, 2018; 2017). Moreover, the findings presented in this paper suggest an approach to innovation that integrates remote and collaborative methods into the process of teamwork to enable designers to see a problem holistically and understand the interconnectedness of communities, organizations, and other stakeholders. Empowering diverse teams to work better together not only helps them to come up with better ideas or pursue difficult problems, it also addresses a widespread need to instil cultural appreciation and respect while expanding the range of voices who contribute to global discourse and social progress (Resnick, 2016).

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Treasure Hunting: an exploratory study of how designers and scientists identify potential collaborative projects

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Abstract: Design and science collaborations are becoming increasingly common. Yet we have little understanding of how both designers and scientists identify what makes a good collaborative project brief, a phase we call treasure hunting. We conducted two studies with 18 designers and 10 scientists to better understand this mechanism: how do designers generate ideas from laboratories and how scientists perceive these ideas? We found that designers' strategies rely on identifying the uniqueness of the laboratory's research and their long-term vision. We also identified four strategies to ideate from the laboratories' research: finding new application domains, bringing the research to the hands of the end-user, styling and finding new research directions. In the second study, we presented the resulting ideas back to professors and results suggest that initial designers' ideas —sacrificial ideas— can be a powerful tool to support scientists reframing process.

Keywords: collaboration; interdisciplinarity; design brief

1. Introduction

Natural science and design collaborations are becoming increasingly common, from collaboratively developing a proof of concept for an oxygen-mask (Driver, Peralta, & Moultrie, 2011), to exploring the future of synthetic biology using a speculative design approach (Ginsberg, Calvert, Schyfter, Elfick, & Endy, 2014; Catts & Zurr, 2014; Sawa, 2016) or investigating novel ways to explain complex quantum physics' concepts (Gentes, Renon, & Bobroff, 2016; Bobroff, Azambourg, Chambon, & Rodriguez, 2014). To better understand these collaborations, a growing body of research has been focusing on identifying their potential benefits. Rust argued that "designers can act as provocateurs in the early stages of interdisciplinary work"(Rust, 2007) and foresaw that they could help scientist seeing things in a new light. In their study of three different collaborative projects between designers and scientists, Driver et al. (2011) identified three major contributions designers could bring to

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science, namely "supporting the commercialization of new technology, steering the research direction, and assisting with the communication of science". Moultrie showed the different roles that design "demonstrators", prototypes and mock-ups can have to support research (Moultrie, 2015). Beyond supporting research, Dance reported that collaborations also helped biologists broaden their perspective of what "design" could do (Dance, 2015).

In their review of design and science collaboration, Peralta and Moultrie proposed a model of design-science collaborations divided in four different levels of research engagement (Peralta & Moultrie, 2010). In the first level, designers work as executants, performing design tasks assigned by the research group, such as prototyping for example. In the second level, designers are part of the research group, but their contributions are focused on specific "design issues" such as exploring design concepts based on existing research. In the third level, design activities are related to the research questions, such as creating tools for scientists, but scientists still drive the research agenda. In the last level, designers and scientists "team up to define the research questions and to find its answers". Peralta and Moultrie as well as Driver et al. who studied collaborations in the context of a technology transfer initiative call for developing this last type of collaboration. However, it is also the most challenging type of collaboration: as pointed out by Driver et al., full collaborations with designers are sometimes still received with doubts by scientists. In a series of interviews they conducted with scientists to gauge their initial perceptions of designers, they reported that "scientists were generally sceptical about the potential for industrial designers to contribute to early stages of scientific research" (Driver et al., 2011). Therefore, understanding how designers and scientists can identify project ideas for full collaborations remains an open challenge. In this paper, our aim is to describe the existing strategies for generating ideas for collaborative projects. This is a first step to help us develop tools and methods that better support the initial collaboration phase.

2. Background

This research project started in the context of a "design lab". In 2017, a small team of graduates from the Royal College of Art was invited to reside within a large research institute of industrial sciences in Tokyo. The institute has over 110 laboratories spanning all natural and industrial sciences. The initial goal was to develop design-science collaborations aiming at, eventually, "turning science into deployable innovation". To launch the project, the design team started by inquiring in the different laboratories to identify relevant research and generate collaborative project ideas. This activity was initially carried out in an ad-hoc manner with designers visiting different research laboratories. The term "treasure hunting" was coined by the design team to describe this emerging design activity. The most promising initial ideas were then developed further by a team of scientists and designers for a couple of months and the three resulting projects were exhibited at national (The National Art Center, Tokyo, 2018) and international venues (Ars Electronica 2017). As participant observers during the initial year, we identified the key role played by the "Treasure Hunting" phase in ensuring a fruitful collaboration and identified the need to better understand this process.

In most traditional approaches, as well as most design research, designers start ideating based on briefs provided by clients (Ryd, 2004; Gonçalves, Cardoso, & Badke-Schaub, 2016) or design problem statements (Silk, Daly, Jablokow, Yilmaz, & Berg, 2014) given in pedagogical contexts. Scientists have shown that these initial definitions of the project space can deeply impact designers' ideation process depending on the stimuli provided (Koronis, Silva, Kang, & others, 2018; Encinas et al., 2018) as well as according to the designer's perception of what is appropriate or possible (Eckert, Stacey, & Clarkson, 2004). However, as mentioned by Paton and Dorst "the activities associated with the creation of a brief and the negotiations for its (re)definition are not often examined" (Paton & Dorst, 2011). In fact, many designers are already creating their own briefs or even working without ones, using different strategies to initiate their project, including ethnography (Barab, Thomas, Dodge, Squire, & Newell, 2004), material-first approaches (Karana, Blauwhoff, Hultink, & Camere, 2018; Fischmeister, 1989), critical design approaches (Bardzell & Bardzell, 2013) or technology-driven innovation (Yoshioka-Kobayashi, 2018).

In the context of design-science collaborations, case study analysed by Drive and colleagues were originally selected by the university technology transfer office (Driver, Peralta Mahecha, & Moultrie, 2012). Scientists found this approach limiting as it prevents designers from participating in early stage research. While a few studies have explored the impact of briefs on creativity, we have very little insight into less conventional briefs, such as the initial project ideas we observed, especially when designers and scientists need to generate project ideas that show potential value for both communities of practice.

In this paper, we are interested in understanding what are designers and scientists' strategies for identifying promising ideas for collaboration. This first step will help us develop tools and methods to better support this initial phase. Grounded in our preliminary observations and interviews, we designed two complementary exploratory studies that operationalize the observed treasure hunting process. The first study focuses on understanding what are designers' strategies for identifying relevant research and generating ideas based on it. The second study focuses on analysing how scientists interpret and engage with designers' ideas. Given the current lack of understanding about the treasure hunting process, our goal is not to test hypotheses, but rather to create comparable conditions —structured observation— for identifying common patterns and differences that emerge, despite the highly individual nature of the activity (Garcia, Tsandilas, Agon, & Mackay, 2014; Ciolfi Felice, Fdili Alaoui, & Mackay, 2018).

3. Study 1 – Treasure Hunting

With this first study, we have two research questions: when first visiting laboratories, what are designers' strategies for identifying relevant research and what are their strategies to generate ideas from it.

3.1 Method

We recruited 18 professional designers living in Tokyo. Participants' ages ranged from 24 to 50 (average: 33). We used purposive sampling (Arber, 2001) to gather a relatively varied sample of designers in terms of design disciplines in order to elicit as diverse design views as possible. Design disciplines included graphic designers, UX/UI designers, product designers, space designer, service designer and character designer. In our pre-questionnaire, designers who enrolled reported having a strong interest in science (average: 4.44/5). However, most of them had never worked with scientists before (11 out of 16).

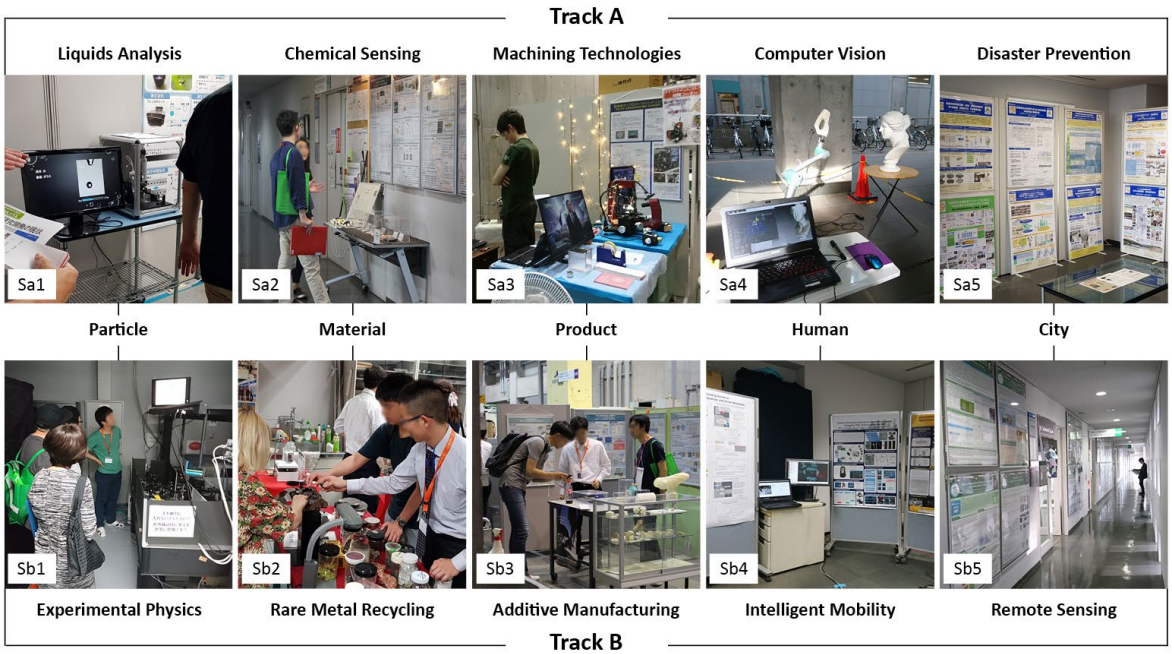

Figure 1 *Each of the chosen laboratory presents their research through scientific posters, samples and demonstrations. Half of the designers (Da1 to Da9) visited the five laboratories of track A, and the remaining half visited the five laboratories of track B (Db1 to Db9)*

We designed the study in the context of the "open-campus day". During that event, laboratories open their door, using posters and demos to present their research to the public. The research institute is divided into five different departments working on particle, material, product, human and city scales respectively. Each designer visited one laboratory per department, in order to observe how different types of laboratory might influence the quantity and types of ideas generated by designers (Figure 1). To avoid having several participants present in the same laboratory at any given time, we devised two treasure hunting tracks and randomly assigned participants: half of the participants (Da1 to Da9) visited the five laboratories of track A, and the remaining half visited the five laboratories of track B (Db1 to Db9). To select two laboratories from each department, we sampled the laboratories who appeared to make the most effort for the open day.

Before the study, we asked participants to fill in a pre-questionnaire about their background

and their relationship with science. On the day of the study, we gave each participant a prepared itinerary with five laboratories to visit (figure 2). We instructed them to spend 10 to 15 minutes in each lab in order to be able to complete the study in 2.5 hours. In each lab, we asked them to engage with the research and sketch or write ideas that might stem from it on the dedicated idea sheets. We, on purpose, did not characterize the type of ideas we were expecting because we wanted to observe what types of ideas designers would generate. We also explicitly told them that it was not a problem if they didn't have any. We gave each participant an instant camera and asked them to take photographs of the things they found inspiring in each lab. Before exiting each laboratory, we asked them to fill in a one-page questionnaire sheet about this laboratory. After visiting all the laboratories, we asked designers to fill a post-questionnaire about their experience doing treasure hunting. We also conducted semi-structured interviews that lasted between 15 and 30 minutes each, using the ideas as starting point (Barton, 2015). We had two main goals: eliciting their strategies for treasure hunting and eliciting the origin of the design ideas. We audio recorded and took notes during interviews.

We analysed the collected material using the Braun and Clarke approach to thematic analysis (Clarke & Braun, 2014), where coding is flexible and evolves throughout the coding process. To answer our two research questions, we conducted two different analyses. We first analysed the designers' strategies for doing treasure hunting. We then analysed the rationale behind the ideas. Two authors respectively identified categories in an inductive manner and we regularly met to discuss the data, the coding and our interpretations, to ensure that they were coherent, comprehensive and reflective of the actual data. In the result section we provide counts of frequency, not as a way to rank strategies, but instead to "to guide the further interpretation of data" (Morgan, 1993).

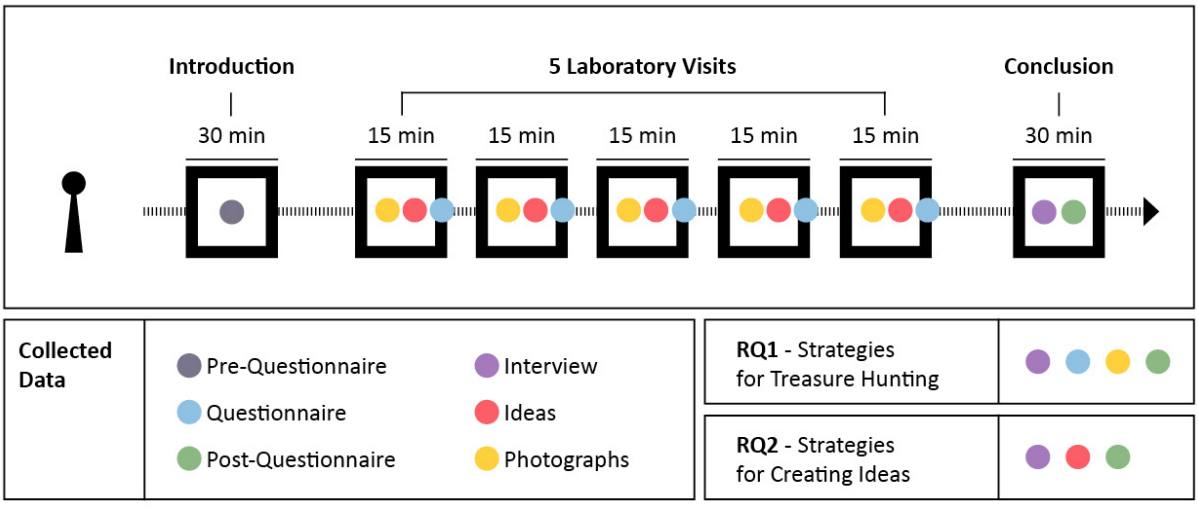

Figure 2 *After filling a pre-questionnaire, each participant visited five laboratories. In each laboratory they took photographs, generated ideas from the research and filled a questionnaire. At the end of the session, we conducted a semi-structured interview and participants filled a post-questionnaire.*

3.2 Results

The key element in the treasure hunting process identified by designers was the conversation with scientists. In most cases (70%) designers engaged in conversations with scientists in the laboratories they visited. Overall, designers were more likely to find ideas when they talk with scientists (93%) than when they did not (73%). When we tried to understand why that was the case, Da2 explained about the posters on display: "It is like if I tried to read a research paper in 5 minutes". This suggests that the type of visual prompts used by labs, mainly scientific posters or demos, are generally not sufficient to support designers' understanding and ideation.

Designers identified key questions that would lead to interesting insights: one key strategy mentioned by half of the designers is understanding the uniqueness of the lab and the strength that distinguishes them from other labs. For Da3, for example, "There is a unique point in the technology, [...] ideas should critically use this unique point". For example, in the intelligent mobility lab (Sb4) it was hard for Da9 to ideate because he thought that "this research is good, but […] other research centres can do the same thing. It's too common". Similarly, Db1 explained about the liquid analysis lab (Sa1): "basically I understood the explanation from the researchers, […] but I didn't understand what the unique point of the research was". A second strategy mentioned by 4 designers is to inquire about the scientist's motivation to do this research and long-term vision: "why do they do this research?', or "what is the researcher's dream".

One of the key questions we wanted to explore was how different laboratories might be more suited for designers to generate ideas than others. Designers generally managed to propose at least one idea per laboratory. They couldn't find ideas in only 13% of the case. However, the number of ideas greatly varied according to the laboratory (from 3 to 17 ideas per lab, average: 9.2). We didn't find evidence of differences between laboratories working at very large or very small scale, as none of the designers mentioned the scale of the research as being an issue to ideate. However, in the interviews, we identified two main factors that seem to influence designer's ease of ideation.

We found that for designers, there is a "sweet spot" for getting ideas in laboratories as well as two difficulties of opposite nature (Figure 3). On one hand, if a laboratory has a too specific and narrow application area, it becomes difficult for designers to generate ideas. In that case, designers feel that there is not much left to design anymore: "as a designer it's easier to think of idea if they don't know how to use it, how to apply it for society. But here, I don't know what to do for them as they already know what to do." (Da9). On the other hand, when the scientists did not have any idea about potential applications for their research, it was also very difficult for designers to find ideas.

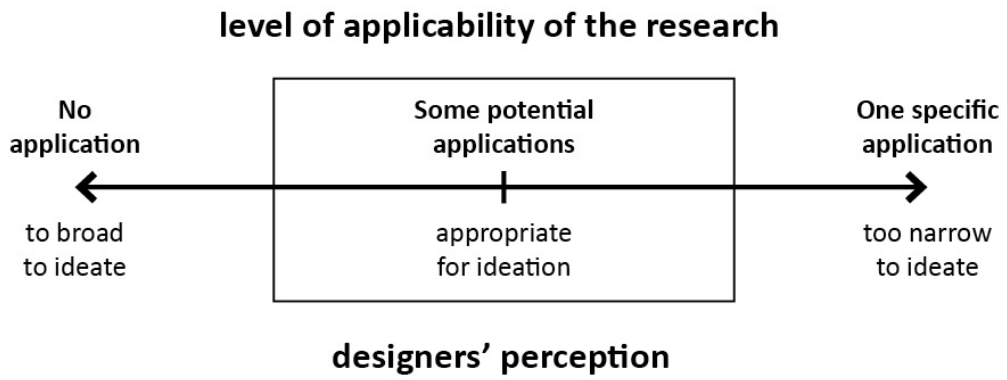

Figure 3 *Representation of the correspondence between the level of applicability of the research and the designer's perception. Designers find it most difficult to ideate when they perceive the laboratory to have no application for their research, or if it has only one specific application. In the middle is the sweet spot for designers to ideate, when there are some potential applications.*

For example, Da9 was facing this problem in Sb3 lab: "This (additive manufacturing) is a too basic technology that can be applied to everything. It doesn't create new things, but we can apply it to new things". In that case, the laboratory focuses on optimizing existing processes and technologies. This was also the main issue identified by designers about the experimental physics lab (Sb1) whose research was perceived as very fundamental by designers and had no direct connection with daily life applications.

The 18 participants generated a total of 91 ideas (Figure 4). In this section we focus on understanding designers' strategies for creating ideas from the laboratories' research. Our analysis revealed that the majority of ideas proposed by designers focused on bringing the research and technologies developed by the laboratories into the hands end-users (39 ideas). For example, in the metal recycling lab (Sb2), Da2 wanted to create "an iPhone grinder" that people could use to grind their used smartphone. Da2's idea was to embed the technology developed by the lab into a home appliance that could be used directly by people at home.

We identified 3 different strategies to bring the research in the hands of the users: changing the scale, changing the quality or creating new applications for existing research or technology developed in the laboratories (Figure 5). The most common way for designers to ideate was to find new applications for the technology or the research performed in the laboratories. In Sb4 laboratory, designers proposed many new applications for using Sb4's computer vision algorithms, including analysing what pet or babies think when their intentions are difficult to understand (Da4), showing the stress level of a person to understand which persons are "good for you" (Da3) or analysing which items customers took in the store (Da7).

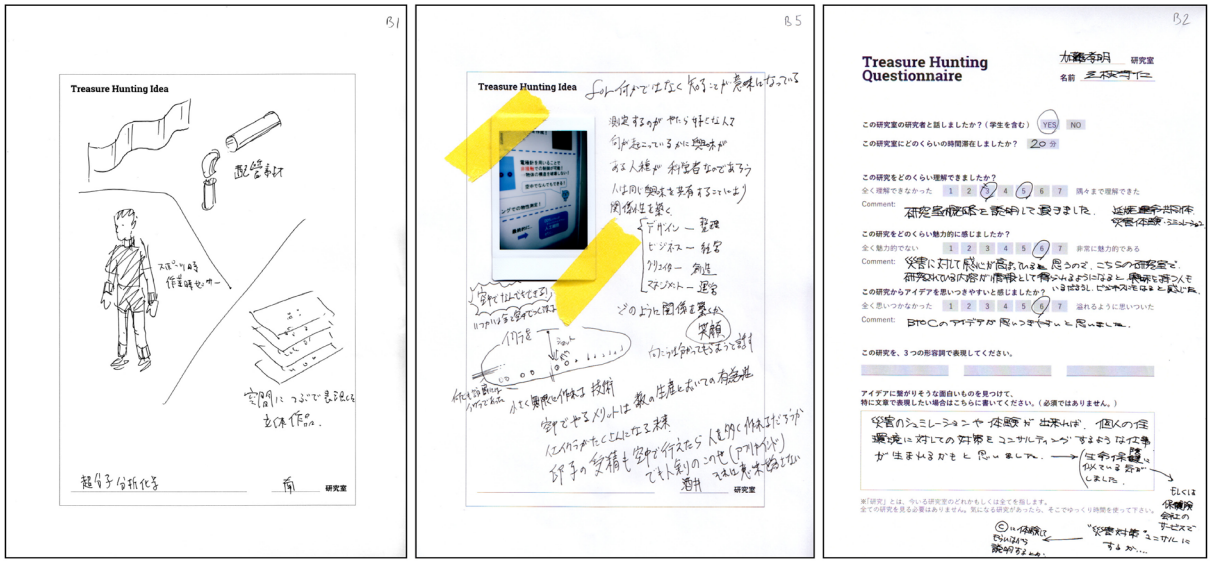

Figure 4 *Three examples of participants idea representations: Db1 used mainly sketch, Db5 described her thought process onto the idea sheet and Db2 preferred to use the questionnaire to express her ideas.*

Another strategy is to change the scale of the technology. Using sensors developed in Sa2 lab, who is working at a very small scale, Db8 wanted to visualize the city personality from the river data. In this case, he scaled up the research to make it usable at city scale. Db5 wanted to apply Sa1's technique to prototype human-scale products such as chairs instead of their current tiny scale printouts.

A third strategy proposed by designers is to improve the quality of the research output to make it acceptable as a product: for example, in the computer vision lab (Sa4), Db2 proposed a way to improve the quality of the virtual reality demo presented to make it a product suited for end-users.

Beyond this first approach designers also used the research for its aesthetic qualities and wanted to display it in either art pieces or exhibition for helping people understand the research (16 ideas). The objective is here to promote the research by using its aesthetic qualities. From the interviews, we found that this was one of the common strategies when it was difficult to think of new use cases. For example, Da5 and Da7 had ideas about using lasers for creating interactive art or stage effect in Sb1 Lab. Db3, in the additive manufacturing lab (Sb3), wanted to create tiny 3D sculptures or jewellery.

Designers sometimes proposed reflections about the impact that the research (7 ideas) and technology would have on the world, proposing scenarios on how the technology would impact society. For example, Db5 speculated about how the computer vision lab (Sa4) changes the value of material. If things can easily be copied and reproduced, then what is the value of real materials? Similarly, when Db2 discovered Sa5 lab's research about disaster spreading, he thought that it could dramatically affect the price of house and land if people could easily have access to this data.

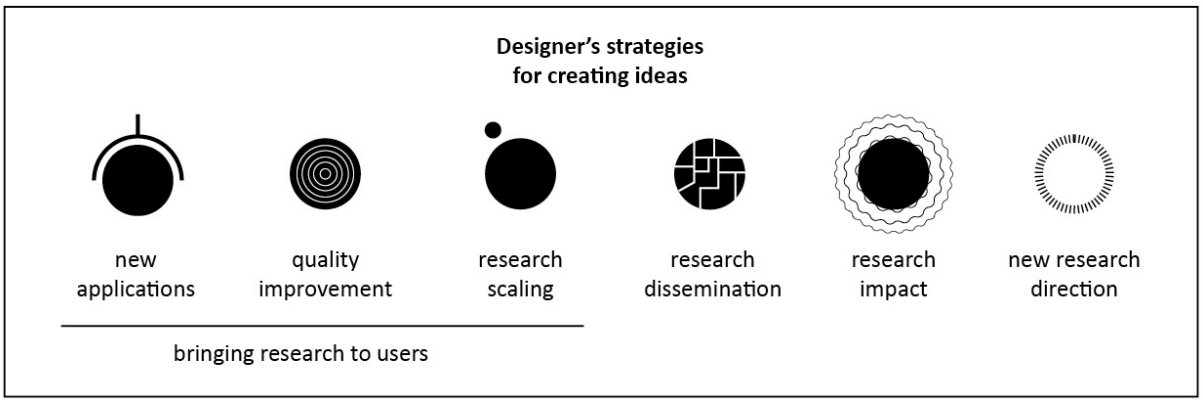

Figure 5 Summary of the designers' strategies for creating ideas.

In a few rare cases (4 ideas), designers proposed either new research directions or methods. For example, in the chemical sensor lab (Sa3), Db7 thought that by using machine learning, scientists in the laboratory would be able to find patterns of deterioration. Similarly, Db8 proposed a different strategy for collecting data for the computer vision lab (Sa4), by crowdsourcing data collection from individuals in their neighbourhood. In the remote sensing lab (Sb5), Da3 thought that creating a map that emphasizes the parts that changed a lot could help scientists understand the place at a glance and more easily analyse their data.

4. Study 2 – Going back to scientists

In study 1, we gathered ideas created by designer inspired by laboratories. In this second phase, we wanted to explore scientists' perception of designers' ideas: which ideas would they find interesting to develop and why. From Feast's observations (Feast, 2012), we know the importance of having tacit permission to critique ideas as necessary for constructing collective understanding in interdisciplinary collaboration, so we chose to act as proxy for presenting the ideas back to the professors.

4.1 Method

We conducted this study with the same ten laboratories we had selected for Study 1. We recruited either the head researcher of the lab or a senior researcher with at least 5 years of experience in the laboratory. Among the participants, two professors (Sb2 and Sb3) had already an experience collaborating with an industrial designer. In Sb5's case, the professor had also asked 5 PhD students to join the meeting, for education purposes.

Before the study, to facilitate the comparison between ideas and avoid bias caused by the different types of representation and their quality across designers, we redrew all of them. We generated representations of all the ideas created by the designers by either replicating the designer's illustration or creating one based on the textual description when designers had not drawn the idea. One author drew all the illustrations of each laboratory to ensure a coherent style across ideas. Each session lasted one hour. We first explained the purpose of

our study, the process behind the idea creation and introduced in random order all the ideas created for that laboratory. We first asked scientists to freely comment each idea during the presentation and we probed for the reasons behind their opinions. In order to elicit idea comparison, we also created two different scales: Research Understanding, ranging from "too far from the research" to "building on the research"; and Usefulness, ranging from "unusable" to "useful". At the end of each session, we asked scientists to put all the ideas along the two scales printed on paper and we asked them to verbalize their reasoning.

We audio recorded the sessions and the two authors took notes during interviews. We also took pictures of the different steps of the scale exercise and we later transcribed the interviews. Following the same analysis protocol defined in the first study, we analysed the interviews using the Clarke and Braun approach to thematic analysis (Clarke & Braun, 2014), focusing on professors' strategies to judge ideas. As we could observe with Sb5's PhD students, judging ideas in not an objective task and two scientists from a same laboratory might have different perspectives on the same idea. Therefore, we focus here on uncovering the breadth of possible interpretations. In our scale exercise, we deliberately chose the ambiguous word of usefulness to foster the conversation with scientists. We wanted professors to tell us how, in their opinion, designers' ideas could become useful for them. From the conversation and the scale exercise, we identified 2 main types of usefulness: usefulness for research: by providing new research direction, or usefulness for society: by disseminating the content of the research to a general audience, by deploying the research into products usable by the public or by establishing partnerships with other collaborators.

4.2 Results

Unsurprisingly, scientists judged the ideas as unusable when they felt they had already been done, or when they were perceived as too distant from the laboratory's research (Sb3, Sb1, Sa5 & Sa4). In the experimental physics' lab (Sb1) for example, one idea was about using visible lasers but Sb1's research is about infrared lasers, which are not visible. Even when designers created ideas that were related with the research conducted in the lab, another difficulty for producing relevant ideas was understanding the unique weakness and strength of the research developed in the lab. For example, Sb2 lab works on recycling titanium and many designers proposed new applications for using titanium. However, in most cases, Sb2 found that the same idea could be developed using other metals for a cheaper price. This confirms the intuition that many designers had identified during the first study about the importance of understanding the uniqueness of the lab's technology or research for establishing a good collaborative project brief. However, perfectly understanding the research was not necessarily a prerequisite for producing useful ideas. When designers had slightly misunderstood the research, they were sometimes able to generate ideas that professors had never thought about, but sparked interest for them. For example, a designer proposed to use laser for ID control. At first, the scientist was puzzled by the idea, but as he gradually made sense of it, he realized that this could become a new research topic.

Beyond research understanding, we identified a tension around the novelty of the ideas.

The ideas that were deemed most useful by the scientists were either the ones that were completely novel for them, such as the one we just described, or, on the contrary, ideas that aligned well with existing goals. When scientists had already had the same idea, they had already been assessing its potential from their perspective. Therefore, some of the most useful ideas were also ones that scientists had previously wanted to develop. For example, Sa4 found especially useful an idea about sensing and visualizing pollen using VR because several people had already suggested the idea to him before so he thought that it could become commercially successful.

During this second study, we found that scientists actively engaged with the ideas: interpreting them, drawing connection with their research and evaluating their potential from their perspective. In that sense, scientists engaged in reframing. Given the time constraint, ideas developed by designers were minimal, but their abstraction allowed scientists to interpret them in their own terms. They started inquiring about more specific details that they needed from designers in order to develop the ideas and identified key questions that designers would need to answer in order to proceed further with the project. For example, when an idea proposed to use tape to fix train and cars, Sa3 explained that he needs more detail, including: “should there be a remaining space between parts or not” and “is it ok if the connection is flexible”. Scientists also appropriated the ideas in their own terms, by providing more precise technical vocabulary and notions. Sa3, for example, wanted to better define the terms used in an idea about haptic feedback.

Ideas became steppingstones that allowed scientists to reflect about the next steps: if they were to develop this idea, what would they need to do, know or experiment on. In the experimental physics’ lab (Sb1), one of the ideas was very close to his “long-term dream”, which is to use lasers to fold molecules, a vision that is not directly understandable from his daily research. In that case, he explained the future steps and experiments needed to reach this outcome. Professors also tried to propose technical solutions to the ideas. Reacting to an idea that wanted to use laser for visual effects on stage and instead of rejecting the idea because the infra-red lasers he is using in his research cannot be seen, Sb1 proposed a technical solution: “using invisible light, it is sometimes possible to emit visible light with some material”. On the other hand, scientists also used their knowledge in the field to justify why some ideas could not work and, in doing so, they explained some of the current limits and constraints of their research. In that sense, designers’ ideas were instrumental in allowing scientists to define more precisely their research. For example, Sa2 explained the current limitation in realizing sensor sheets for supporting athletes: “We can measure the lactic acid, we are trying to achieve real time monitoring, but we haven’t succeeded yet”. Similarly, Sa3 explained that he had been trying to achieve the idea of extracting human skills to teach robots to perform the same task, but that not all human movements are necessary. Instead, if we could create better machining tools, we might be able to avoid using human movements altogether. In that case, the designer’s idea was not directly useful but helped Sa3 explain some of the critical constraints and opportunities in his research.

5. Discussion

In their paper on "miscommunication", Torrisi and Hall showed how ambiguity can be a productive design trigger when it happens during the initial idea generation phase in interdisciplinary teams (Torrisi & Hall, 2013). Ambiguity played a crucial role at two moments. First, designers themselves felt that they did not perfectly understand the research when they visited the laboratories, especially because of the limited amount of time devoted for this phase. In some cases, this initial limited understanding of the research led them to produce ideas that were surprising to the scientists. This was the case, for example, for the idea about using laser for ID control in Sa1 lab that opened a potential new avenue for research for him. In that sense, ideas became probes (Mattelmäki, 2008; Bowen, 2007), tools that could be used to gain a better understanding of the research context. What matters most is not the intrinsic quality of the idea, but how well it could help to set up the conversation at the right level of detail about the research. This echoes the notion of "sacrificial ideas", a strategy first developed by Berstein (2011) where ideas are "meant to be jumping-off points for discussion and innovation". Välk, Maudet & Mougenot's exploratory study (Välk, Maudet, & Mougenot, 2019) also suggest that boundary objects play a critical role in designers and scientists' conversations. While this initial research suggests that sacrificial ideas could become a useful tool in the treasure hunting phase, future research should investigate sacrificial ideas more thoroughly in order to understand its potential value as a design methodology for design and science collaboration.

6. Conclusion

In this paper, we presented two exploratory studies to investigate how designers and scientists can generate project briefs for collaboration. In the first study focusing on designers' strategies for identifying relevant research and generating ideas from it, we found that the relevant information is generally not available in the materials produced by scientists and require deeper probing through conversation with scientists. Understanding the uniqueness of the laboratory as well as its vision beyond the daily work was especially important for designers. We also analysed some of the main strategies used by designers to ideate from the research, especially bringing the research into the hands of the end-user by adapting its scale or finding new potential applications for it. In the second study, we found that scientists engaged with the ideas as part of a reframing process during which they were able to appropriate the ideas from their perspective. We also observed how a medium research understanding can still lead to useful ideas by provoking surprise and nudging scientists into exploring novel avenues for their research. In this exploratory study, we operationalized the treasure hunting process into two distinct phases in order to facilitate a preliminary analysis. While this approach was productive for providing a first understanding of the strategies and challenges of treasure hunting, we need to complement this research with real case studies that will provide a better understanding of the collaboration. The effect of a longer period of time devoted to exploration and discussion will be especially interesting to observe. This first study also opens doors for developing methods and tools that can

support the treasure hunting process and facilitate designer and scientist collaboration. We identified two especially promising avenues: exploring strategies to present research in a format adapted to designers and exploring the role of sacrificial ideas in treasure hunting.

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The Role of Narrative Thinking in Design: Taking the Mathematical Hall of the London Science Museum as an Example

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Abstract: In daily life, people are accustomed to using narrative thinking to understand, communicate and disseminate information naturally and flexibly. Applying narrative thinking to design is a practical and powerful strategy; here, narrative thinking is the default method and mechanism that supports design. This article combines the research results of narrative and narrative thinking in literature and psychology, and draws on and compares the research methods of design thinking to roughly outline the characteristic framework of narrative thinking purpose, process, cognition and evaluation. It then further integrates the characteristics of narrative thinking into the specific case of the Mathematics Hall of London's Science Museum for innovative research, analyses and interprets the role of narrative thinking from the aspects of theme deduction, meaning construction, integration of elements and interpretation of experience. The paper looks forward to gaining a certain understanding and grasp of the application of narrative thinking in design.

Keywords: narrative; narrative thinking; design; display space

1. Introduction

Narrative encompasses the basic rules and power for how people understand the world, and it is also the basis for human expression of experience. Expressing wishes through narratives is not only reflected in daily life, it also extends to all areas of human society. Under the influence of the narrative turn, more and more design activities have begun to apply narrative research and practice, and the exploration around narrative has become an emerging topic in the current design community. However, in the existing research, the interdisciplinary application of design narratives so far has focused on the concepts, techniques and rules of literary narratives, the deeper narrative thinking logic and mechanism has received very little attention. This article takes a different approach, using narrative thinkin as a method of research design. In addition, this method combines

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literature and psychology, and is based on a narrative theory in literature to outline a set of narrative thinking contours suitable for explaining design. This formulation assumes that narrative thinking can be used as a systematic method of design; that is, narrative thinking is an interpretable pattern feature. This article also uses a specific case of museum exhibition space to analyse the application of narrative thinking in design.

2. Narrative and narrative thinking

2.1 Narrative

Narratives are most often referred to as 'story' and 'storytelling' (Chatman, 1980; Brooks, 1992; Abbott, 2002). This dual concept is mainly derived from narratology, but also includes literary studies, anthropology, psychology and sociolinguistics. In fact, whether it is narratology or other disciplines, the focus of narrative is 'how to tell a story', not 'what is a story', and it refers to the techniques, methods and rules of storytelling (Shen & Wang, 2010; Herman, 2009). In traditional narratology, narrative must have two or more related events—real or fictional—and the events that can be called narratives must be related to people. Without characters, events, such as natural phenomena, cannot be regarded as 'events' of narratives. Second, narratives need to be mediated; there is no narrative in life, narratives are artefacts (Shen & Wang, 2010, p. 2; Prince, 2011, p. 137; Zhao, 2013, p. 10). Narrative as a purposeful communication activity: 'It is someone telling others, on some occasions, for some purpose, telling something happened to someone or something' (Herman, & Phelan, p. 3). In fact, narrative is not only a communication activity, it is also a common way for humans to organize their personal survival experiences and social and cultural experiences. Narrative is everywhere, and it is closely related to human life, with different themes and varieties, transcending the country, history and culture, just like the existence of life.

What mechanism supports the widespread application of narrative? In the academic tradition, some scholars point out that narrative functions as ideogram, media, logic, transformation and aggregation (Meng, 1989, p. 18). Sarbin(1986, p. 9)regards narrative is a way of organizing plots and actions compared to other more traditional organizing principles,it is a combination of ordinary facts and marvellous creations,time and place in this organization are causally combined. Narrative explains how things happen and why they happen through a combination of related events (Morgan, 2017). It is strongly believed that narrative is a human ability that is genetically closely linked to our thinking, as if it were our innate 'deep structure' (Abbott, 2012, p. 4). In a nutshell, the wide application of narrative is the function of the narrative mechanism, while the deeper consciousness is affected by narrative thinking.

2.2 Narrative thinking

Since the 1980s, narrative has been proposed as a mode of cognition. Bruner published *Actual Minds, Possible Worlds* in 1986, which pointed out that human beings have two

different cognitive models: the paradigm mode (also called the scientific mode) and the narrative mode. The paradigm mode mainly uses the method of rational deduction and logical analysis; and the narrative mode deals with human beings or human-like intentions and behaviours and marks the changes and results of their processes. The former focuses on truth and facts, and the latter focuses on the possibilities and vividness of expression (Bruner, 1986, p. 11). The results of scientific thinking are often general and abstract, while the results of narrative thinking are often specific and unique (Robinson & Hawpe, 1986, p. 114). Herman (2009, p. 7) points out that narrative is a way of understanding cognitive structure or experience, and as a resource of communication and interaction, it can be shaped by the practice of storytelling. Robinson and Hawke (1986, p. 111) emphasized that narrative thinking is an inspiring method of causal thinking; the power and versatility of narrative thinking is rooted in cognitive schemas, which are the basis of any story. Robinson and Hawke (1986, p. 112) also believe that narrative thinking involves creating a fit between the situation and the story schema and establishing a suitable one, that is, creating a story from experience is an enlightening process that requires skill, judgement and experience. Rein and Schon (1977, p. 115) argue that the narrative schema is actually a framework process that strategically organizes and drives a solution. As part of this narrative psychology, theorists such as Wertsch (2002, 2008) proposed that narrative templates are the basis of collective narrative, so these templates constitute a common understanding and memory of events and experience. In summary, narrative thinking is mainly thinking through storytelling. It is not only different from paradigm thinking (scientific thinking), it is also closely integrated with paradigm thinking. This thinking mode is a basic way of thinking for humans.

3. Analysis of the mechanism and logical characteristics of narrative thinking

Narrative thinking is not just a human cognitive model. In fact, narrative thinking has become a basic organizational mechanism. The following will selectively explore the mechanism and logical characteristics of narrative thinking from the aspects of purpose, process, cognition and evaluation that are relevant and helpful for design.

3.1 The main purpose is to interpret

Narrative thinking is different from the scientific and rational way of thinking. The latter mainly connects things through positivism, reasoning and logic. As a basic way to understand the world, narrative grasps things and understands the world through plotization (Zhao, 2013, p. 1). In contrast to rational thinking, which aims at prediction, control and change, narrative thinking aims to understand and interpret. It can be said that narrative thinking focuses more on explaining things, and the main purpose is interpretation (Xiang, 2014). This mechanism of interpretation organizes a series of independent events through narrative logic to obtain continuity, and establishes a connection between these independent events. Put another way, if you can’t understand and explain a problem, you can’t talk about predicting, controlling and solving the problem.

If the characteristics of narrative thinking and design thinking can be compared with a feasible hypothesis, it can be determined that, compared to design thinking, focusing on problem discovery and problem solving (Jensen, 2014), in design, the goal is to create as many new specific conditions as possible to meet specific needs (Farrel & Hooker, 2014).

Narrative thinking emphasizes the construction and interpretation of meaning—specifically, to explain a problem. In contrast to solving problems, it is necessary to provide a set of controllable solutions through analysis and prediction, and interpretation provides a method of meaning-based understanding. At the same time, design thinking and narrative thinking are interdependent and complementary. In the process of design thinking, problems such as finding problems, locating problems, developing problems and solving problems are inseparable from the necessary explanations. Therefore, in design thinking, it is often necessary to use narrative thinking to present and explain various processes, such as using storyboards and scene diagrams to explain a problem. For design thinking, good ideas cannot be understood, recognized or implemented unless they are explained well. At the same time, in a design, the problem itself needs to be presented in a specific way. In this way, the design symbol becomes the carrier of explanation. In other words, any interpretation and description must have a carrier and a medium and must have a specific form and symbol. In general, narrative thinking is complementary to design thinking and has a characteristic that emphasizes ‘explaining the problem’.

3.2 Structured process driven by plot

The narrative thinking process brought about by the purpose of interpretation is characterized by a plot-driven structure. Plot is not only a noun, it is also a verb. Aristotle (2015(p. 37) pointed out that the plot is the most important one of the six elements of tragedy, and ‘the plot, that is, the arrangement of events’. Plots are often viewed as an important narrative technique of art processing to achieve a heterogeneous effect. The narrative mode mainly grasps things and understands the world through plot (Zhao, 2013, p. 1). Without plot, the events, fragments, actions, etc. in the narrative cannot form an interconnected and intentional whole, and cannot be understood (Brooks, 1992, p. 5). Plots emphasize the value of causal events, the plot has the power to promote the development of narrative (Herman, 2016, p. 60). Plots can make complex events clear and organized. People describe life events through plot, and listeners understand life through plot.

A structured process, such as literature, must first have an idea or theme after which the narrative can be developed by adding details with specific sentences and paragraphs, which is all driven by the plot. This process is different from the traditional design process, primarily, in the different goals of the two. The generalised design process is to discover the problem through the material, and finally form a solution; the result is a funnel form from large to small. The design process includes not only problem solving but also problem finding, and it is an iterative process (Steen, 2013). The structured process of narrative thinking is different. It is mainly through the connection of the plots between the materials to form a higher-level narrative unit, which ultimately forms a complete novel, script, etc.

The process of narrative thinking vividly and from multiple angles illustrates the theme and concepts through a complex structured work, and finally forms a multi-dimensional and complex structure.

3.3 Context-based cognitive approach

Narrative forms events into contextual meaningful bodies. In contrast to the logic-scientific model, which seeks conditions of universal truth, the narrative model requires a special connection between events. The explanation in the narrative mode is contained in the context, while the logical-scientific explanation is inferred from time and space (Berger, 2006, p. 10). In contrast to illustration science, which uses abstract thinking and logical reasoning, the narrative thinking process mainly depends on specific, plot-related contextual relationships. Narrative is an active mechanism for connecting different objects (Quesenbery & Brooks, 2014, p. 22). It can be said that narrative thinking is a relationship-based way of thinking that emphasizes placing objects in a logically related situation, thereby gaining a holistic grasp of the story.

Narrative thinking brings to the user a kind of relevance and situational cognition. This kind of cognition can enable the viewer to realize that the association and arrangement of elements have a time relationship and a causal relationship. The content and meaning of the interpretation are interconnected; for example, you can trace the cause forward through the effect, or infer the effect through the cause. Narrative thinking is a situational cognitive method that logically associates the objects of meaning interpretation to form a context. Under this logic, discourse and symbols are not presented in isolation, but instead form a background and a figure relationship. In addition, the situational cognition of narrative thinking is not static and solidified; it is a dynamic process of moments and slices that are constantly developing and marching forward. In this kind of situational dynamic process, ideas, viewpoints and meanings are constantly produced, so that the past, present and future form a whole meaning that contains thought and wisdom, for example, using a situation to explain the motivation or purpose of a design so that the design is in an interconnected whole. With the help of the situation, the user's imagination can be triggered, bridging whatever gaps there are in understanding. The situation-based information exchange method is very natural and rich. In this way, a stable carrier is prepared for the narrative; experience can be built on it, and it can be experienced from multiple angles (Wurman, 2001, p. 36).

3.4 Emphasis on vividness as the evaluation criterion

Vividness in the narrative thinking model is used as the basis for the evaluation criteria. Bruner (1986, p. 11)points out that the exemplifying pattern is convinced by authenticity, while the narrative paradigm is convinced by lifelikeness. Foster (2015, p. 81) also believes that a good story should be like a living organism. Aristotle (2015, p. 72)described this vividness thousands of years ago: 'in the creation, the scene in the play should be tried hard, and only then can you see clearly—as if in the event in the field—can be properly handled

without neglecting the contradiction, and every effort should be made to express it in various languages'. It can be said that the emphasis on narrative thinking is more vivid than exemplified thinking, which emphasizes rationality and scientificity.

To sum up: vividness refers to lively, active, impressive and dynamic beauty（He,2010）. From the perspective of experience, it is mainly the richness of the information presented by the media objects to the audience;The vividness can also be decomposed into two dimensions: breadth and depth. The former refers to the senses that the media can stimulate (such as hearing, vision, and touch) Quantity, the latter refers to the extent to which the media can stimulate the senses (Steuer,1992). In general, specific and detailed information is more vivid than abstract information, and pictures and videos are more vivid than text (kim, 2015, p92).

Specific to the field of narrative,, the vividness is reflected in several aspects. The first is specific vividness. Narrative avoids abstraction and rises to the concrete (Prince, 2013, p. 146). As for the interpretation of meaning, the specifics are not abstract, not general, and the details are clear. From the perspective of narrative thinking, this kind of concrete interpretation requires that meaning be placed in a situation where various elements are related to the whole. This specific vividness corresponds to the requirement in the design that it is not Euclidean geometry, but the pursuit of rich details and rich content.

Second, the vividness evaluation standard in narrative thinking requires the narrative to emphasize particularity. The narrative focuses on the particular rather than the general (Prince, 2013, p. 146). It emphasizes a personality to find the difference from the ordinary; it requires keen insight and expression with unique and real needs, which are different from the focus group method, future scenario method, joint analysis method and questionnaire method in design thinking. It emphasizes each living individual, not the general nihilistic group. In fact, design needs to be aware of the real particularity and differentiation, not homogeneous standardization.

3.5 Frame diagram of narrative thinking

The above-mentioned mechanisms of narrative thinking do not operate independently and are often intertwined. Narrative thinking with interpretation as its main purpose needs to be supported by a set of theme-oriented structured processes. This structure is a kind of human mental activity that cooperates, influences and interacts. This thinking mechanism can be consciously marked and explained, which can be further applied in design.

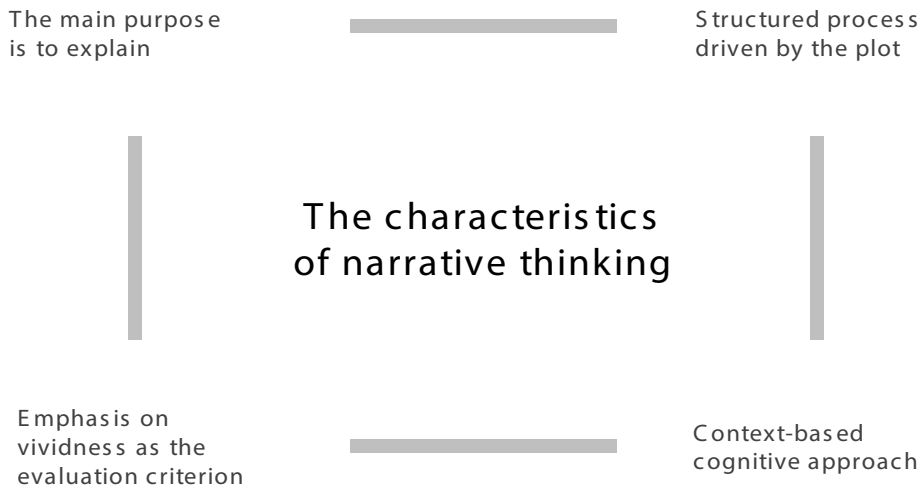

Figure 1 Frame diagram of narrative thinking

4. Taking the Mathematics Hall in London's Science Museum as an example

London's Science Museum, located in central London, has a long history of 150 years. It was founded directly from the Crystal Palace World's Fair held in London in 1851. This fair is usually regarded as the beginning of modern exhibitions. The Mathematics Hall was designed by the famous architect Zaha Hadid's studio. It was opened in 2016 and is a permanent exhibition hall. Since its opening, it has been well received and regarded as a star exhibition hall of the Science Museum. Taking the Mathematics Hall as a case to analyse in depth the role of narrative thinking in the design of museum exhibition space, it is undoubtedly of practical and academic significance. The idea is to apply the mechanism and logic of narrative thinking to spatial design and use the mechanism of narrative thinking to reinterpret and grasp the design.

4.1 Focus on thematic interpretation

'Theme' is derived from the ancient Greek word *thema*. The theme of a work is the idea or concept on which it focuses. The theme emphasizes how the content is related to real life, how life is described, and the various problems, challenges and experiences of life (Brooks, 2014, p. 114). More broadly speaking, the subject is the meaning of the work (Prince, 2016, p. 231). Whether it is a novel, a play or a display space, the theme is one of the most important core elements of a work. Works without a theme often become loose material piles, fragmented into scenes without cohesive elements. For museum exhibition space, a powerful theme can not only integrate scattered information into a meaningful system, it can also play a role in commanding the design of the space and help the audience recognize and

understand the meaning of the display.

In narrative thinking, the structured process mechanism aims at interpretation driven by plot that is, in fact, inseparable from the theme. Applying narrative thinking to the design of museum exhibition space will help make the design pay closer attention to the theme. Attaching importance to the theme means that the design needs to realize that the task is not only to solve the problems of form and technology, but also to reflect the ideas, concepts and meaning of space in the design. For the design of museum exhibition space, attention to the theme can also standardize and unify various elements in the design, which helps develop logical display content and enhance the audience's awareness of the display. Focusing on the theme requires that the theme be reflected and strengthened in the design on the one hand, and all designs require a theme-based framework and strategy. On the other hand, if there is no theme in the requirements given in the previous period, the design effort is required to construct the theme in the design so that the design is more thoughtful and soulful.

The theme of the Mathematics Hall's presentation is 'How Mathematics Shapes Our World'. This theme indicates that the design of space needs to explain and show mathematics around life and show how mathematics is related to our world of life. Based on the design of the exhibition space, the theme is not described in words, but in a visually-oriented way. Good narrative theme needs to have a certain conceptual meaning to avoid the superficial and obscure as much as possible (Lu, 2018, p. 67); it needs to arouse the topic and have multiple interpretations (Hertzberger, 2017, p. 101).

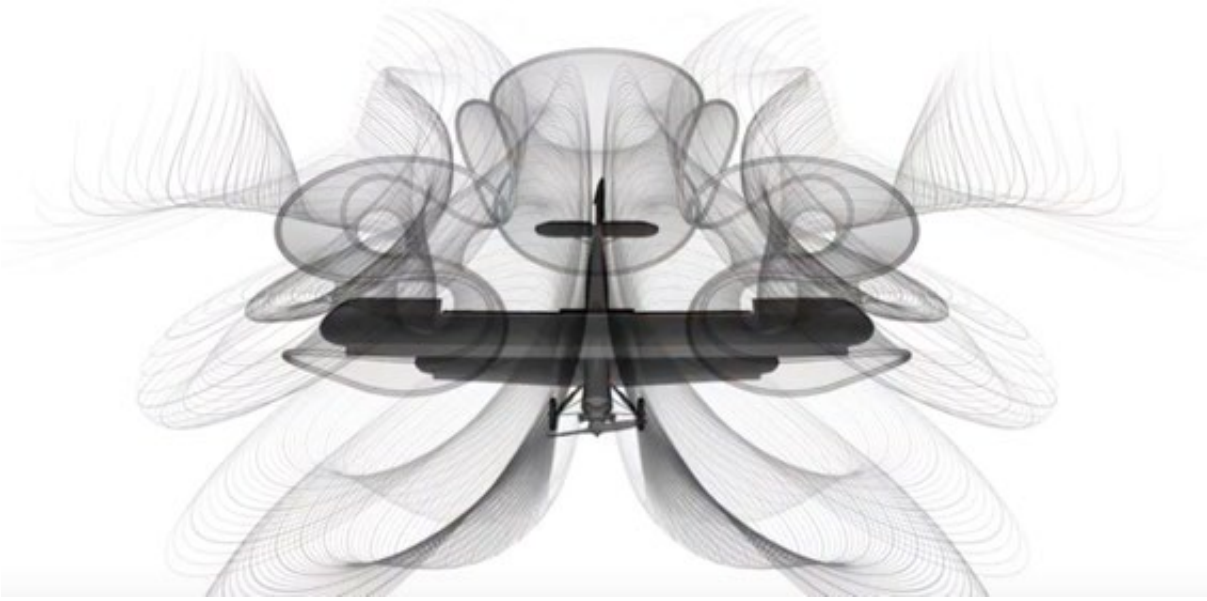

Figure 2 *Thematic interpretation of the exhibition space in the Mathematics Hall of London's Science Museum*

The spatial interpretation of the Mathematics Hall theme was inspired by the daughter of the famous British poet and mathematician, Lord Byron, and computer program founder Ada Lovelace. The design of the plan (2015) coincided with the 200th anniversary of Lovelace's birth. Her 'Notes' reveal the abstract world and logic of the analysis engine. The application of mathematics is extremely valuable, making her famous in the mathematical world. The Science Museum hopes that the Mathematics Hall does not simply display academic mathematics, but emphasizes the application of mathematics. It is necessary to describe mathematics as a practice that affects our technology and changes our way of life. It reflects that mathematics has always been a core tool to promote human understanding of the world and the building the world. The designer took the tribute to the great mathematician as the interpretation of the theme of the space. At the same time, the designer also hopes that the design of this exhibition hall can inspire and encourage more people to participate in the world of mathematics, let the audience experience the innovation and driving of mathematics in daily life from a multi-dimensional perspective, and satisfy the audience's multi-dimensional exploration desire. Eventually, the visual design of the Mathematics Hall was an adaptation of a 1929 airplane. The streamlined space was used as the visual symbol of the overall space. This symbol is directly derived from the concept of aircraft aerodynamics, and this aerodynamics and mathematical geometry and calculations are closely related. Based on this, the design concept was transformed based on aerodynamic space calculation, and its theme is interpreted into a giant space installation (see Figure 2). Not only can the theme of mathematics be narrated through this design, it can also be a space of intention that stimulates the audience's thinking and resonates with the theme so that the space has a narrative event nature and symbolic allegory.

Storytelling cannot exist without themes. Based on narrative thinking, the museum's display space is the same as a novel or a plays. Only by paying attention to the theme in the creation and recognizing the value of the theme can the work have soul so that it can reach the audience more deeply. The heart can make the audience think and feel and help them remember and cherish the story.

4.2 Enabling meaning constructs

Narrative thinking can empower the meaning structure in museum exhibition space design because the ontology of narrative thinking has the ability to construct meaning. As Zhao Yiheng (2013, p. 168) said, events in both the empirical world and the imaginary world need to form meaning through narrative, that is, meaning must exist in various narratives. The narrative process is the process by which people give meaning to events and express this meaning. This 'empowerment' process is the most basic cultural and spiritual behaviour of human beings (Li, 2012). Narrative can give display imagination and create meaning. (Bedford, 2014, p.133). Using narrative mechanism in museum display can create an attractive, meaningful and unforgettable narrative environment (Maclead, Hanks, Hale, 2012). Applying narrative thinking in the design of museum display space can empower meaning, which is a value-added structure of museum display space.

For museum exhibition spaces, this kind of empowerment is first reflected in the infusion of meaning into the structure of meaning. In the organization of meaning, narrative is not a mechanical structural combination. It is destined to involve the narrator's perspective, position, ideas and emotions. These factors will undoubtedly increase the power of meaning construction. It can be said that the application of narrative thinking can make the meaning structure of the museum display space no longer provide a straightforward and arbitrary answer, but a story that compresses emotion, wisdom and philosophy. In this way, narrative can be interpreted and metaphorized into a story with plot, whether historical, biological, cultural or chemical, and then interpreted through this narrative logic among many disciplines. For example, in the theme structure of the Mathematics Hall, there is the connotation of the designer's tribute to Lovelace. With this layer of connotation, the concept of space will not be so pale; it will be more meaningful and embody certain emotions. The theme itself also contains certain ideas and concepts. Here, the word 'our' shows that the meaning construction of this theme has an affinity perspective, which suggests that the interpretive position is to integrate the narrator and the experiencer, and the speaker strives to stand on the viewer. This perspective can easily immerse the audience in the story and create a fascinating desire to continue reading; it can make the audience feel the connection between the theme and themselves, and can share experiences with others..

Second, the construction of meaning in narrative thinking empowers meaning interpretation. When a person is telling his or her own story, it is the subject 'I' who constructs the story with the object 'self' as his/her principal, and it is also the subject 'I' who examines and reflects on the object 'self' (Shi, 2004). Storytelling also gives designers and viewers a sense of empathy. Telling stories requires imagination as does understanding stories. A good story is reasonable and unexpected. This requires that storytelling provide the audience with a plot gap and encourage them to participate in the construction of meaning together, which is essentially an inspiring meaning construction. For example, the organic giant luminous body device at the centre of the exhibition space of the Mathematics Hall unifies the entire hall in a space environment with a stage effect. From the perspective of meaning structure, this device inspires the audience to respond and think through the strong expressiveness of the device, and then complete and fill in the blanks in meaning. At the same time, the answer to this blank is not the choice of A and B, but it gives each person a certain degree of freedom, which is open and inspiring. At the same time, this installation form itself reflects an open, decentralized and inclusive form meaning, which brings the idea to cater for the multicultural needs of contemporary audiences' participation, curiosity and sense of self, and encourages the audience to explore and consider the entire space and its theme. From the perspective of the construction of spatial meaning, the installation of the Mathematics Hall has formed a relatively independent design landscape, which has created a complex interface, has a multi-dimensional sense of layers and enriched the dimensions and connotations of the space interpretation and experience—a value-added meaning construct.



Figure 3 *Thematic interpretation of the exhibition space in the Mathematics Hall of London's Science Museum*

In addition, the empowering significance of narrative thinking lies in digging through the stories behind the exhibits in an effort to find new insights and value, as shown in Figure3, for small aircraft. This is not a brief introduction to what the aircraft is called, when it was produced, etc. Instead, it first makes a very clear statement: without mathematics, the public's dream of flying would be ruined. This narrative method can psychologically hook the audience to further explore the subsequent narrative development.

Then the storyline development of this exhibit is implemented in five units: 1 the birth of civil aviation, 2 mathematics and the civil aviation industry, 3 aircraft safety 4 Frederick Handley Page (British aircraft designer, engineer, aviation entrepreneur, and designer of this exhibit), and 5 the great progress in aircraft design. A more detailed narrative is set up under each unit. It can be seen that this kind of display has not stopped at the introduction of the object itself, but has developed a valuable story around the exhibit, thereby making the exhibit more meaningful. In this way, for the construction of the meaning of empowerment based on narrative thinking, the interpretation of the exhibit is not to stay on the external form of the exhibits, but to dig deeper into the story behind the exhibits, strive to find new insights and value meanings, and activate and excavate the exhibits. The historical experience and culture behind it enrich the content of the exhibits. Only in this way can the audience obtain deeper satisfaction and leave an impression when interpreting the exhibits.

4.3 Rules for integrated elements

Narrative thinking can also provide logic and rules for integrating diverse elements. The narrative has a law of interconnected and intentional elements (Brooks, 1992, p. 5). For the

museum exhibition space, the elements in the space are like the words and phrases of a written text. Although they have independent forms of existence, they cannot present the theme and meaning independently. This requires grammatical connections and combinations between certain logical relationships, so as to integrate them into higher-level spatial elements, such as sentences and paragraphs. The narrative is a whole, a continuous complex of events (Chartman, 2013, p. 7). In this way, narrative thinking can help the scattered and disordered spatial elements to be integrated into a larger spatial structural unit with context and logical order and promote the development of the plot. Because this kind of spatial structure unit has narrative logic and order, it is easy for the audience to perceive and experience it, and ultimately explain and understand the meaning of the overall display. To sum up, narrative thinking can provide two main types of grammar for the integration of display space elements: time-based element integration and theme-based element integration.

The integration of elements based on time means that the events described in the narrative are organized on a time axis (Prince, 2013, p. 65). In the real world, there is usually no obvious time relationship between 'events' or 'elements'. This is the actual state of existence of the world. The museum's display needs to be interpreted. If there is no order relationship between the elements in the display space, it will be difficult to understand because it is too scattered. For narrative thinking, the significance of the integration method based on time elements lies in the ordering of the elements spatially in order of time to make the transmission of meaning possible. Time focuses on beliefs and demands for a sense of order and certainty in the world (Yang, 2007, p. 42). The integration of spatial elements based on time has a strong sense of narrative structure, clear guidance and clear order. From the perspective of the fluidity of time, integrating elements according to time is intuitive because history itself is immersed in the flow of time, and recreating history is organized to make the flow of time visible and allow for the audience's perception and experience.

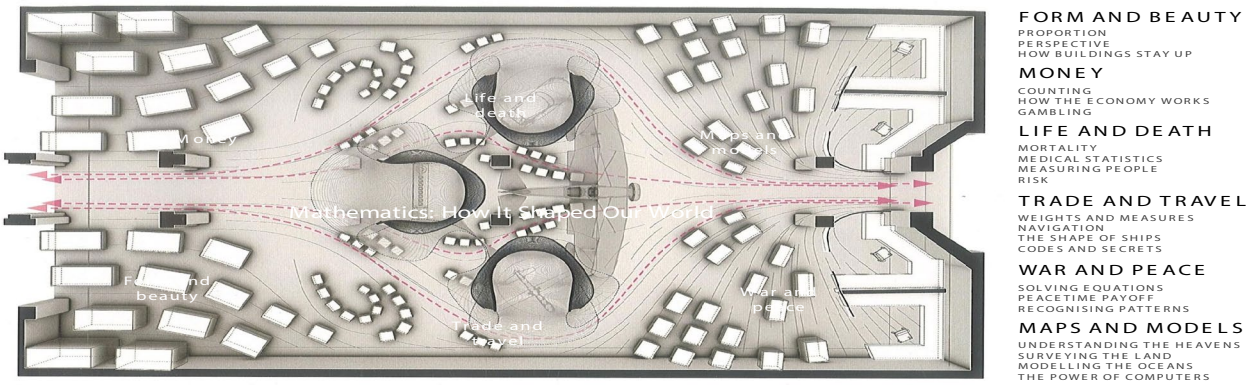

Figure 4 Thematic space layout

Of course, not all museum display space elements can find the chronological relationship associated with them. In this case, themes can be used to integrate the elements to form a

related spatial structure. The integration of theme-based display elements is to group them into a series of sub-themes that can be associated with the primary theme. The characteristic of this narrative connection is that each element in the space has an internal thematic relationship, and there is no time sequence. Each 'theme' is equally important. However, care needs to be taken to ensure that the audience remains connected to the entire subject (Locker, 2011, p. 9). The designers of the Mathematics Hall chose this method to integrate the elements, as shown in the figure below. It contains six sub-themes and 21 terminal themes. From a logical perspective, there is no obvious chronological order between these subtopics and terminal topics, so it is suitable to integrate spatial elements in a thematic way (Figure 4). Based on narrative thinking, the integration of spatial elements based on themes enables the 21 terminal themes and the overall theme to be closely cantered around the theme of mathematics, which can produce a clustering effect. The spatial structure layout brought by this integration of elements is open, and viewers can freely choose interesting points of interest for understanding and exploration. On this basis, different display methods can be set according to each independent terminal theme, such as physical models, visual data display, video loop playback, interactive query devices, etc., to enrich the development and expressiveness of the narrative. The logic-based integration of elements based on the theme of the Mathematics Hall is to use the theme to lead and make coherent the entire space, and guide the creator to further develop specific spatial details through the framework. In this way, the theme guides and regulates the structure of the space. It will not focus on the specific details and ignore the initial goals and directions. It will continuously enrich and emphasize the meaning and value of the theme in the process of spatial expression.

The internal power of narrative thinking promotes the integration and development of elements. The motivation of the narrative moves the narrative process from the beginning, through the middle, to the end (Phelan 2016, p. 6). The motivation of narrative thinking enables the elements in space to form a fusion and symbiotic relationship, rather than independent and obtrusive elements, which allows the audience to actually feel the sense of order and art brought by integration in the experience. For the design of museum exhibition space, the motivation provided by narrative thinking is not a single-channel advancement, but a binary opposite transformation relationship; that is, the museum exhibition space provides the potential of narrative motivation, and the development of this motivation needs the action and reading of the audience to activate and construct, so the plot is derived from the interaction between the audience and the exhibition space. It is narrative power that drives this interaction and promotes the development of space into a continuum with overall significance. In this process, we must always consider the motivation of the audience to read, combine the power of spatial development and the power of their experience to promote orderly display space development, feedback and conversion. Here, the museum display space is a kind of dynamic field composed of complex elements.

4.4 Providing a credible interpretive experience

The narrative thinking based on the vividness as the evaluation standard can also provide a credible means of interpretation for the museum's exhibition space discourse experience. The mechanism of narrative lies in believable suggestions and recognition (Zurlo & Cautela, 2014). The credibility of the knowledge generated by science is mainly based on objective facts as the logical basis and the standard is consistency and testability, while the credibility of narratives mainly comes from fidelity and vividness. The narrative 'truth' is judged by its plausibility rather than verifiability (Xiang, 2014). Specific to the design of museum exhibition space, the vivid and credible interpretation experience mainly comes from the role of fiction and imagination in narrative thinking.

Non-fictional scientific thinking often tells us how life is, and fictional narrative thinking tells us how life should be,it is a pursuit of realism and poetry. Fiction refers to the relationship between a world and things outside its boundaries (Ronen, 2004, p. 15). Without fiction, there is often no narrative (Peng, 2019). From this perspective, we can understand that narrative is fictional, and it is the product of creation, imagination and construction (Peng, 2016). The Mathematics Hall itself is actually a kind of spatial fiction, a real and poetic construction. Each specific mathematical story does not tell the audience exactly what mathematics is, but based on certain exhibits, vivid scenes are formed through fiction to more vividly explain what mathematics can do, how mathematics affects and changes our lives. These do not need to emphasize the authenticity of these scenes here, but focus on the vividness of the narrative of these mathematical stories, and then use this vividness to capture the audience's attention, so they can understand and recognize the purpose and appeal of the display.

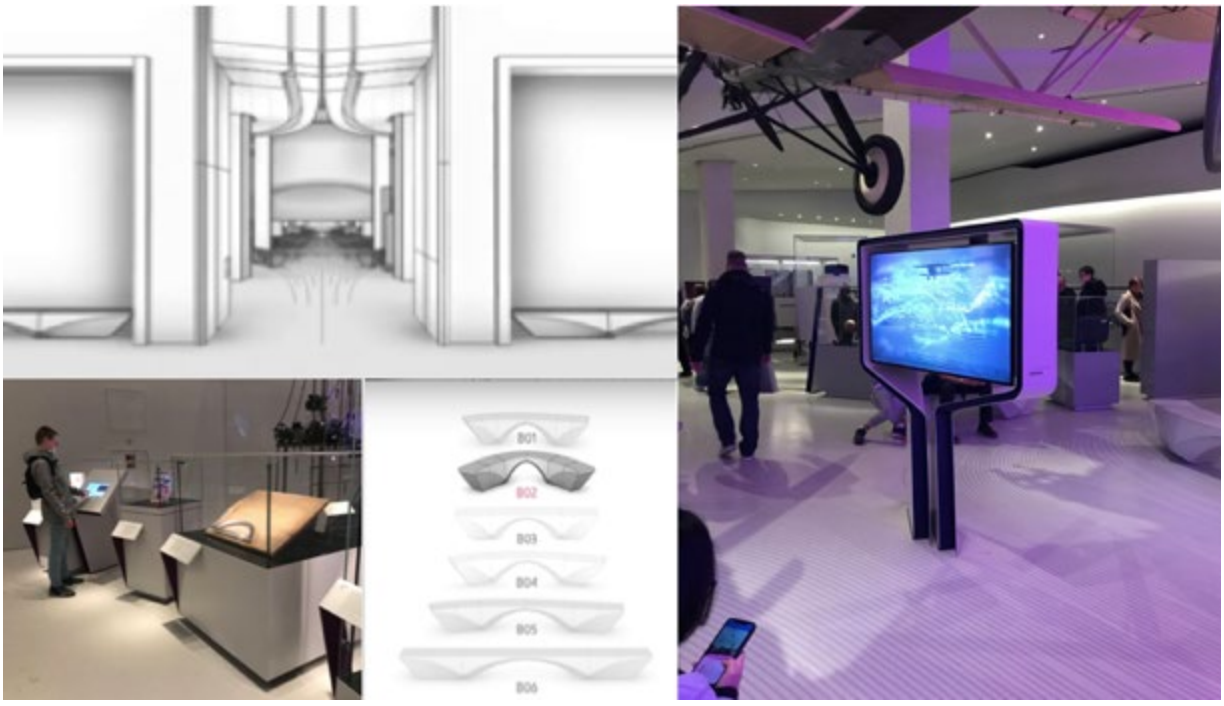

Figure 5 Space narrative discourse

The credible narrative interpretation method is also inseparable from the human imagination, which can find the inner structure between facts beyond the trivial and the grand (Palmer & Jankowiak, 1996). The imagination in narrative is an artistic method based on fiction and reality, the way in which the mind blends fiction into facts. Imagination has the function of connecting known and unknown meanings, and it has the function of generating presence and evoking absentness (Folkman, 2014). It is more purposeful than reasonable and points to specific conclusions, while imagination is derived from the experience of individuals and organizes the material relatively loosely or casually (Pauwels, Meyer, Campenhout, 2013). Narrative requires no empirical facts, but consciously selects and reorganizes the human mind, and then forms a narrative whole with intrinsic meaning (Zhao, 2013, p. 15). Compared with history and facts, the narrative of the Mathematics Hall is not a reproduction. It is formed by the fragmentation of experience and facts through imagination and cooperation, which forms the experience and facts and clarifies the meaning of the structure. So narrative imagination can make the perfect combination of events in narrative. On the other hand, it can also bridge the gap between readers and authors so that narrative communication can proceed normally. To some extent, imagination can trigger the emotions of the listener, and it can help the listener complete the direct leap beyond linear logical thinking to a certain extent (Quesenbery & Brooks, 2014, p. 23).

For the designers of the Mathematics Hall, the credible interpretation experience requirement does not just rely on history, it also requires active and appropriate fiction, positive imagination. Narrative thinking can fuse fiction and imagination together to form a chemical medium that connects multiple elements such as history, society and culture. It can be said that the space is limited and the story is unlimited. In this way, narrative thinking can construct the exhibition space of the Mathematics Hall into a miracle, a lifelike and infectious interpretative experience.

5. Discussion and Conclusion

In fact, the study of narrative thinking involves knowledge of many disciplines, and it is difficult to explain the complex content in an article. The main purpose of this article is to try to explore some of the main characteristics of narrative thinking that can be used in design with reference to the way of design thinking. Of course, this position is based on the differences and comparability assumptions between the two disciplines.For the design of the museum exhibition space, the application of narrative thinking helps the theme of the exhibition space pay closer attention to interpretation and expression. Narrative thinking can also be used as a value-added structure to give meaning to the space. Structure can provide an integration rule for the elements of the exhibition space and can provide a credible interpretative experience. In summary, as shown in the figure 6, for the design of museum exhibition space, narrative thinking is both an interpretive mode and an experience mode; one can either interpret the museum exhibition space through narrative or experience it through narrative. As shown in the figure, the four main characteristics of the narrative thinking on the left side of the figure can be basically applied to the design of the exhibition

space of the museum, which is illustrated by light colored lines. Dark lines indicate that the features on the left are the key areas that are applied to the specific theme on the right. For example, the structured process is mainly related to meaning construction and element integration, and the evaluation annotation is mainly related to interpretation experience.

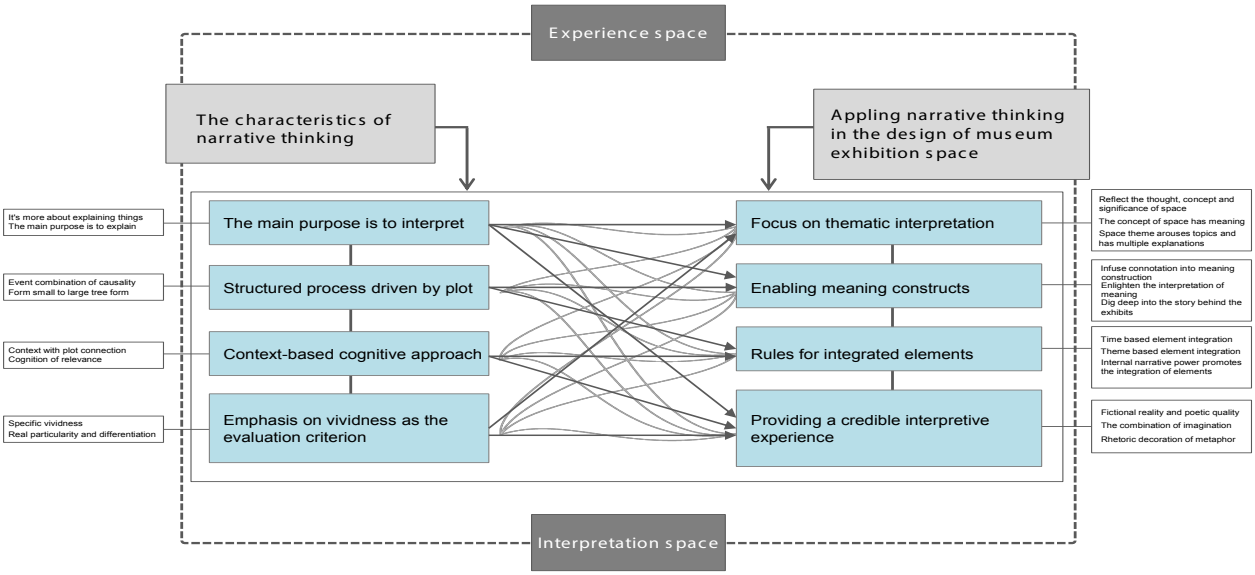

Figure 6 Frame diagram of narrative thinking applied in exhibition space

Contemporary design is not only seen as a professional system and a special skill, it is also seen as an art of communication (Buchanan & Margolin, 2010, p. 1). Based on this background, the museum display space, no matter the form, the needs of the audience or the standard of the experience, no longer has a fixed definition, but it varies with time and place. The museum display space has gradually changed from the earliest place for preservation to a public space that encourages participatory experiences, becoming a part of popular culture, a cultural product that integrates the attributes of learning, leisure, tourism and communication. In this context, the design of museum exhibition space is more concerned with artistic aesthetics and technical aesthetics (Lorenk, Sconick, Berger, 2008, p. 12). These spaces put emphasis on participation and interaction and strive to improve the efficiency and effectiveness of the information displayed through sound, light and electricity; display design that emphasizes the experience of information itself focuses on cognition and emotion of reading information (Lu, 2002, 14). Inquiring into the design of the museum's display space based on narrative thinking is actually a choice, that is, choosing to explore the design language itself with a language that is internal to human experience and structure. If this exploration cannot outline design thinking, the doctrine, at least, also proposes a museum display space design skills and topics, which deserve further research.

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Design and Science: A workshop-based approach for identifying commercial opportunities in universities

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Abstract: Universities are expected to play an important role as drivers of innovation and economic growth. Despite efforts to match these expectations, the commercialisation of scientific research remains poor. Issues in the commercialisation of research that have been identified in previous literature include scientists' lack of business skills, poor understanding of industry needs and lack of funding for development. However, there is a lack of studies proposing practical tools to bridge the gap between research and the market.
Studies analysing the activities of certain technology companies propose using workshops to assist technology innovation. However, the method for using these workshops in universities remains unexplored. This paper aims to explain why the workshops should include designers assisting scientists if used in the academic context. It takes recommendations from literature and uses interviews with multiple scientists developing technologies to inform the design of the multidisciplinary workshop structure.

Keywords: multidisciplinary collaborations; design and science; technology development; research commercialisation

1. Introduction

Universities' scientific research is a key factor identified to a nations' ability to innovate, generate and sustain economic growth (Mansfield & Lee, 1996). This has recently been substantiated in Australia, with the National Science and Innovation Agenda (NISA) aimed at leveraging scientific research to generate new business opportunities. In addition to generating new knowledge, the Australian government funding structures expect university research to impact the economy, society, environment or culture (Government, 2019). Studies have shown that universities have been reacting to these expectations by increasingly modifying their mission to encourage science commercialisation (Rasmussen, Moen, & Gulbrandsen, 2006). However, despite universities efforts to increase research impact and collaboration with industry, in some countries such as The United Kingdom,

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commercialisation of research remains poor (Livesey, Minshall, & Moultrie, 2006). Others, like Australia, show poor university-industry collaborations (OECD, 2017). This gap between university research and the market is referred to by Wessner (2005) as the 'the valley of death'.

This paper proposes that designers and scientists need to work together in the university context if they aim to match the research impact expectations of goverments and universities. It explains why design and science should collaborate, and focuses on practical methods that utilise designers' skills set to align scientific research with commercial opportunities early in the technology development process.

Technology Management literature recommends using technology roadmaps to align technology development with commercial opportunities in tech-based companies and suggests using multidisciplinary workshops to facilitate this process (Phaal, Farrukh, & Probert, 2007). It also recommends to analyse market trends and create future scenarios as technologies require a long time to be fully developed (Brem & Voigt, 2009). Based on these various recommendations, the authors propose using multidisciplinary workshops with designers and scientists in the university context. The methods reviewed in the literature refer to those used by technology companies. How such tools can be used in universities to assist in scientific research remains to be explored. Therefore, this paper explains how these workshops can be implemented in an academic context.

Interviews with multiple scientists developing technologies were used to inform the workshop design relevant for an academic context. The design researchers also used the interviews to understand the readiness of the scientists to participate as co-creators. Based on the analysis of the interviews, the authors propose a workshop structure where possible future scenarios are used as stimuli for generating ideas. These scenarios are based on existing literature analysing market, user and technology trends. This work is part of a more extensive PhD research study that seeks to test different design activities in scientific research based on the framework for technology development (Mesa, Thong, Ranscombe, & Kuys, 2019). This work is undertaken with the science Centre for Translational Atomaterials' of Swinburne University of Technology.

In the context of this paper, multidisciplinary collaborations will be understood as different disciplines working together and providing different views on a problem based on their expertise (Stember, 1991). The word 'co-creation' has been used in multiple contexts as explained by (Ind & Coates, 2013). In this paper, co-creation will describe the joint effort of designers and scientists generating and refining ideas and concepts together with a shared objective. 'Design' refers to the activities of people with specific procedural training to create practical design artefacts across communication, industrial, service and digital design fields.

Technology or knowledge transfer offices play a significant role in the commercialisation of university science. However, these activities are generally derived from business and entrepreneurship disciplines and are outside the scope of this paper.

This paper seeks to answer the following research questions:

- RQ1: What are “key points” to take from existing activities used by technology companies to identify commercial opportunities through workshops?
- RQ2: What “key points” should be emphasised when implementing workshops for technology development in universities?

This work explores literature describing the challenges scientists face in recognising commercial opportunities from their research. Then, it identifies how designers’ skills can assist scientists in this process. To answer the first research question, the authors analyse technology management literature and the recommendations of authors in this field. For the second research question, this paper presents the results of eight in-depth semi-structured interviews that helped in understanding technology development in universities. Based on the interview results, this study proposes a multidisciplinary workshop to assist opportunity recognition in scientific research in universities. The paper focuses on science that may lead to novel technology development, and acknowledges that not all university science should or needs to be commercialised.

2. Scientists’ challenges, designers’ strengths

2.1 Scientists’ challenges identifying commercial opportunities

Different studies have analysed the reasons for the low commercialisation rates of universities’ scientific research. According to Würmseher (2017), scientists’ lack of business skills is one of the main reason for their commercial failures. Compounding this, Würmseher (2017) explains that scientists fear that commercialising technologies negatively affects their academic careers. Zappe (2013), reflecting on his own scientific career, argues that scientists usually do not understand industry needs and motivations. Zappe explains that in some science fields like physics, chemistry, engineering and biology there is a vast gap between an exciting result that can be published in ‘Nature’, and its embodiment into a form that can be used by a company to start the development of a product. Even in technology-based companies, recognising an opportunity for commercialising is far from easy; managers usually underestimate the time and effort required to develop new technologies, causing premature insertion into the market (Eldred & McGrath, 1997).

Expecting scientists to be excellent researchers and at the same time to be experts in marketing, product design and business is not fair or realistic. Here lies an opportunity to explore how other disciplines can collaborate with science. This paper is concerned specifically with how designers can do this, with a focus on university science as the context.

How can we then — as designers — assist scientists through multidisciplinary collaboration to facilitate the translation of their work?

2.2 Designers’ skills and contributions to science when collaborating with scientists

Before understanding how designers’ skills can complement scientists’ commercialisation

activities, it is essential to understand the difference between both disciplines. Roozenburg and Eekels (1995) argue that scientific enquiry *analyses and understands* the natural world to create new knowledge. Design, in contrast, uses knowledge to *transform* the natural world. This idea is also supported by Rust (2004). He explains that while scientists focus on understanding and exploring what already exists, designers focus on invention and novelty. Therefore, the identification of commercial opportunities for new technologies sits between the interests of both disciplines. Simply put, a scientific project requires finding a market need — or predicting one — if it is expected to be transformed into a commercial technology product.

Previous studies describe how designers can assist scientists in conducting research. For example, Rust (2004), Driver, Peralta, and Moultrie (2011) explain that designers can imagine new and future scenarios to assist scientists in understanding the potential usability of technologies. Simeone, Secundo, and Schiuma (2017), based on the work of Sainsbury (2007), explain that design can assist scientists in developing commercial applications during research stages. After analysing multiple collaborations between designers and research institutions, a study by DesignCouncil (2015) reports that designers can help scientists identify commercial opportunities for their work. Driver et al. (2011) found through case studies that designers ability to do market and user research can enhance the commercial potential of the outputs of scientific research. Moultrie (2015), continuing the identification of design contributions to science, found that in early stages of scientific research visualising potential future applications was critical to the case studies. As the authors put it: “these visualisations stimulated discussion regarding the enabling science and the likely market potential”.

Simeone et al. (2017) focus on understanding the role of designers in collaborative activities. They point out that designers can help multidisciplinary groups ideate through graphical representations such as prototypes, sketches and data visualisation. Simeone et al. (2017) found that design enables knowledge sharing and translation of ideas between stakeholders.

Analysing designers’ skills, Crismond and Adams (2012) state that experienced designers delay decision making in terms of defining a solution for a problem. Through market research, technological investigations, and doing brainstorms, designers gather a clearer understanding of problems to come back with multiple solutions for them (Crismond & Adams, 2012). These activities conducted by designers complement the research skills of scientists.

3. Adapting tech management tools to the university context

3.1 Industry practices for opportunity recognition in early stages of technology development

The problem of identifying commercial opportunities for new research is not exclusive to universities. To understand how to deal with the innovation issues in companies, Brem and

Voigt (2009) study the approach of a thriving technology firm in Europe. The study highlights that workshops mixing internal and external experts in technology, marketing and regulation represent a central first stage in commercialising research (as illustrated in Figure 1). Within workshops, trends are identified and discussed alongside technology competence and corporate interests of the company. The goal of workshops is leveraging a team of different experts to define future scenarios for the next 5 to 10 years. After the scenarios are fully analysed, ideas for new products and services are generated. The authors explain that the success of these workshops depends on the right mix of people from different disciplines, ideally those known for being innovative and creative.

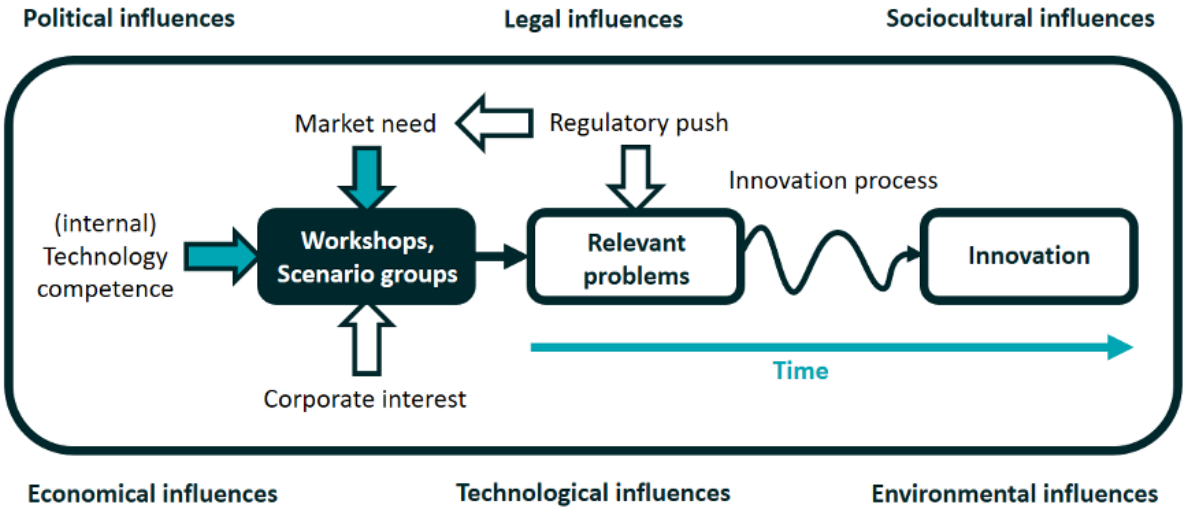

Figure 1 Triggers and key elements in technology innovation management (Brem & Voigt, 2009).

Alongside the workshop activities mentioned above, technology roadmapping (TRM) is cited in technology management literature for assisting the innovation process (Probert, Farrukh, & Phaal, 2003). TRM help align markets with technical competences, resources, technologies and products to identify the best commercial opportunities for organisations (Phaal et al., 2007). Phaal et al. (2007) propose a workshop based TRM uniquely suited for innovation process and identification and exploration of opportunities. The authors say that traditionally, the workshops aim to set organisational short- and long-term goals. In terms of participants, they concur with Brem and Voigt (2009) who suggest having a multifunctional team representing both the technical and commercial side of the company. Phaal et al. (2007) also go on to propose a workshop structure consisting of six main stages:

1. Planning: Determine the aims, roadmap architecture, participants, logistics and workshop agenda.
2. Workshop stage (a): a strategic landscape is developed based on brainstorming. It aims to capture perspectives in areas of interests and critical issues.
3. Workshop stage (b): Opportunities are identified and prioritised using the strategic landscape from the previous stage.
4. Workshop stage (c): Opportunities are explored in more depth and roadmaps are

constructed and presented in small groups.

5. Workshop stage (d): The opportunities are reviewed, learning points identified and a plan of action is set.
6. Review: At a suitable time, the execution of the technology roadmap is reviewed to ensure that the plan of action is being executed.

Figure 2 illustrates the structure of a traditional technology roadmap; the graphic representation constructed with the workshops. The roadmap shows how the different ideas, driven by multiple experts, are aligned with future opportunities. The work by Phaal et al. (2007) shows that the purpose of TRM workshops is to create divergent thinking and explore many ideas, before converging in the most attractive opportunity. This process, typical in design, is similar to the renowned 'double diamond' design process proposed by DesignCouncil (2005) (see Figure 3).

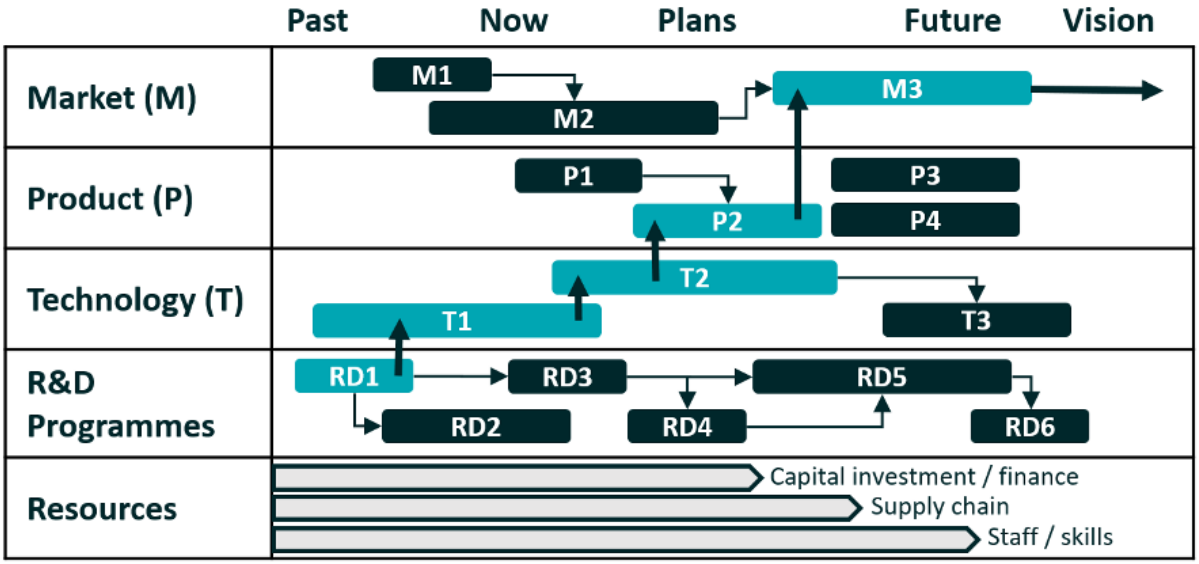

Figure 2 Traditional technology roadmap structure adapted from (Phaal et al., 2007).

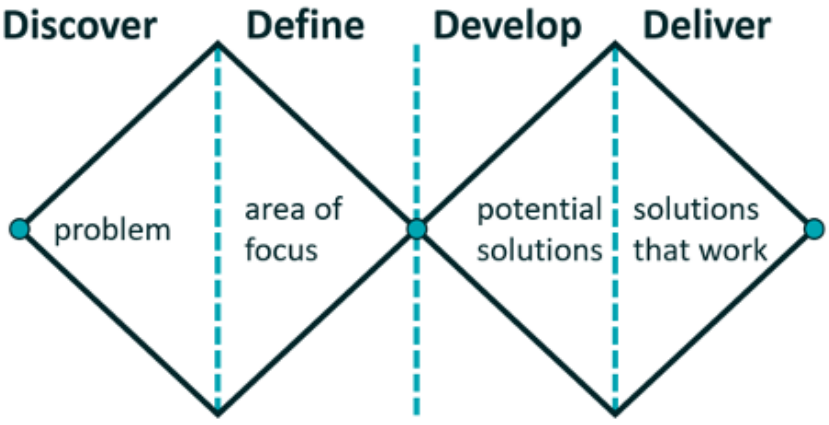

Figure 3 Double diamond design process adapted from DesignCouncil (2005).

Based on the key literature discussed in this section we can see that workshops with multidisciplinary stakeholders are crucial at the start of technology commercialisation and that divergent and convergent idea exploration are vital activities. The next section will summarise the key elements of technology innovation in companies and will explain how these can be adapted to universities using design-science collaborations.

3.2 Integration of technology roadmapping into the academic context and the role of design

The works of Brem and Voigt (2009) and Phaal et al. (2007) (previously reviewed) describe the characteristics that contribute to successful technology innovation management; including the important role that workshops play in that process. Below, ten key elements are highlighted in these works that must be considered when designing these types of workshops:

1. Define a clear strategy and long-term goals before selecting a project for development.
2. Include experts and people from different areas with decision-making power to steer the technology project.
3. Analise market, user and technology trends to understand the upcoming future.
4. Consider legal, political, sociocultural, environmental and environmental policies that may affect the projects.
5. Create future scenarios based on the trends analysed.
6. Maintain frequent communication with people from different departments to understand their insights.
7. Give all participants a voice to contribute to the ideas and share their knowledge.
8. Have people understanding the technical side of the technology and people that can understand markets and users.
9. Have innovative and creative participants in the workshop.
10. Define a plan of action with all the participants involved in the project.

These activities include market research, understanding of users, the creation of future scenarios and teamwork. As presented in the review of the literature in section 2.2, these are skills that designers are trained for; and it has been shown that they can assist scientists in their research (Driver et al., 2011; Moultrie, 2015; Rust, 2004; Thong & Kuys, 2012). In other words (and as previously explained in section 2.2), once knowledge is generated by scientists, the design domain can translate how this knowledge (technology) can be embodied into a product.

4. Research approach

4.1 Interviews: objectives and planning

As presented in the previous section, a key imperative for tech-based companies is

making sure that there is an appropriate strategy and clear goals defined. While literature reviewed suggests conducting workshops with experts from different departments to create technology roadmaps, the potential value of this in university contexts is unexplored. Universities rarely have focused areas aligned to commercial goals, but they do have experts from multiple disciplines. Thus, we contend there is an opportunity to leverage this diversity with collaboration activities such as multidisciplinary workshops.

Before proposing a structure for multidisciplinary workshops, it was necessary to understand scientists' motivations, incentives and approaches to technology development. For these reasons, interviews were conducted. These interviews with scientists informed the plan for a workshop suitable for the specific university setting needed and the level of maturity of the technology to be explored.

The interviews had a checklist of topics, but some questions were covered more in-depth depending on each participant expertise, as recommended by (Robson, 2011 p.285). Following Robson's recommendations to avoid biased answers, the open-ended interview questions were carefully selected so the participants could share their own thoughts and opinions. The themes covered by the interview were: scientific project selection; understanding of designers' skills; roles in technology development; and tools used to assist technology development and commercialisation.

4.2 Sample demographic data

The interviews targeted eight scientists with different backgrounds and varied research experience (see Table 1). The reasons behind this were to see if each scientist had different views on technology development according to their experiences as academic researchers and if they had different project management.

Table 1 Interviews' demographic data.

Participant	Age	Background	Gender	Position	Research field
Scientist 1	30-34	Physics	Male	Post-Doc	Micro-photonics
Scientist 2	25-29	Robotics engineering	Male	PhD student	Micro-photonics
Scientist 3	30-34	Physics	Female	Post-Doc	Bio-Photonics
Scientist 4	20-24	Materials science	Female	PhD student	Micro-photonics
Scientist 5	30-34	Electronic engineering	Male	Post-Doc	Integrated photonics
Scientist 6	40-44	Optics and economics	Female	Professor	Micro-photonics
Scientist 7	50-54	Physical chemistry and biophysics	Male	Professor	Bio-Photonics
Scientist 8	50-54	Engineering and chemistry	Male	Professor	Biomaterials

4.3 Analysis of Interview data

As the objective was understanding the thoughts of the scientists and the meaning of the answers, thematic analysis was selected as the analysis method. The data segments were grouped in themes and then further coded in subthemes; until no more were identified, as suggested by Gilbert (2008, p.259-264). The codes were labelled using meaning condensation; a method where the answers of the interviewees are compressed into short sentences (Kvale & Brinkmann, 2009, pp. 205-207).

4.4 Interview results

Theme 1: Scientists' generative mindset and selection of projects

Most of the scientists highlighted that they like solving problems and generating new knowledge. The results show that they target research areas based on trending research topics. When asked about the process to conduct research and select projects; the answers indicated that the professors in charge of the group are the ones steering most of the group research, or at least the primary goals.

> "Well, I think the final goal, and at least one of the individual goals are provided by our supervisors. They will give us most of the guide for how or what kind of small targets we have to reach" (Scientists 1).

One of the professors said:

> "The main thing is a unique contribution that highlights our expertise. Then, if I think that it is an important project for us, and I think that it is where we should be focusing on, the decision is made" (Scientists 7).

As one of the recommendations from technology management literature was including multiple experts while selecting the projects, teamwork and a co-creation approach should be emphasised in the workshop to mitigate the issue of one person taking critical decisions on their own. When the scientists were asked how the research projects were selected for development, most of them replied that the process is done by comparing experiment results to other publications in the field, looking what other scientists did before, and

attending conferences to identify "hot topics" and research trends. Only one professor, who had been previously involved in technology development and commercialisation, explained that maintaining frequent communication with clinicians (end-users of his research) was essential for defining selection criteria for his projects (see Figure 4).

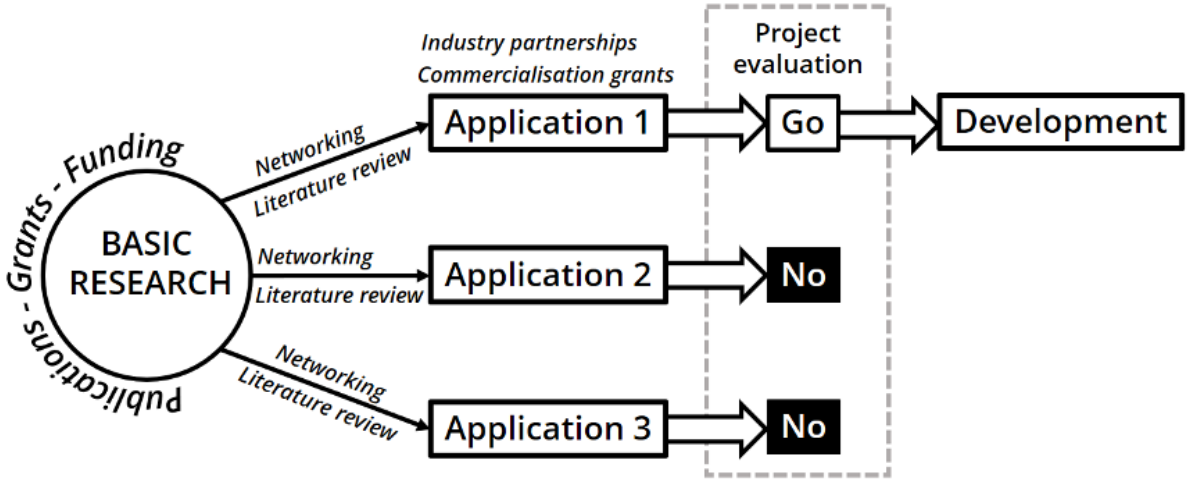

Figure 4 Illustration of "Scientist 8" management approach for scientific research projects.

Despite most interviewees being aware of the importance of understanding industry needs, only one scientist mentioned defining a commercialisation strategy. Furthermore, none mentioned conducting market research, reviewing trends or defining future scenarios. The lack of awareness of the importance of these activities, already identified in this paper as key elements for identifying commercial opportunities for new technologies, is an indicator that they should be the focus of the multidisciplinary workshop.

Theme 2: Scientists' understanding of designers' skills

The results showed that scientists did understand that design could contribute to technology commercialisation; however, they had different opinions and highlighted different designers' skills.

> "I think we, as scientists, do not have a very good idea of how a product that needs to be sold into the market has to look like. So, we definitely need someone who has that knowledge" (Scientist 3).

> "We are doing research from the fundamental end and then the design is more from the real product end… if we can meet somewhere or guide the design from the very beginning, that would be a very efficient way" (Scientists 6).

One scientist talking about his previous experience with a designer said:

> "They (designers) allowed the project to expand considerably in areas where we never ever thought it would go into and it was directly attributed to getting more funding as well. Because we do not just have a project based on a material, we have a project-based around a holistic approach to developing a product. Things that material scientists would never think

> of" (Scientist 8).

Although the interviewees understand some of the benefits of working with designers, it was not clear for most of them — with the exception of the professor who worked with designers before — when designers should be called to collaborate, and in what degree it would be beneficial for their research group.

Theme 3: Disciplines' involvement in technology development for commercialisation

The analysis shows that the scientists interviewed understand that they play a role in technology development; however, some of them still think that the commercialisation of technology is industry's responsibility.

When asked who should champion the technology to market some interviewees replied:

> "To market? The industry. In terms of marketing, access to market, all those things, the industry is responsible... I would leave that to them" (Scientists 2).

> "Tech companies. I think that researchers develop new techniques and these companies, who are developing techniques as well would like to buy those patents and prototypes from researchers; to move or push them into the market if they want to" (Scientists 4).

The interviews showed that although scientists' knowledge that other disciplines can assist technology commercialisation, most of them did not know when the right time was to reach them or what resources are available in the university for this process. Again, only the scientist who had been involved in research commercialisation before knew the importance of working with other disciplines. However, even he said he did not enjoy the process:

> "This transition into commercialisation, I am getting more and more into it. Probably 5–6 years ago I did not like it at all. I just found it very different and very confusing, in terms of what to do… I was more comfortable back in what I was familiar with; analysing the data…In more recent time I'm getting to get excited about commercialisation" (Scientist 8).

As the process to commercialise technology is not clear for scientists, the workshop should make emphasis on explaining and using tools as technology roadmapping. These tools are expected to help them align their resources and technologies with commercial opportunities adding clear short- and long-term goals. Additionally, the workshop should provide a space for multidisciplinary interaction that can make clear the role of other disciplines in the process of commercialisation.

Theme 4: Scientists' understanding of technology management tools

During the interviews, the scientists did not indicate using technology management tools or structured methods. Each interviewee described a different process for managing research and developing technologies based on their knowledge. The lack of experience using the tools recommended by literature could be a challenge for implementing the workshop; scientists could consider it irrelevant and unfamiliar. Therefore, before conducting each activity of the workshop, the objectives need to be explained. As designers are familiar with

brainstorming and teamwork, we also recommend having at least one designer in each team participating in the workshop.

5. Workshop preparation and structure

Based on the recommendations from literature, and the insights from the interview analysis, the researchers suggest that the following set of activities are conducted to prepare content for the workshop. The workshop organiser (preferably a designer with experience conducting workshops) and the scientist/s that lead the scientific research group of the technology should be involved in preparation.

1. Accurately measure the current state of research: It must be defined what the technology can currently do and the "know-how" of the group. It can help identify short-term commercial opportunities. A fair judgement is required, as a very optimistic strategy can lead to unrealistic objectives setting (Rec 1, Theme 1).
2. Define a realistic projection of the technology performance if it is further refined: This activity will assist the brainstorming process during the workshop as it will help to imagine how the technology could be implemented in future scenarios as well as identifying long term goals and ideating disruptive technology applications (Rec 8).
3. Summarise existing commercial agreements and current funding sources: The scope of the intellectual property agreements needs to be understood before ideating applications. The explorations of commercial opportunities cannot create legal issues for the group. Overlapping developing efforts will have adverse effects and conflict with existing funding partners.
4. Understand potential routes to market: The challenges and implications of exploring different entrepreneurial approaches must be discussed – such as licensing or creating spin-offs (Würmseher, 2017).
5. Define the advantages and limitations of the technology: This requires both identifying other research projects with similar development objectives and other technologies in the market with similar properties. Based on this comparison, that should include technical data, limitations and advantages of the research should be identified.
6. Defining a commercialisation strategy: Once all other considerations are considered, a strategy should be defined to exalt the strengths of the technology and the group. Even before applications are ideated, the group should know their competitive advantages.
7. Analyse market, user and technology trends: Trend reports help identifying the critical problems in the upcoming future as well as the socio-cultural challenges that will define how people interact with products (Rec 3, Theme 1).
8. Define future scenarios: Identify in the trend reports categories that can be grouped in different scenarios. Each scenario should describe in short sentences

the main problems and challenges of the upcoming future, considering socio-cultural, environmental, political, legal, economic and technological influences (Rec 5).

5.1 Workshop design

Generally, the workshop follows the model of "design charrette" as proposed by Hanington and Martin (2012). We now describe the specific details relevant to the context of design science collaborations.

Stage 1 – Identification of market sectors and opportunities for each future scenario

The workshop facilitator, preferably a designer with experience conducting co-creation workshops, starts explaining the workshop objectives and presenting the participants. The facilitator role is controlling time and presenting and moderating the activities. A quick icebreaker activity helps get in the "creative mood". Then, participants are evenly split into teams and each given a future scenario. Each team is provided with a whiteboard, sticky notes and markers. Each participant is asked to write down as many market sectors and opportunities for the assigned scenario in a few minutes. Then, using mind-maps, each team is asked to organise the ideas on a whiteboard and to identify as many sub-categories as possible. When each mind-map is saturated, half of the team members rotate to the next whiteboard/trend to provide ideas in a different context.

Stage 2 – Ideation of applications for the market sectors

The technology being researched by the scientists is briefly introduced and explained to all participants in simple words. Then, a similar process of individual ideation and team changing is repeated. However, this time the ideation is around how the technology could be used in different products to solve particular needs in each of the market sectors previously identified.

Stage 3 – Selection of concepts and classification

When ideas are saturated, and participants slow down the idea generation process, they are asked to go around each whiteboard selecting their favourite technology applications. Then — again in teams — the most voted concepts are classified in a desirability, feasibility and viability diagram. The diagrams are presented to the rest of the participants and then there is a discussion of the workshop results. These applications can be further classified in technology roadmaps by the head of the scientists with assistance of the design facilitator.

6. Discussion

There are two main challenges that still need to be explored. First, the openness of scientists and designers to engage in this type of activity. This relates to the second challenge; the incentives for designers to engage in these collaborative activities are not yet identified. It

may change from one institution to another, but for collaboration to succeed it is essential to identify benefits and workloads for every person involved.

The workshop and the preparative activities suggested in this work will be tested with a group of scientists developing graphene-based energy storage technology. The results will be analysed and presented in another manuscript. After, it is aimed to continue exploring how these tools can be applied to other technologies being developed in the university. As the use of these tools is unexplored in literature, it needs to be applied with different university technologies to test replicability.

After analysing the literature in this field, more questions arise; to what extent do technology companies use co-design activities? Can this co-creation workshop tool be tested with similar technologies in industry? To be able to answer these more research is required. The role that different design disciplines may play in this co-creation activity and the desire to engage is still unknown, as it may be related to the organisations desire to innovate. Is commercialisation of technology only dependant to the head of the scientific group? What is the role of individuals and university mechanisms? Finally, it must be mentioned that co-creation activities done with trend analysis and future scenarios may not only be useful to identify commercial opportunities, but to identify undesirable outcomes before technologies are developed.

7. Conclusions

This paper has explored the literature of technology management to identify best practices to apply in universities. It has also shown that designers have the skills necessary to assist scientists in applying those recommendations. Moreover, the study collected data from interviews to understand the scientific research process before proposing tools for identifying commercial opportunities in this environment. Finally, based on the recommendations from literature, and the knowledge acquired from the interviews, this paper proposed a workshop structure that allows the combination of scientists' technical knowledge with designers' generative and teamworking skills.

The interviews showed that scientists are aware that designers can contribute to their work and are aware that designers have a better understanding of users and industry needs. However, scientists do not seem to know mechanisms to collaborate with designers, and literature does not provide tools to assist this process. Only one scientist, who worked with designers before, understands in-depth the value of these collaborations. Therefore, this study furthers the idea of the importance of design and science collaborations for technology development and commercialisation in universities and proposes a multidisciplinary workshop as an initial bridge between disciplines.

The proposed workshops have the potential to help identify commercial opportunities early in scientific exploration. However, the tool still needs to be tested, and the potential of implementing technology roadmaps in university contexts further explored.

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Optimizing the Adoption Process in Public Animal Shelters through Service Design Thinking

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Abstract: This study employs holistic service design thinking to analyze and optimize the existing services of a public animal shelter and improves adoption experiences at the animal shelter using co-creation workshops. The proposed service design will provide adopters with proper assistance while reducing the burden on staff members. The finding of this study including three aspects: first, this study presents critical aspects when optimizing services in public adoption agencies through the case. Second, in service cases with complex stakeholders, co-creation workshops help effectively combine the needs and perspectives of all parties. Finally, service design testing integrated with stakeholders' opinions helped enhance the recognition of the design concept and the probability of implementation. The findings can help increase the efficiency of communication between animal shelters and the public and further enhance the shelter's reputation and adoption rate. Furthermore, it will increase our understanding of service design.

Keywords: service design; co-creation; public animal shelter; adoption process

1. Introduction

In 2015, Taiwan became the second country in Asia to implement the "no-kill" policy, thus establishing an important milestone in stray animal protection (CoA, 2017). However, the current number of stray dogs in Taiwan is approximately 147,000, whereas the maximum capacity of the public shelters is about 7,000 stray animals (CoA, 2018). These conditions put immense pressure on an already burdened staff. For example, the researchers worked with a shelter in which each staff member not only had to care for an average of 20 dogs but also were tasked with adoption-related administrative work. Stray animal education for adopters can be time-consuming and difficult to achieve even with the help of volunteers. As a result, in the studied animal shelter, 47% of adopters returned their pets and the adoption rate seemed to stagnate.

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Therefore, this study aims to conduct an in-depth analysis to determine the difficulties and key touch points of the adoption process for stray animals and accordingly, improve the process using service design thinking. The proposed service design will provide adopters with proper assistance while reducing the burden on staff members. The findings can help increase the efficiency of communication between animal shelters and the public and further enhance the shelter's reputation and adoption rate. Importantly, it will help optimize the adoption process to ensure that stray animals find a permanent home and are not re-abandoned.

1.1 Research Objectives

This research focuses on optimizing the adoption experience and process through service design with three main objectives. First is to provide useful adoption assistance and improve the adoption rate at the animal shelter. Second is to establish an effective matching mechanism and convey full information to the adopter to reduce the possibility of animal re-abandonment. Finally, it aims to re-aggregate the staffs' adoption goals to ensure consistent services, optimize the staff's workflow, and enhance the animal shelter's reputation and adopters' overall adoption experience.

These objectives can be narrowed down to the following:

1. Use a service design process to explore adopter's pain points and needs in the adoption process;
2. Explore how to use the co-creation workshop to integrate staff experience to create a conceptual design;
3. Discuss the role of service design thinking in improving adoption experiences.

2. Background

2.1 Service design

Service design is a cross-disciplinary approach that combines methods and tools from various areas (Stickdorn & Schneider, 2011). Moritz (2005) defines service design as an emerging academic field with holistic, multidisciplinary, and integrative characteristics and illustrates the five principles of a service: user-centered, co-creative, sequencing, evidencing and holistic. Similarly, Martin and Horne (1993) interpret service design as a process beginning with conceptualization and ending in realization. A service design must reflect a user's opinion, provide a unique service, integrate expertise from various disciplines, be interactive, and keep improving.

Mager and Sung (2011) suggest that service design not only creates comprehensive customer experiences but also results in efficient and effective services from an organizational perspective. In addition to customers, service experiences include service providers and any relevant stakeholder in the experience network (Helkkula, 2011).

In sum, service experiences are created through interactions among multiple participants (i.e., individuals and organizations) and direct/indirect activities involving the participants are the main platform for experience co-creation (Helkkula et al., 2012). A service journey has numerous stakeholders and it is necessary to integrate the benefits and needs of all parties to create a comprehensive service concept through value co-creation. This case study focuses on co-creation by stakeholders and its key role in service design.

2.2 Kano model

Parasuraman, Zeithhaml, and Berry's (1988) service quality scale (SERVQUAL) is widely used to measure service quality. Fick and Ritchie (1991), however, indicate that SERVQUAL does not apply to service experiences including overall factors. The relationship between the performance of quality attributes and customer satisfaction is not necessarily linear, that is, the impact on satisfaction varies by quality attribute (Anderson & Sullivan, 1993).

The quality attributes of a product or service are determined by customers. Thus, Kano, Seraku, Takahashi, & Tsuji (1984) propose a model that uses positive and negative questions and compare the responses to classify quality attributes (Matzler & Hinterhuber, 1998; Schvaneveldt, Enkawa, & Miyakawa, 1991). The two-dimensional quality model serves as a reference for decision-making regarding resource investment. Figure 1 shows the five quality attributes of the Kano model with coordinates.

The Kano model (Kano et al., 1984) can be used to effectively evaluate existing or newly developed products because it elucidates customers' needs and expectations. In addition, it provides critical inputs when assigning weight to factors during the development stage. Therefore, this study employs Kano's model to conduct a preliminary analysis on the service concepts.

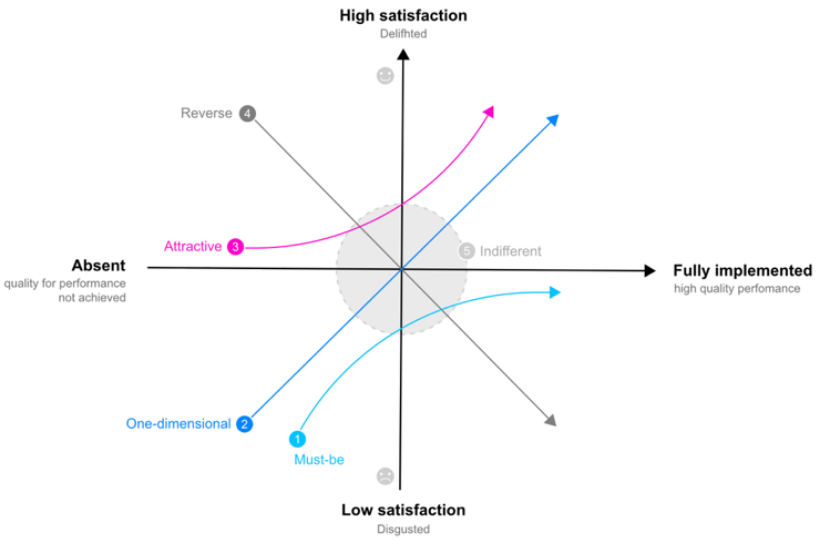

Figure 1 Kano two-dimensional quality model.

3. Method

Drawing on the British Design Council's (2005) double-diamond design process, this study integrates the design of pre-, core-, and post-service encounters and defines the service design process as three main phases. Figure 2 illustrates the overall implementation.

1. **Discovery and definition**: This phase involves the organization of the initial adoption process to gain an in-depth understanding of the difficulties faced in the animal shelter and of adopters' needs through observation, interviews, and contextual Inquiry. Then, the issues are analyzed and integrated and the insights are summarized from a service design perspective.
2. **Development and delivery loop**: Using insights from the previous phase, the designers propose an initial design concept and create a prototype film. The prototype film is introduced in the co-creation workshop for a new round of collaborative design with the animal shelter staff. The iterative concept is then integrated and designed on the basis of workshop insights from different stakeholders.
3. **Design concept testing**: The new service design concept is tested using the Kano model and as per the staff and adopters' preferences and opinions regarding feasibility. Finally, the implementation order for the new service concepts is proposed.

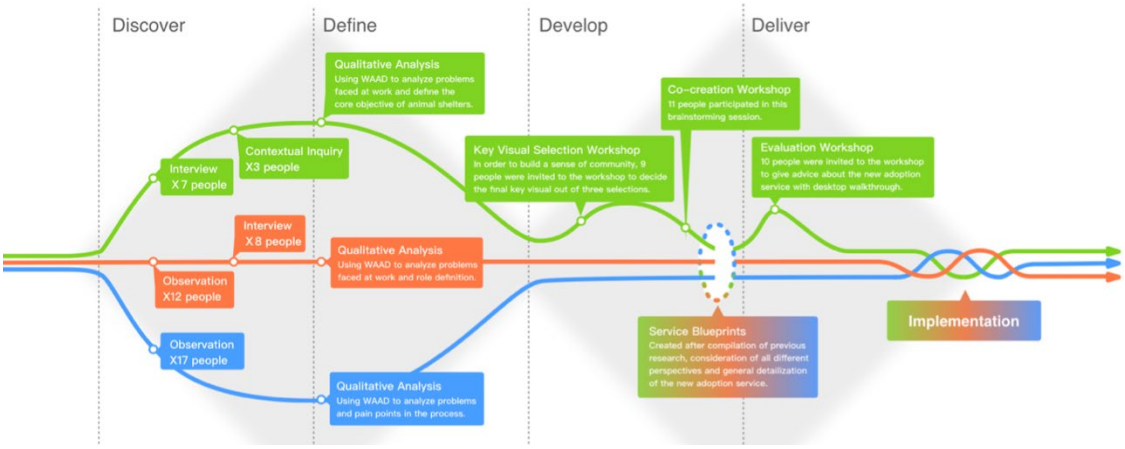

Figure 2 Research method and process.

4. Case of Animal Adoption

This section comprehensively discusses the three phases of service optimization for the adoption process at the animal shelter and highlights the insights.

4.1 Discovery and Definition

This phase involves identifying the difficulties faced by service providers and the needs of service recipients during the adoption process. More specifically, first-hand observations of adopters' behavioral patterns and the adoption process as well as in-depth interviews with the staff and those with prior adoption experience in the animal shelter are performed. The findings help understand a visitor or adopter's motivation, the environment of the animal shelter, and staff–visitor interactions. The improvements in and optimization of key touch points is the basis for design and development.

Observations

Observations of stray animals' selection and interactions with adopters were conducted for 2–4 hours for a period of one month. During the observation, preliminary interviews with the research subjects helped integrate visitors' motivation and experiences in the study and deepen the understanding of the adoption process.

The adoption journey at the animal shelter can be divided into eight steps: visitors enter the animal shelter, visitors are guided to visit by staff, visitors select an animal, adopters have a Q&A session with a shelter staff, adopters interact with the animal, both parties complete the adoption procedure, animals are handed over to their adopters, adopters leave the shelter with their animal. These eight stages are the moment of truth (MOT) between service recipients and service providers for tangible or intangible interactions.

In-depth Interview

Prior to conducting the interviews, a stakeholder analysis is performed to understand the organizational structure of the animal shelter and select the appropriate respondents. Service recipients include those with a successful or failed adoption experience and other shelter visitors. A total of eight service recipient respondents participated in the interview. Service providers are management staff, vets, team members for dog or cat containment, and administrative and control team members.

The interview content was integrated and interpreted using the work activity affinity diagram (WAAD) (Beyer and Holtzbla, 1998) and summarized into three major findings, which are applied as a basis for future design.

Insights

The field observations and in-depth interviews with service recipients and providers indicate that the problems can be divided into information asymmetry, poor navigation instruction, information gap, unsynchronized information, and lack of consistency and efficiency in personnel (Table 1).

Table 1 Research insights through observations and interviews.

Problem	Definition	Respondent type	Findings
Information asymmetry	Information and service quality offered by animal shelter is insufficient	Recipient	Map positioning is not accurate and thus, shelter is difficult to locate
			Adopters expect to select animals as per their age and characteristics
			Shelter does not offer adoption tools (e.g., leash and cage) in settlement stage and thus, adopters may be disappointed at the end of the adoption process
			Animal shelter does not provide relevant information about stray animals
			Often the animal shelter is closed and their working hours are not clearly communicated to visitors
		Provider	Animal shelter does not have diagnosis instruments and thus, adopters only know limited information, e.g., an animal's age range
			Adopters have to arrange for adoption tools
Poor navigation instruction	Navigation and visual identification systems in the area of animal shelter are incoherent	Recipient	First-time visitors often cannot find the relevant doghouse or cattery because of the shelter's semi-open area and lack of proper navigation information; some even enter restricted areas
			Staff do not have labels or uniforms and thus, adopters are unsure of whom to consultant
			Shelter does not offer guidance to first-time adopters who tend to be unsure of how to interact with stray animals
Information gap	Information provided by animal shelter and service quality are unsatisfactory	Recipient	Adopters find it difficult to obtain precise information because of the complex and diverse information on the bulletin board
			Animal information card is limited to medical treatment and does not offer other care information for adopters
		Provider	Adoption documents are too many and lengthy

Unsynchronized Information	Changes in stray animal information are not simultaneously updated online and offline	Provider	Cage numbers and diagnosis information are manually adjusted, which can easily cause information synchronization errors and delays in online updates
Lack of consistency and efficiency in personnel	Lack of corresponding adoption service target	Provider	Staff cannot provide consistent services because of different personalities
			Feelings of futility can reduce staff's willingness to publicize
	Complex adoption procedure leading to low efficiency		Adoption matters are left unattended when there are many visitors
			Staff need to explain adoption matters repeatedly

4.2 Development and Delivery Loop

The five-level problem definition is used as a reference to design the adoption service process through co-creation. This subsection presents concept generation, co-creation, and iteration.

Service design, version 1: *TAKE ME!*

Pain points faced by adopters at different stages include the environment, information, personnel, processes, and hardware equipment at the animal shelter. This study explores three design concepts:

- Information integration (e.g., visit specifications and adoption process flow);
- Navigation system design (e.g., route planning);
- Matching system (e.g., animal information card and design for adoption matching questionnaire).

Accordingly, this study proposes an innovative adoption service concept, *TAKE ME!*, which aims to guide and assist adopters throughout the adoption process. Adopters will be offered a step-by-step approach to finding a suitable animal for adoption. The concept includes 11 scenarios (Figure 3).



Figure 3 Storyboard of service design, version 1: TAKE ME!

This service design version focuses on meeting the primary needs of adopters and addressing related pain points. The concept was proposed to the animal shelter for evaluation and possible implementation. However, certain difficulties were identified in the actual implementation. For example, the matching questionnaire does not accurately reflect the characteristics of dogs with an unstable personality. Thus, it was necessary to further integrate adopters' needs and staff experiences to optimize the concept.

The next stage of concept development involves service providers (e.g., staff) in the co-creation process. This concept not only addresses customers' needs but also ensures that the organization can efficiently and effectively execute the concept. Thus, the iteration phase introduced *TAKE ME!* as a stimulus in two co-creation workshops that accounts for the characteristics of the animal shelter staff.

Co-creation workshop

In the co-creation workshop, the staff were asked to collaboratively redefine the core values of the animal shelter on the basis of the previous ***TAKE ME!*** concept. The objective is to define experience goals (during and after adoption) in advance to create the route and visual identification design. The workshop is customized to the context of the animal shelter. The workshop accounts for the staff's goals to ensure the creation of a consistent service experience. This serves as an alternative vocalization channel and an opportunity to improve the workflow.

Following are details of the two workshops conducted during the co-creation phase:

1. Adoption process and navigation design using previous concept as stimulus: In the first workshop, the staff and designers re-planned the route and position of the navigation visual design by organizing the adoption process. This ensured that the previous design concept accounted for cost and utility as well as more favorable implementation conditions (Figure 4).



Figure 4 Co-creation workshops to determine new adoption process and navigation design.

2. Experience goals definition: In the second workshop, the staff collaborated to identify the different ways to organize the adoption process and then, develop experience goals using the consistent benefits benchmark (Figure 5).



Figure 5 Co-creation for experience goals for adoption process.

The co-creation workshops highlight the following experience goals for the proposed adoption process:

1. Before adoption: *Explore carefully*. The adopter should explore all aspects prior to adoption (e.g., tolerance level of animal) and develop a complete

understanding of how to care for the animal.

2. During adoption: *Real experiences*. During the adoption process at the shelter, adopters must explore the animal's characteristics (e.g., a dog's bark or an animal's smell) to gain a sense of their post-adoption experiences.
3. After adoption: *Convenient consultation*. Post-adoption, adopters are likely to face problems related to the animal's health and care. Access to convenient consultation can ensure that the problems are resolved and reduce the probability of adopters abandoning the animal.

SERVICE DESIGN, VERSION 2: *CON+*

Based on the experience goals identified during the co-creation workshops, a new version of the service design concept was proposed. *CON+* focuses on the animal shelter and extends to three key stakeholders:

- Stray animals: The animals must be treated equally and have the right to be loved
- Adopters: Irrespective of whether visitors adopt an animal, their experience at the animal shelter must deepen their understanding of the animals and how to care for them
- Animal shelter staff: The staff's work responsibilities must be integrated with the mission of caring for a life

The revised version of the service design concept, *CON+*, proposes nine functions during the adoption process on the basis of the identified experience goals (Figure 6).

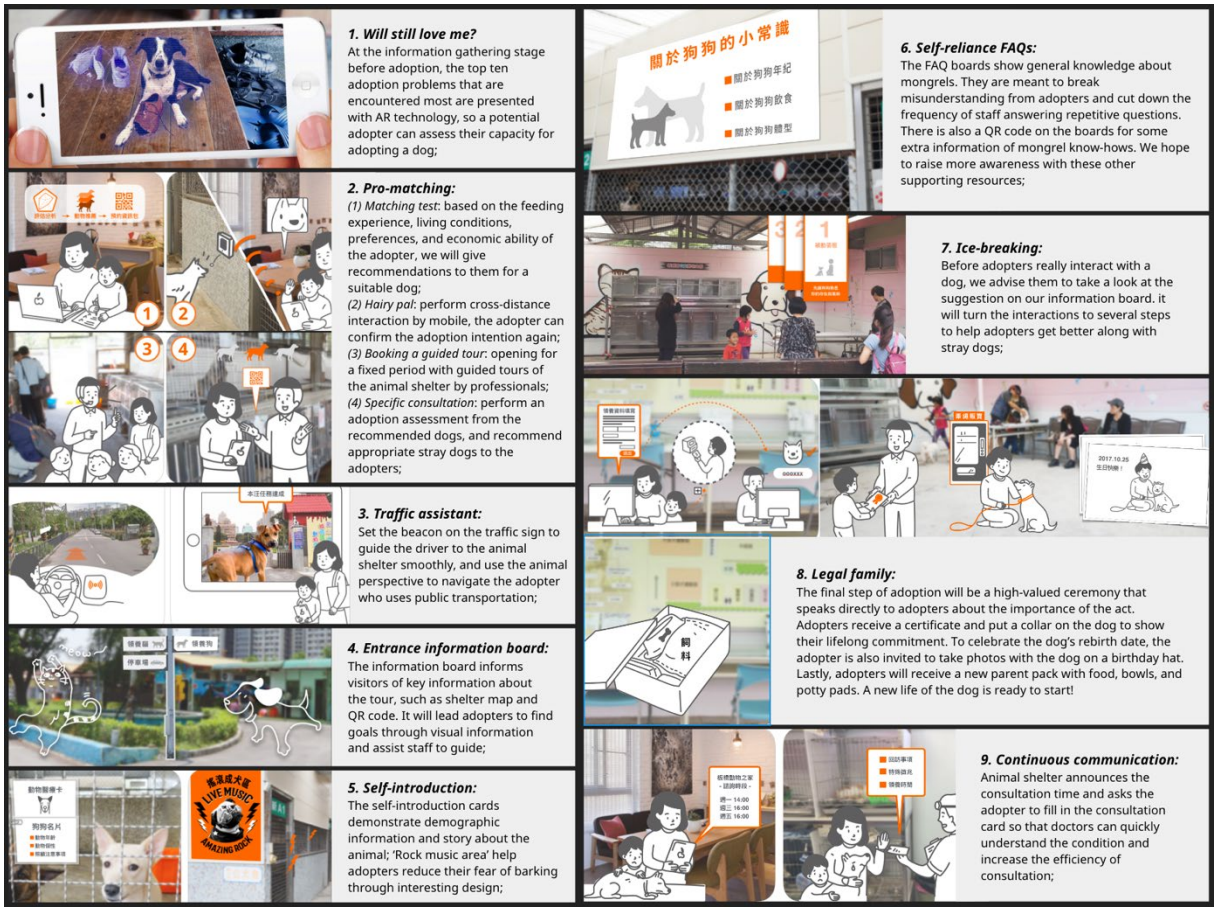

Figure 6 Scenarios of service design, version 2: CON+.

In sum, this study conducted two workshops involving service providers to co-create a service design for the adoption process. Service providers at various designations were invited to provide their input on the user-centric service design concept, *Take Me!*, and accordingly, propose a new version, *CON+*. The co-creation workshops not only bridged the gap between the service design concept and actual implementation, but also facilitated innovative thinking in a public institution that significantly influenced the design process.

4.3 Design Testing and Findings

This concept-testing phase entails a stakeholder analysis and the submission of the concept to a service design competition. The outcomes are discussed in the following sections.

Stakeholder Analysis

The stakeholder analysis applies the Kano model to test the nine adoption services in *CON+* on the service recipients and providers. The service recipients rank the services according to their subjective preferences and service providers rank the feasibility of implementation on the basis of their existing resources.

- Service recipients: The questionnaire is divided into two parts with a total of 31

questions. It includes the Kano two-dimensional quality assessment of the CON+ and a survey focused on adoption and feeding experiences. Service recipients are asked to select the top-three services as per their subjective preference. The questionnaires are distributed on various stray animal community platforms. A total of 127 valid questionnaires are obtained.

- Service providers: Service providers were asked to fill out the questionnaire after the researcher explained the concepts to them. The questionnaire included the Kano two-dimensional quality assessment of CON+ and a survey on basic staff characteristics. The questionnaire asked service providers to rank the feasibility of service implementation on the basis of their practical experience and existing resources.

Finally, the results from the three tests were integrated and compared to determine the appropriate implementation approach.

Service design competition

The final service design concept was submitted to a 2018 design competition hosted by SDN (Service Design Network). The concept was awarded the *Best Student Project* and was vetted by international service design organizations.

Summary and direction for implementation

The Kano model results reveal that service providers rate *Traffic Assistant* and *Continuous Communication* as one-dimensional quality services and consider all other service concepts to be attractive quality services. Notably, the absence of these attractive quality services does not affect overall customer satisfaction. Therefore, it is important to first optimize one-dimensional quality services that could increase satisfaction, including *Self-Introduction*, *Self-Reliant FAQs*, *Legal Family*, *Pro-Match*, and *Ice Breakers*. Optimizing the one-dimensional quality services increases satisfaction levels of not only service providers but also service recipients. Service recipients rank the attractive quality services of *Entrance Information Board* and *Will You Still Love Me?* the lowest for optimization.

On the basis of their subjective preferences, service recipients ranked *Legal Family* (28.3%) the highest, followed by *Ice-Breakers* (22.8%) and *Self-Introduction* (18.9%). Among these services, *Legal Family*, *Ice-Breakers*, and *Self-Introduction* recommend actual contact with stray animals and are all one-dimensional quality services under the Kano model, thus reiterating the importance of the services.

In terms of feasibility, service providers ranked Self-Introduction and Self-Reliant FAQs the highest, followed by Entrance Information Board, Legal Family and Continuous Communication, Pro-Match, Traffic Assistant, Will You Still Love Me?, and Ice-Breakers. Table 2 summarizes the results of the stakeholder analysis.

Table 2 Summary of stakeholder analysis.

Implementation order based on Kano model	Respondent type	Kano quality categories	Feasibility ranking
Self-Introduction*	Recipient	One-dimensional	1
Self-Reliance FAQs			1
Legal Family*			4
Pro-Match			6
Ice-Breaker*			9
Continuous Communication	Provider	One-dimensional	4
Traffic Assistant			7
Entrance Information Board	Recipient and Provider	Attractive	3
Will You Still Love Me?			8

*The top-three categories based on subjective preference ranking

The Kano model classification, service recipients' subjective preference ranking, and service providers' resource feasibility assessment are used to classify and organize the implementation priorities of the nine adoption services.

To improve the adoption rate, optimize resource consumption, and maximize utility, it is imperative for the service implementation stage to account for the Kano model results and users' needs. The stakeholder analysis results prioritize *Self-Introduction*, *Self-Reliant FAQs*, and *Legal Family* for implementation.

5. Conclusions and Suggestions for Future Work

This study employs holistic service design thinking to analyze and optimize the existing services of a public animal shelter. It does so by considering various touch points and channels from the viewpoints of service recipients and providers. The key conclusions of the study are as follows.

First, this study highlights critical aspects that warrant consideration in a service design process aimed at optimizing adoption services in public adoption agencies. More specifically, it demonstrates the use of different tools and channels to create a low-cost service optimization design focused on improving adoption experiences at the animal shelter. The design process considers adopters and the animal shelter as key stakeholders.

For adopters, it is necessary to facilitate a positive experience during the adoption process by meeting their adoption goals. An expected outcome is an increase in the adoption rate. The researchers attempted to streamline the adoption process to deepen adopters' experience at the shelter and their attitude toward caring for a life. Continuous post-adoption assistance is a key factor preventing adopters from returning the animals to the shelter.

From the viewpoint of the animal shelter, it is necessary to assist the staff in improving their work efficiency, reduce the repetition of problems, and address post-adoption issues.

The objective must be to re-aggregate work values to enhance their sense of enthusiasm, responsibility, and honor.

Second, in service cases with complex stakeholders, co-creation workshops help effectively combine the needs and perspectives of all parties. Incorporating the concept of stakeholders in the service design process allows for co-creation, which treats service providers as internal customers, helps understand their pain points, and facilitates a consensus among service providers through in-depth interviews. The in-depth interviews highlight the staff's attitudes and habits and this information can be used to customize progressive workshops, which significantly help in the co-creation process. In addition to the abovementioned advantages, the workshops assist staff member at different designations in conflict resolution by promoting communication and helping them identify a common goal for the adoption experience.

Co-creation workshops must be conducted using a step-by-step approach considering the participants may not have prior experience. In this study, the workshops were conducted for a short duration and they did not involve the same participants. Thus, the researchers were faced with challenge of explaining the problem and purpose to the participants within a short period. The first step was gaining the approval of the main stakeholders to help enlist other participants. Second, the researcher assessed the participants' awareness and attitude toward the issues facing the animal shelter through preliminary interviews, which helped design the two co-creation workshops. The final step was a meeting to report the preliminary survey findings to help the participants understand the direction of the workshop topics. The first workshop was conducted with focus on the design concepts, that is, adoption processes and navigation visual design. The key objective of the workshop was to experience the implementation process of the workshop. Scenarios and artifacts as well as a semi-gamified desktop walkthrough were used to increase participation and guide participants in their design review. Once the participants became familiar with the workshop format, a second workshop was conducted to enable staff at different positions to collaboratively determine adoption experience goals.

The co-created service design re-inspires the passion of the staff. The workshops give proactive improvement by externally stimulating the staff's internal drive. After the co-creation workshop, the staff has spontaneously implemented one of the innovative adoption services, *Self-Introduction* (figure 7). It is such a powerful symbol that even the few staff who originally show little interest in participation were eager to contribute to the idea.



Figure 7 The staff has spontaneously implemented one of the services concept: Self-Introduction.

Finally, service design testing integrated with stakeholders' opinions helped enhance the recognition of the design concept and the probability of implementation. Fick and Ritchie (1991), as previously mentioned, indicate that SERVQUAL is not applicable to service experiences involving overall factors. Thus, this study integrated the subjective evaluation of multiple stakeholders to test the service design concept. In particular, it adopted the Kano model to test the nine adoption services with focus on service recipients and providers. Service recipients ranked the services on the basis of subjective preferences and service providers ranked the feasibility of the implementation as per their practical experience and existing resources.

Design thinking is a human-centric approach to innovation that integrates user needs, technological possibilities, and the success factors of a business. In other words, innovation accounts for users' desirability, the viability of a business, and technological feasibility. Therefore, a concept evaluation must account for these three aspects and the subjective evaluations of both service providers and receivers to ensure their needs are met. Using these evaluation aspects to gain insight for subsequent optimization can deepen service providers' recognition of the final service concept, thus increasing the possibility of implementing the service concept.

5.1 Suggestions for Future Research

This study proposes a new service concept for an existing adoption process by considering both service recipients and providers and using the Kano model for a preliminary evaluation. However, the service system is subject to certain drawbacks that remain to be addressed. Issues warranting further research and the direction for further studies are discussed as follows.

1. Consider a holistic channel: The service design concept proposed in this research is primarily based on the physical environment and service process optimization. Future research could attempt to combine various other channels to optimize the system at the different adoption stages.

- Pre-adoption: This phase aims at ensuring adopters receive accurate and comprehensive information about animal adoption. The online channel is an important touch point for adopters because it helps establish brand image and thus, strengthens brand recognition.
- During adoption: In addition to passive navigation methods (e.g., navigation visual design), researchers can connect channels from the pre-adoption stage to the offline physical environment (e.g., provide multi-directional navigation through ChatBot). Including diversified channels also ensures consistency in service experiences.
- Post-adoption: This stage focuses on assisting adopters to prevent them from returning their animals to the shelter. Future research must consider establishing convenient consultation channels to help adopters and the animal adapt to each other.

2. Include more stakeholders: This study examines the needs and pain points of adopters and the staff through two co-creation workshops. Opinions from multiple stakeholders help expand the team's design horizon. However, service recipients and providers also include other stakeholders such as animal protection organizations and volunteers at the animal shelter. Expanding the team to a diverse set of stakeholders will help broaden research insights and design possibilities.
3. Establish a more comprehensive system for service concept evaluation: This study employs the Kano model to test the preference, feasibility, and priority for each service concept from the perspective of service recipients and providers. However, it does not verify the effectiveness of each MOT. Thus, future research must consider a more comprehensive evaluation system. In addition, when conducting the Kano model test, researchers ought to explore ways to accurately present the service concept considering participants have not previously experienced the design concept.

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Auckland Plan 2050: A narrative experience of a Social Design project in Aotearoa New Zealand

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Abstract: This paper describes a Social Design student's project conducted during 12 weeks in a Communication Design degree in Aotearoa New Zealand. The project employed a studio-driven educational structure that integrates social, technical and cognitive dimensions of knowledge construction. In this sense, the aim of this paper is to present our experience in order to shed light about Social Design as a context for studio activities in Design teaching. The brief employed a pragmatic framework to problem-solving to develop design outcomes capable of impacting local and global society. As a result, there was increased student engagement within the paper, a fact associated with the process of designing under real-world settings, that produced strategic platforms for collaboration and cultural diversity.

Keywords: auckland plan 2050; design education; social design; design-based research

1. Introduction

Social Design is often described as a concept that uses design to benefit the environment, and our communities, challenging the traditional framework of designing. It holds the "unique power of design toward serving the greater good" (Tromp, 2013, p. 12). In the last ten years, there has been an increased interest in social design (Melles, de Vere, & Misic, 2011; Tromp, Hekkert, & Verbeek, 2011; Rizzo, Deserti, & Cobanli, 2018; Nasadowski, 2015; Chen, Cheng, Hummels, & Koskinen, 2016), and in how designers can influence and create public awareness about environmental and community issues.

Papanek's and Fuller's pioneer work Designing for the Real World, first published in 1972, positioned social design in relation to social problems and in a critique of the dominant market-oriented culture. Their position was deepened by the 2008 financial crash that opened opportunities for designers to find alternatives in Non-Governmental Organisations (NGOs) and the public sector. Since then, social design has been promoting a change of paradigm "towards a wider and more complex social and human-centred agenda" (Souleles,

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2017, p. 928). More than ever, design faces the needs of a constantly growing world population and the challenge of living in a harmonic balance with nature and its resources.

Winograd (2006), Baynes (2010), and Souleles (2017) all remind of the importance of social design competencies and skills for design graduates. Souleles (2017) advances that design education should "allow graduates to deal successfully with the challenge of design for social change, [that] entails the adoption of a variety of strategies that at their core are human-centred" (p. 927). The Professional Association for Design (AIGA) published a report on the 21st of August, 2017 as a result of the AIGA Conference Why design education should pay attention to trends that details key ideas for a profound transformation in design education, moving from an industrial model to the emergent social conditions. This new model predicted a different scenario where designers' skills were reconsidered in the ambit of schools and universities, requiring a fine adjustment on the set of competencies and abilities for a professionally relevant designer.

Sangasubana (2011) argues that social design employs a range of skills that expand the designer's essential competencies, including identifying the relationships between people and the environment. As a result, design briefs should cater to projects that go beyond aesthetics and seek new forms of problem-solving. Accordingly, these skills prescribe an approach that requires knowledge in strategy, planning, prototyping, and testing. Besides, Armstrong, Bailey, Julier, and Kimbell (2014) place social design in education in an interplay between entrepreneurship and social activism. A paradigm shift requires education models to address responsible designers who can innovate and use visual technologies to address social problems that are wicked by nature and are far more complex and interdisciplinary (Chen et al., 2016). Additionally, this new designer will face a new social complexity, populated by virtual societies in sophisticated layers of technology that will create the demand for a designer that is not a passive consumer of information but an active developer of content and experiences.

The ubiquitousness of mobile usage by university students already show their relevance in studio-driven practices. Accordingly, technology prompts opportunities and questions about its usefulness and advantages in design education. These devices can also offer great opportunities for the design-studio classroom promoting collaboration and increasing student engagement (Wankel, 2011; Moran, Seaman, & Tinti-Kane, 2011; Bor, 2014).

According to Kurt (2010) and Costley (2014), technological tools applied to studio education can create meaningful experiences that increase student engagement and improve critical thinking and problem-solving skills. Also, the integration of media and design tools promoted by technological resources including devices (hardware), apps (algorithms), and platform (web) reinforce the problem-solving character of the designer (Bonnardel & Zenasni, 2010) and brings new applications and uses of design practice.

Thus, this paper discusses how social design and technology have been implemented in the studio-driven classroom. It details the methodological framework where this project is situated, including the student's brief, methods, and tools observed inside the execution of

the student's projects. It aims to narrate an experience and the chronology of studio-driven activities that generated perceptions from lecturers and students.

2. Methodology of the Project

The methodology used in this project is defined under Design-based Research (DBR) and refers to methodology used by researchers in learning environments. It is mainly concerned with the "...design of educational materials (e.g., computer tools, learning activities, or a professional development program) [that ...] is interwoven with the testing or development of a theory" (Bakker & Van Eerde, 2015, p. 2). DBR has its origins in the 1960s as a movement from designers and researchers that aimed to create methodological practices to observe the academic rigour and develop an independent scholarly discipline (Christensen & West, 2017). It brought scholarly attention to the methods used in design studies to extract theories. Margolin (2010) argued that putting design methods under academic scrutiny could improve the quality of practitioner's practices and design outcomes.

Many thinkers (Getenet, 2019; Zinger, Naranjo, Amador, Gilbertson, & Warschauer, 2017; Brown, Taylor, & Ponambalum, 2016; Ebaeguin, 2014) note that this methodology can improve the quality of the outcomes in education practices. Christensen and West (2017, pp. 12-13) argue that DBR is design-driven, situated, iterative, collaborative, theory-driven, practical, and productive. Wang and Hannafin (2005) define it as "a systematic but flexible methodology [that can] improve educational practices through iterative analysis, design, development, and implementation" (p. 6). The main difference of this framework is that pedagogical approaches can be amended along with the ideation and testing of design solutions, leading to "contextually-sensitive design principles and theories" (Bakker & Van Eerde, 2015, p. 6).

In this paper, we refer to DBR as the group of instruments and tools used for specific research in accordance with the parameters of social science. Using a pragmatic framework through traditional forms of qualitative and quantitative research, DBR was implemented as a framework that allowed dynamic adjustments of components during the process. The studio-driven classroom operated in the form of collaboration that brought research and practice together operating in real-world settings. This approach enhanced students to engage with research, where there was "no strict separation between theory development and theory testing" (Markauskaite, Freebody, & Irwin, 2010, p. 39). It promoted an environment where theory was researched through practice, and where research-informed practice as much as practice-informed research.

3. The student's brief

The brief Auckland Plan 2050: Promoting and researching a design plan for a growing city was initiated as a response to a hypothetical research question: How design outcomes can contribute to increasing the awareness of a problem in the real world, extracted by the categories defined by the Auckland Plan 2050?

The project asked students to research a human-centred model and a collaborative design process that enabled them to delineate specific problems and challenges towards several design solutions based on Auckland Plan 2050, a Council's long-term spatial plan for Auckland city in New Zealand.

Auckland Plan 2050 (2018) is an open-access digital document developed by the Auckland Council that comprises issues, opportunities, and developmental strategies taking sustainable actions for a growing city (document is accessible at https://tinyurl.com/y8zz3r6x). According to the Auckland Plan 2050 (2018), this document is a "streamlined spatial plan with a simple structure and clear links between outcomes, directions and measures. It shows how Auckland is expected to grow and change during the next 30 years" (p. 5). The plan provides "a pathway for Auckland's future physical development [... and] a framework to prioritise and coordinate the required supporting infrastructure" (Auckland Plan 2050, 2017, p. 6). It considers Auckland's (the largest city in New Zealand) key six main areas of actions that includes strategic points and opportunities for social change for Auckland until 2050. These are the areas the plan aims to promote and improve:

- Community interaction and participation
- Māori identity and wellbeing
- Housing and urban places
- Transport and access
- Environment and cultural heritage
- Opportunity and prosperity for all Aucklanders

The brief asked students to investigate, define, and develop design outcomes to promote awareness, facilitate a process and/or promote a change of attitude using one of the six main action areas of the plan. Students were divided into groups and were required to identify a potential problem and opportunity for design solutions relating to a specific social issue. Aiming to provide an opportunity for reflection and interest of students (and accessibility of data), we established the university students themselves as the target audience and encouraged a personal reflection regarding their own responsibility and relationship with the project.

3.1 Guiding principles of the student's project

Working in groups of four or five members, students created interpersonal relationships based on the Auckland Plan 2050's (2018) guiding Māori principles of Atawhai — Kindness, generosity; Kotahi — Strength in diversity; Auaha — Creativity, innovation; Pono — Integrity; Taonga tuku iho — Future generations. These principles were defined in the online document, encouraged as driven forces for the project, and used as a lens through which we looked at the designer's outcomes, teaching pedagogies, conversations, and group dynamics. The brief recognised the importance of Mātauranga Māori traditional knowledge and values as a "way of being and engaging in the world [using] kawa (cultural practices) and tikanga (cultural principles) to critique, examine, analyse and understand the world" (Kia Eke Panuku,

n.d., p. 1). Using the concept in its simplest form, classes were initiated with the sharing of kai (food) as a symbolic gesture to indicate care and reciprocity between group members and lecturers. In these sessions, we discussed aspects of community behaviour and respect between students working in collaborative projects.

We also discussed ongoing considerations of non-Western epistemologies, including how to embrace cultural backgrounds, navigating language barriers, and other ways of thinking and behaving. Many AUT South Campus students live in Manukau region (one of the poorest areas of Auckland where the campus is located) and more than 60% of the classroom was composed by diverse cultural backgrounds, including Māori, Samoan, Tongan, Japanese, Singaporean, Vietnamese, Sri Lankan, Chinese, Filipino, Brazilian, Fijian Indian, and South African. In consideration with these ideas, we discussed the importance of design solutions to encompass a positive and productive relationship with Auckland's Māori and wider society and to recognise Te Tiriti o Waitangi / the Treaty of Waitangi. It's important to note, that during this assignment, we are aware of the complexity of whakapapa and Mātauranga Māori traditional knowledge and values. In alignment with that, we invited the AUT Te Ara Poutama lecturer Dr Robert Pouwhare, a tohunga (spiritual leader) from Ngāi Tūhoe (a Māori iwi in the North of New Zealand) to introduce students to some Māori concepts and discuss some aspects of the students' projects. Robert Pouwhare discussed the history and principles of the Treaty of Waitangi, also giving guidance and knowledge to specific Māori sites and stories in the Auckland region.

3.2 Design framework

In this paper, the design framework operated under a problem-solving model that was supported by a mixed-method approach. To conduct the research and identify design opportunities inside one of the six areas of development in the Auckland Plan 2050 (2018), students followed a pragmatic approach, that according to Powel (2001) aims to facilitate human problem-solving.

Students were asked to solve real-world problems, considering the practicality of the solution in relation to the user. The focus was on 'what works' as the truth regarding the research questions under investigation (Teddlie & Tashakkori, 2003). The pragmatic principles are well aligned with the analysis of problem- solving and the ability of design to "look for meaningful problems, frame them into appropriate contexts, and design a process for developing and implementing a solution" (Irwin, 2015, p. 92). The pragmatic principle is often associated with the use of mixed methods and convergent design described by Creswell (2014) where only the combination of qualitative and quantitative data can provide the big picture in social research. Usually, it refers to a process of research where qualitative and quantitative data gathering are carried out separately in parallel and then compared to create the convergence.

The pragmatic view offered a chance to use mixed methods to explore a range of perspectives, alternatives methods, combining different worldviews, and philosophical

treatises. The advantages of mixed methods allowed a bridge between the quantitative and qualitative approaches and the result was a more practical outcome in terms of reach and impact, while it provided a richer platform of exploration. Accordingly, the quantitative approach exercised a rational dimension by informed design decisions, while providing subjective qualitative responses from interviews and focal groups.

3.3 Chronology of the studio-driven activities

Design education and the studio-driven approach exemplifies experiential learning. The studio culture values creativity and collaboration, where the knowledge is produced instead of disseminated. By this means, the studio-driven activities created a dialogue between the research data, the making, and contextualising theory. During the teaching classes, lessons encouraged intersections between the methods developed every week. These lessons and development of the project evolved from beginning to end through six consecutive two weekly phases (Figure 1):

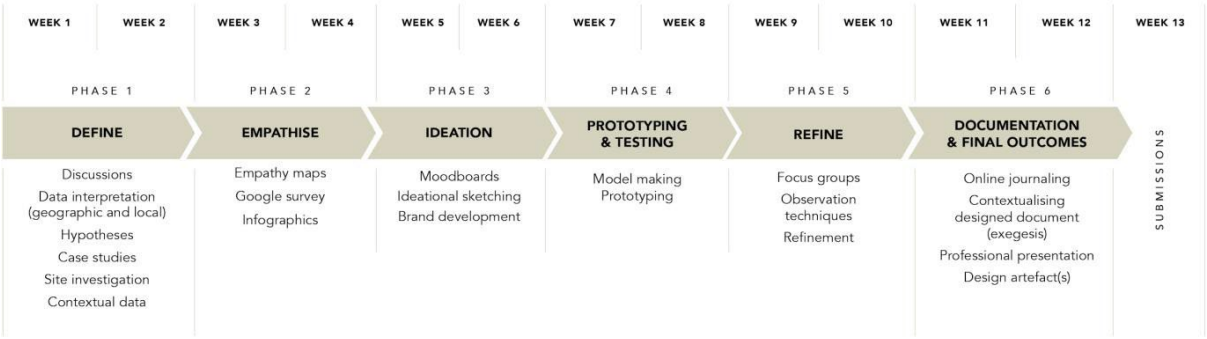

Figure 1 Chronology of weekly lessons and phases conducted during the twelve-week period until submission.

Phase 1: Define (weeks 1-2)

In the first two weeks, students discussed the role of research within practice, the importance of social projects in design, ethical conduct, and different aspects of the brief. Using the Auckland Plan 2050 (2018), students decoded regional maps and infographics, and interpreted geographic and local data about different regions in Auckland, understanding the issues and opportunities from the existing documentation. Students also created hypotheses of problems within the context of their chosen theme, indicating potential design opportunities for their individual briefs. Within the process of defining their arena of research, students documented existing case studies, including site investigation, competitors, and contextual data.

Phase 2: Empathise (weeks 3-4)

This second phase allowed students to deepen their understanding about the needs, thoughts, and feelings of the demographics. This stage was conducted throughout empathy maps and re-framing and defining the problem in human-centric ways. Using google survey,

students tested their hypothesis through surveying a minimum of 100 university students that branched out from not only questions about statistical data (relating to a particular group such ageing, gender, and economic backgrounds), but also potential media platforms that could be used for the final design solutions. During this process, students took notes and documented their perceptions about the users and their environment to generate qualitative data and insights about the profile of their audience. Outcomes of quantitative and qualitative research were compiled and translated into a designed infographic containing the findings collected during the empathy maps and questionnaire process.

Phase 3: Ideation (weeks 5-6)

During the process of ideation, students utilised moodboards as a process of inspiration and communication as "triggers for idea generation and providing anchors for structuring mental representations" (McDonagh & Denton, 2005, p.3). A visual collection of imagery operated as functioned environments for indwelling and as communicative devices for discussions with other designers. During this process of moodboarding, the designs started to gather increasingly explicit form and the directional idea around the concepts started to develop and to be discussed among other designers. These developmental stages were followed by ideational sketching and stages of brand development towards a range of possible designed materials. These processes of ideation occurred as free as possible and encouraged divergent and convergent thinking towards a collection of ideas and led to three possible design solutions to be converted to prototypes.

Phase 4: Prototyping and testing (weeks 7-8)

During this phase, students were encouraged to operate in the process of model-making and prototyping. This stage operated through engagement with materials, reflection, and discovery-in-action (Schön, 1983). A process of "move testing" allowed students to experiment with design solutions in a free manner "…in order to see what happens: tak[ing] action in order to produce an intended change" (Schön, 1983, p. 146). This phase was highly encouraged in activities in the classroom where exploration with material operates as active participants and interactors with the maker and the making in the creative process (Carter, 2004). Before the final execution and presentation, students had to provide a final prototype to be tested and refined for the next stage. AR technology, design mock-ups, and signage prototypes were some of the methods used by students in order to indicate the testing of some of their ideas.

Phase 5: Refine (weeks 9-10)

Towards the end of the process, students produced outcomes to be tested in focus groups. They organised five to six selected university students to discuss aspects of the generated design outcomes. These tests indicated the usability of the product, the elements, and principles of design investigated (brand solutions, colour, typography, etc), the communicative approach and technical aspects of the project. During a method of conversation and documentation, students allowed the audience to engage with the design

products and give their insights, while also asking questions and observing their interactions without intervention. Observation techniques allowed them to reflect on patterns of engagement and spontaneous reactions towards the work. During the sessions, students documented the process and reflected towards the refinement of the existing prototypes.

PHASE 6: DOCUMENTATION AND FINAL OUTCOMES OF RESEARCH (WEEKS 11-12)
During this phase, students were required to analyse the process and contextualise the research. This phase was conducted over the process of documentation through a contextualising designed document (exegesis), online journal (blog), professional presentation, and the design artefact(s).

3.4 Contextualising Documentation

One of the deliverables of the paper included a final 3,000 word designed publication outlining the trajectory of the research. The document had a traditional exegesis format and included a brief description of the contextual background, data collection, ideation, tests, and commentary of practice using the APA reference system. Exegesis is a document often described as a model for practice-led research documentation forming a specific structure and navigating between objective analysis and personal reflexivity (Hamilton & Jaaniste, 2010). The academic criteria of a written exegesis not only prepared students for postgraduate pathway, but also allowed students to discuss personal perspectives, and situate concepts and creative practice. They were able to understand the relevance of the project for a specific target audience, and to themselves as emergent designers and researchers. The importance of their personal experiences was outlined in their Positioning of researcher chapter, where students reflected in their personal relationships, and the relevance of the research for them as designers, and an integral part of the social context.

The exegesis as a contextualising document created an empathetic relationship with the process of social design. It allowed a reflexive method, that provided personal insights, giving students certain awareness of their social responsibility as designers and their relationship to the local area.

In the conciliation of personalised language and objective analysis of data, an online blog operated as an information repository and sites for the reflection and collection of research elements. Working as a journal, these platforms are “not precious, self-conscious object[s], but interactive device[s]” (Gray & Malins, 2004, p. 59). The online platform allowed free note-taking and included work in progress, discussions conducted during classes, homework, and also a reflexive analysis of their experiences, their thoughts in order to identify a connection between the creative voice and the objective broader field of the research. Such platforms supported a reflection in action during the process of making (Rodgers, Green, & McGown, 2000; Schön, 1983), afforded convenient ways to keep track of an ongoing archive between all members of the group that was shared, and allowed an active synthesis of information.

Although a personal analysis of the experience was important in the emergence of social awareness and process of conducting research, a professional presentation to the Auckland Council asked them to act as professional designers and present the final outcomes of the project in a professional and concise manner.

3.5 The design artefact(s)

The design outcomes produced by students materialised the solutions envisioned through the research. It indicated a balance between originality, quality of design outcomes, and adherence to professional standards. Students were encouraged to select at least one technological design approach (e.g. app design, Augmented Reality (AR), or Virtual Reality technology) and one traditional printed media (e.g. publication, posters, or brochures) to demonstrate a solution to a problem within the parameters of the brief. This approach aimed to provide an opportunity for designers to explore the intersections between mediums and find multidisciplinary opportunities in design, in specific to new technologies and applications.

The final projects ranged in explorations with branding, app design, packaging, wayfinding, photographic, and social media campaigns. These outcomes were responses derived within the topics indicated in Auckland Plan 2050 (2018), such as food waste, Māori cultural sites, mental illness, and transportation as described in four detailed design artefacts.

ZERO

The design outcomes resulted in a mobile app, a food waste kit, and a social media campaign to bring awareness about food waste in the Auckland area. The app asked users to keep track of the weekly expenses, savings over a period, and create shopping lists and recipes that avoided waste. The platform provided recipe ideas for different households according to their food preferences and weekly shopping budget. Personalised recipes were implemented into the app, so users were able to set up their meal preferences such as portion size, price, and dietary requirements by using a filter function.

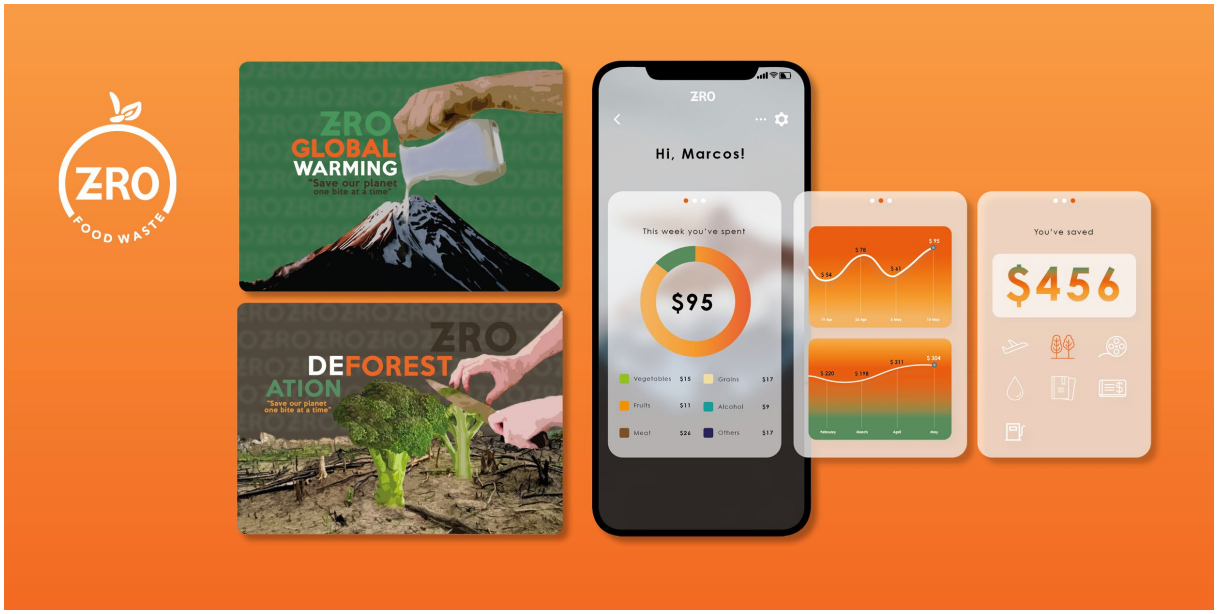

Figure 2 *Postcard and app designs for Zero.*

Auaha

The project resulted in an eco-friendly wayfinding systems that promoted Māori cultural sights in the Auckland area. The design prototypes a pilot project for an implementation of a AR signage system in Mt Eden (Maungawhau) — a Māori site with rich history, but little cultural awareness. Each of the signage included a series of illustrations, written descriptions of the story, and QR quotes that directed the users to voice recordings about the location in both English and Māori.

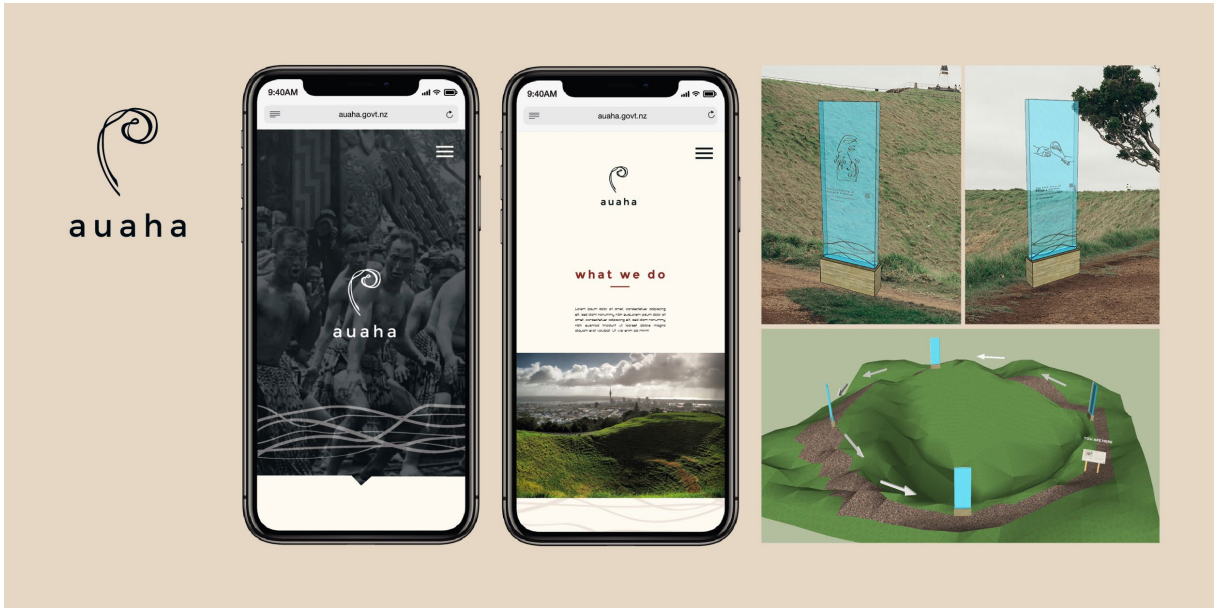

Figure 3 *App design and signage system designs for Auaha.*

MYORA

The design artefact created for this project was called ‘Chill Pack’ and provided various designed elements to contribute to the wellbeing of university students. The elements inside the packaging (candle, tea, stress ball, sleep mask, and recipe book) focused towards the five senses and promoted relaxation and positive mental state. A booklet had some instructions about mindful sensory activities to reduce stress and improve wellbeing. The project included AR posters with QR codes that users will be able to scan that will direct them to the website.

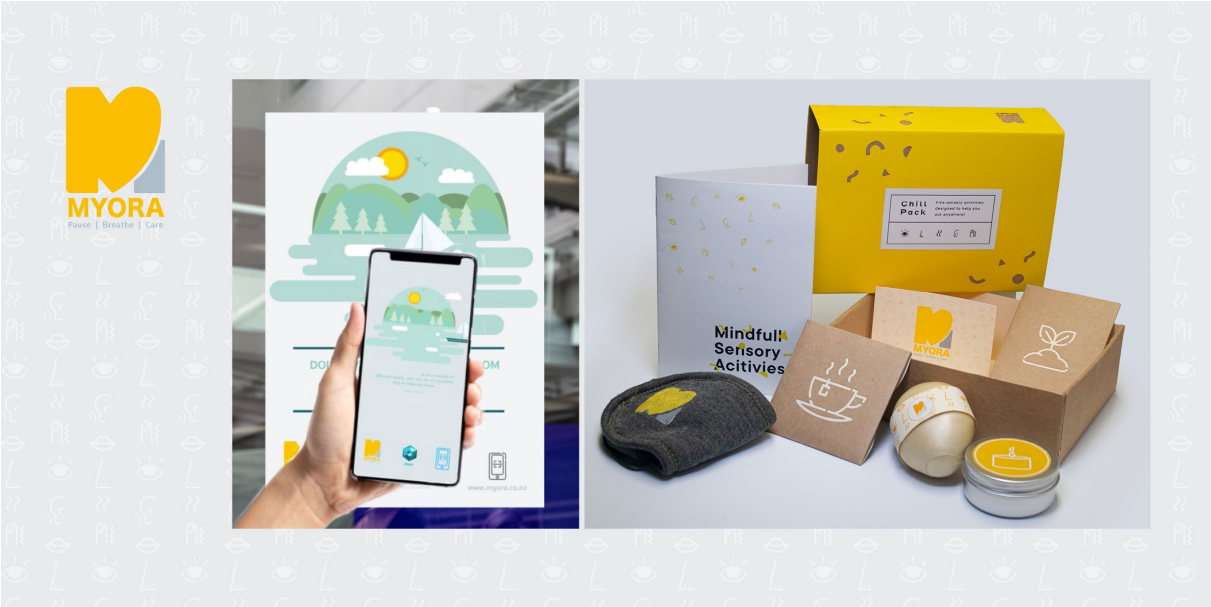

Figure 4 AR poster design and ‘Chill Pack’ for Myora.

WALK UP

Using gamification design and AR technology, this project encouraged students to walk as a form of transportation in the Auckland area. In the app, users were able to create individual profiles, track their journey, ‘scan’ the urban space to collect bonuses, gain achievements, and document their reduction of carbon footprint while walking. The platform offered promotions during the walking journey, promoting business opportunities and partnerships with local stores.

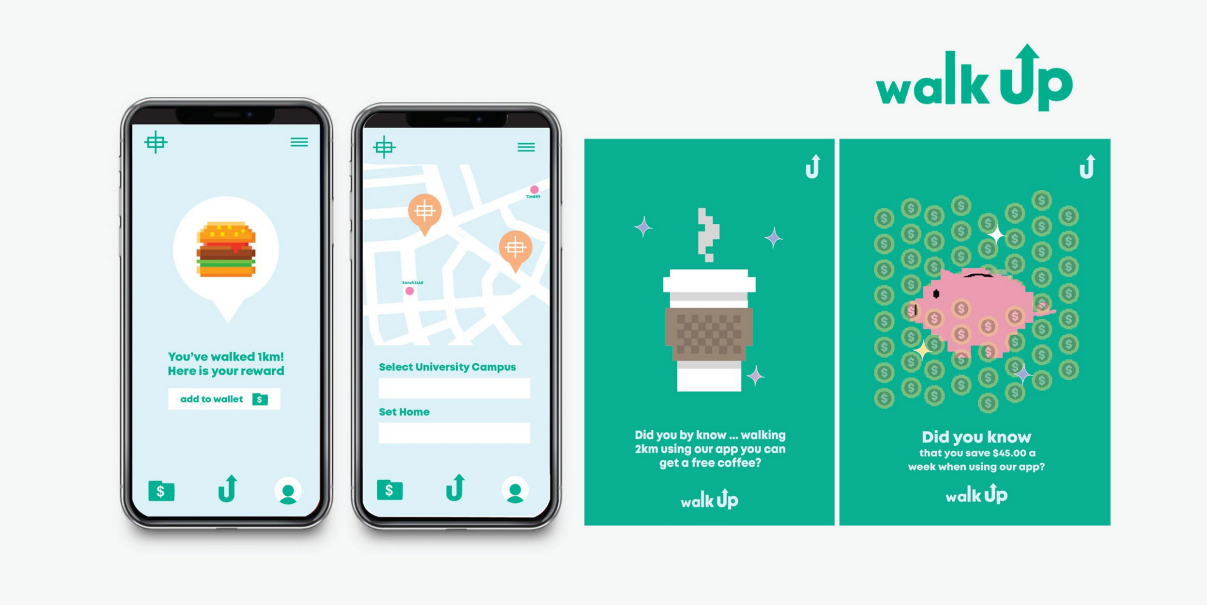

Figure 5 *AR app design and poster designs for Walk up.*

4. Results

In this article, we have discussed several methods and conceptual ideas conducted during the implementation of a student brief. Thus, this study manifested three overarching results:

1. It provided a methodology for studio-driven education that navigated outside the service provider towards a social design approach.
2. It encouraged collaboration and community practices as a mechanism of social design process, providing a platform for cultural diversity and improving student's engagement with the project.
3. It provided opportunities to use social media and emergent technologies as iterative and communication process in classroom activities.

4.1 The studio and social design approach

The use of social design responds to changes in the design paradigm, moving the focus from the form and function of a product to assume social and environmental responsibility. In this brief, social design strategies offered a rich opportunity for lecturers to promote authentic studio-driven experiences filled by real-world context and critical reflection. The Auckland Plan 2050 project asked students to engage and develop skills that went beyond the basic conventions of graphic design and respond to social problems. It connected students to local issues with the purpose to develop problem-solving abilities that mixed different perspectives and tools. It presented social design as a meaningful repository of design skills, that provided a pragmatic problem-solving framework with both qualitative and quantitative views combined in a practical solution. They investigated, defined and understood a problem, then gather and analyse relevant data to create a solution for an audience (Herrington,

Reeves, & Oliver, 2010).

In this project, the lecturer's primary role was not to give the solutions for the project. Instead, s/he aimed to help the students to develop understanding through a range of forms of inquiry, action, reflection, and conversation. The process was aimed to increase the chances of discovery and new approaches for a problem. The classroom offered a platform for students to learn fundamental design and professional skills, allied with the ability to collaborate, to practice empathy, negotiate multiple worldviews, and to accurately gather, record, and evaluate diverse information. At the same time, they had to get in contact with alternative epistemologies: first to the Māori values of the Auckland Plan 2050 (2018) and later to different approaches respective of their cultural backgrounds.

4.2 Collaboration and cultural assumptions

Working in collaboration, groups were formed by a mix of students that went beyond their common everyday relationships, simulating a commercial and professional environment. The distribution of skills was levelled up to accommodate diversity of ideas, in order to distribute capabilities amongst group members. In one way, this dynamism provided constructive relationships between students (who were not familiar with each other) while also creating an unproductive experience for others. In general, group work provided a unique synergy between different values and worldviews, allowing students to understand the complexity and productive and enriching nature of participation and collaboration in studio practices.

In the group dynamics, conflicts were particularly noticed in groups where cultural backgrounds were diverse, and tutors had to intervene to help students to find the right balance between cultural voices. These issues were mainly associated with different ways to negotiate, the collective versus the individual. Lecturers promoted group conversations to find a common ground where individual tasks should be handled by members of the team to achieve group goals and maintain collective interest and professionalism. There was a need to discuss and align differences to promote a positive cultural and ethnic perspective in the classroom, including understanding, responsibility, and respect for cultural differences, including negotiation of ideas, professional, and ethical attitudes in the workplace.

Interestingly, the Social Impact Design Summit Conference in February 2012 pointed out that social designers working globally have to be sensitive within cultures and "have a mandate to tread sensitively within the cultures to which they're providing services, or they will create the perception, if not the reality, of saddling a community with ineffective or inappropriate developing tools" (in Lasky, 2013, p. 22). A cultural perspective has extremely geographic relevance considering AUT South students belong to unprecedented migratory movements in South Auckland area. In this context, the United Nations' Sustainable Development Goals (SDGs) (2015) provides a framework for global competence to exercise world citizenship that prepares students to live and be successful in multicultural and multi-ethnic societies in a globalised world.

Therefore, the project was envisioned to offer students a chance to think about global

competences and provide guidelines of action in design education which takes in consideration new world views, interactions between cultures and issues of local, global, and cultural significance, preserving an open and effective interaction across cultures.

4.3 Emerging technologies and social media in design education

The use of mobile devices has prompted opportunities for students and lecturers to work with AR technology and social media in communication strategies, prototyping, testing, development of their design projects, and data collection. The use of online platforms added a plus to the projects since students brought new forms of communication and design to their projects. The ubiquitousness of students with online platforms improved engagement and curiosity in the studio-driven space. Social media platforms were one of the approaches utilised in the collection of data, exploration, and also in the implementation of design outcomes that included the use of platforms such as Facebook, Snapchat and Instagram and emerging technologies such as AR (AR Spark Studio and Roar AR) and Virtual Reality (VR).

Social media has improved the response time between lecturers and students and allowed all members of the group to see and share posts regarding to the project development. Social Media facilitated collaboration, communication, and engagement between students in the exchange of knowledge and iteration process. Also, the contextual development of ideas operated in an iterative process of a shareable Google Drive and Microsoft Teams (including an online word document for the exegesis), so all members of the group (including lecturers) had access to the development of ideas and ideation process in real-time.

The use of AR technology also allowed explorations in the design process which operated beyond stabilised formulas. Using free AR technology, students considered prototyping and testing formats for their final designs. This new form of technology also presented limitations in the level of interactivity and usability of such platforms. This meant that design decisions evolved according to the technical aspects of the media, through processes of iteration, testing, and development. This process indicated a more volatile design process that presented challenges and opportunities of emerging technology as an education platform for the design process.

4.4 Engagement and feedback

There was an increase in student engagement with the project that was documented in their feedback. Working in groups, a required attendance between group members provided the highest presence rate compared to the same paper in previous years. In a qualitative feedback session, participants responded that higher attendance was due to the group work dynamics, that required them to be present in the majority of the classes; and the nature and progressive structure of the classes that employed an evolving process of design in real- world scenarios. Another reason pointed to by the students was the fact that the studio- driven and the group work required an environment of collaboration, where each student had to contribute to tasks they felt more capable of, optimising the process and

increasing the quality of outcomes. Students felt that the project was rich because it went beyond merely commercial purposes and revealed personal relationships, reflection, and social voice, giving them an advantage towards a unique position in the industry in relation to others.

5. Conclusion

The brief detailed in this paper reminded us of Papanek's (1985) ideas about design's shift to environmental and social. He compared the design activity to the composition of a magnificent poem, the making of a mural, the painting of a masterpiece, or the creation of a concerto. He also noticed the importance of design in everyday life, from organising our habitat, preparing food, supporting a team in a baseball game.

Our aim with this paper was to share an experience where studio provided a platform where to apply design dynamics to social-driven and localised problems. In Papanek's vision, design is in the core of human activity and it could forge strategies and shape objects to impact the world and how our existence is balanced with nature. In this sense, this project considered models where the designer's basic skills are constituted under the human-centred paradigm. The studio-driven space as a core pedagogic component of design teaching, was a sui generis product of experiential and transformative learning practices, that were based on reflection and making. This educational practice was a formative experience where students experienced a constructivist approach to build understanding about ways to solve problems and generate purposeful outcomes.

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SYNERGY

Synergy through Making: Co-designing with Educational Stakeholders in Northeastern Nigeria

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Abstract: Nigerian educational statistics reflect a country in crisis. Several factors drive this trend: early marriages; poorly-trained and underpaid teachers; and extensive armed conflicts. This paper describes a collaboration between three universities on a [removed for peer review] grant-funded project to intervene in this crisis. Focusing on the educational system in two states, the project aims to improve educational materials and teaching strategies in 200 schools. Our research team employs a co-design methodology informed by the "co-creation" work of Dr. Elizabeth Sanders and Pieter Jan Stappers (2008), Dr. Allison Druin's (1999, 2002, 2005) work on "cooperative inquiry," and by [removed for peer review]'s work on child-centered design. The participants provided the research team with personal perspectives through the creation of personas. This paper presents the results, and how we interpreted and analyzed the study. Our goal was to better understand the educational needs, community and people of Adamawa and Gombe states.

Keywords: co-design; ethics; global communities; global education; inclusion; participatory action research; personas; and social justice

1. Introduction

The importance of education to societies, as it contributes to economic development and increases the standard of living of citizens, is highlighted in the literature (Odia & Omofonmwan, 2007; Teaching-Jobs.org, 2017). As Benjamin Franklin said, "An investment in education pays the best," education is supposed to impart societal values and equip students with skills necessary to function in the world of work. Attainment of education is considered a powerful tool by which economically and socially marginalized adults and children can lift themselves out of poverty and participate fully as citizens (Norad, 2019). Research and impact studies demonstrate that participating in education has a positive effect on people's employability, income levels, and occupation (Carnoy, 2000; Blondard et al., 2002 as cited in

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Schuller, 2004a, p.3). Therefore, individuals who are denied access to education can become stagnant, ignorant, and frozen in time (Mackey, 2013); and this situation affects the quality of life of a society. Since education plays such an important role in society, the Universal Declaration of Human Rights (UDHR) in 1948, recognized that: "Every individual, irrespective of race, gender, nationality, ethnic or social origin, religion or political preference, age or disability, is entitled to a free elementary education" (Norwegian Agency for Development Cooperation [Norad], 2019 para #2). In addition to access to education, the UDHR expects the education provided to be of quality: "... Education shall be directed to the full development of the human personality and to the strengthening of respect for human rights and fundamental freedoms. It shall promote understanding, tolerance and friendship among ... racial or religious groups. ..." (see, Article 26). However, despite the declaration, issues of access to basic education and quality of education for many students remain a challenge for several countries, particularly those in developing nations.

1.1 Problem Statement: Crisis in Nigeria

Education in Nigeria faces enormous challenges. Acknowledging the different problems in the north and south of Nigeria, BBC Minute (2019) identifies five main challenges that affect education in Nigeria overall: i) overcrowded, dilapidated, and ill-equipped schools; ii) parents who can't afford to put their children in school;1 iii) teachers who are often untrained and chronically underpaid; iv) negative attitudes towards 'western'-style education, and v) education systems in need of capital. Thus, millions of children find themselves outside the school system (Norad, 2019). It is estimated that 10.5 million children are not being educated in Nigeria (BBC Minute, 2019).

Commenting on the educational challenges in Nigeria, the Norad (2019) report noted:

> The education sector in the north-east has been severely affected by the conflict with Boko Haram. Both students and teachers have been killed and schools destroyed. The result is large numbers of refugees and several hundred thousand children [are] outside the school system (see, Education, para # 1).

With an estimated 1200 schools destroyed, and many of them yet to be rebuilt, this situation creates an enormous challenge on existing educational resources. Fortunately, there are several efforts aimed at addressing some of the challenges facing the educational sector in Nigeria. USAID awarded three universities: American University of Nigeria (AUN), Kent State University (KSU), and Columbia University's Center for Sustainable Development (CSD), a grant to intervene and provide solutions to educational challenges facing public primary schools in Northeastern states. The ensuing Strengthening Education in Northeast Nigeria (SENSE) Activity is a 3-year project that aims to develop teaching and learning materials for primary schools in Nigeria's Gombe and Adamawa states to improve educational outcomes for 200,000 primary school children.

1 Parents cannot afford to send their children to school for a variety of reasons. Some need children to help at home, and others cannot afford basic expenses of paying for uniforms and books--both of which are required expenses.

The SENSE activity is a collaboration between a Nigerian university and two US universities. Two of the partner institutions were foreign to Nigerian culture but well versed in mathematics and literacy education, along with gender, socio-emotional learning, and psychosocial support. Because the team is collaborating to develop teaching and learning materials for states in a region where Western education is not widely accepted, collaboration with local stakeholders was required. As cultural outsiders tasked with developing educational materials for a country with which we had limited familiarity, we wanted to reduce the imposition of western ideas on Nigeria's education. As our goal was to produce materials that would be culturally appropriate, relevant, and useful, the research team sought strategies that would bring local educational stakeholders into the design process to make sure their voices were recognized and properly considered (Mchunu & Moodley, 2019). Subsequently, we chose to adopt a methodology that incorporated local educational stakeholders into the design process.

This paper describes the nature of the collaborative partnership in developing numeracy and literacy teaching and learning materials, and reports on findings from a co-design activity with educational stakeholders in one of the afflicted states in northeastern Nigeria. The focus was to learn more about the experiences of teachers in Northeast Nigeria, what resources and materials they had access to, what they viewed as challenges affecting education in their communities, what they desired to see in their schools, and more.

2. Literature Review

2.1 Including the Stakeholders

Our interdisciplinary team, composed of scholars from the design, education, and information fields, wanted to ensure we included local voices in both the research design as well as the final products. Historically, the idea of including stakeholders in design started with participatory design in Scandinavia in the 1970s as a way of integrating technological developments with very strong unions (Spinozzi, 2005; Sanders & Stappers, 2008). "This early Scandinavian work was motivated by a Marxist commitment to democratically empowering workers and fostering democracy into the workplace," (Spinozzi, 2005, p. 164). While our team was tasked with creating tools for education rather than for commerce, emphasizing stakeholder involvement empowers end-users, such as teachers, and provides them with the agency for co-developing the educational materials they would subsequently use in the classroom.

According to Heslop, Cranwell, and Burton (2019), engaging stakeholders in the development of educational material and services creates a more responsive, integrated service that better meets the needs of the community of practice. Furthermore, the engagement and participation of stakeholders in the development of educational programs and learning materials can boost confidence and motivation levels and help to foster accountability (Matuk, Gerard, Lim-Breitbart & Linn, 2016).

2.2 Co-Design, Collaborative Design, Cooperative Inquiry, and Design Thinking

Co-design is a form of participatory action research that fundamentally involves a team working collaboratively to develop practical service improvements and to enhance skills and knowledge in people and organizations by exploring and sharing subjective experiences of stakeholders (Donetto, Pierri, Tsianakas & Robert, 2015). Co-design provides a collaborative way of collecting information and creating knowledge.

> "When we think of knowledge, we often think of explicit forms of knowledge: things that are written down, defined, categorized, systematized, or quantified. But to understand knowledge-making in participatory design we have to understand that much knowledge tends to be tacit. Tacit knowledge is implicit rather than explicit, holistic rather than bounded and systematized; it is what people know without being able to articulate" (Spinuzzi, 2005, p.165).

The co-design research process uses a combination of making activities along with observations and artifacts developed with users to provide feedback that is reflective of their needs and desires.

> "Since users' tacit knowledge is highly valued, participatory design focuses on exploring that tacit knowledge and taking it into account when building new systems. This task is accomplished with a strong political or ethical orientation: users' knowledge is described so that it can be used to design new tools and workflows that empower the users" (Spinuzzi, 2005, p.166).

The practice of co-design has been used in business and marketing for some time and has empowered users, resulting in financial gains, and successful marketing strategies with the design of new products (Sanders & Stappers, 2008, p.8). Co-design may provide the same for educators and students, as a means of empowering those in the classroom to determine and shape learning materials.

Researchers Sanders and Stappers (2008) wrote: "co-designing threatens the existing power structures by requiring that control be relinquished and given to potential customers, consumers or end-users" (p.9). If we swap out the words "customers, consumers and end-users" with "educational stakeholders," (including teachers, students, parents, and other community members vested in education), the statement still rings true. In many societies, educational systems operate under an authoritative, top-down structure, one that tends to not reflect on teachers' recommendations, or their needs and desires for student experiences.

2.3 Teachers and School-Based Management Committees

The co-design activity aimed to gather as much in-depth understanding as possible from stakeholders, particularly teachers and School-Based Management Committee (SBMC) members, about the state of education in their communities. SMBC's are established to increase community participation in school management. SBMC members include stakeholders from schools and the local community, including (but not limited to) headteachers, parents, local religious leaders, local government officials, students, and

alumni (Ogundele & Adelabu, 2009). In a place where western education is met with suspicion, as it is in northeastern Nigeria, SBMC members serve an important role in ensuring that materials will be adopted and advocating for their use. For the co-design activities, we met with teachers and SBMC members in Northeastern Nigeria during fall 2019 and worked together to develop a comprehensive understanding of the Nigerian education system. Using personas, a design thinking strategy, paired with co-design methodology, the team worked with Northeastern Nigerians to develop teacher personas to aid in curricular and materials development. The personas provided us with information about the issues and challenges faced by teachers in the region, which in turn will shape future co-design with Nigerian colleagues of relevant and appropriate instructional materials.

2.4 Design Thinking and the Use of Personas

Design thinking is a methodology popularized by companies like IDEO, Stanford's d.School and many business schools around the world. It echoes the traditional design process and research by focusing on user-centered problem solving. "It encourages organizations to focus on the people they're creating for, which leads to better products, services, and internal processes."(Ideo, 2019) Design thinking focuses on understanding the user and the problem holistically, a strategy that can approach undefined "fuzzy" problems and find appropriate solutions that speak directly to the users needs and values. According to Dam & Teo ("Stages," n.d.), design thinking begins with empathy by learning about and understanding the user. One of the key concepts behind design thinking is to understand and empathize with the user. The process avoids assumptions and focuses on collecting information and data. "Don't assume you know what someone thinks or feels. Gathering information about your target consumer is a critical piece of the design thinking approach"(Ideo, 2019). "Target consumers," in this case, are the teachers in Northeastern Nigeria. In order to learn as much as possible about these teachers, the research team worked with teams of educational stakeholders (teachers and SBMC members) to create personas of teachers in Northeast Nigeria.

Personas act as a visual for a design team to use while designing tools–in our case, educational tools for use in Northeast Nigeria.

> "Personas are fictional characters, which you create based upon your research in order to represent the different user types that might use your service, product, site, or brand in a similar way. Creating personas will help you to understand your users' needs, experiences, behaviours and goals. Creating personas can help you step out of yourself. It can help you to recognise that different people have different needs and expectations, and it can also help you to identify with the user you're designing for " (Dam & Teo, Persona, n.d.).

Personas are generally inexpensive to create, but they are very valuable in unifying the research team and helping them to imagine a specific user while creating an innovative product ("Personas," 2013). Typically three to four personas are created and include information that is both generic and specific. For instance, it may give the user's name, gender, and age, but also their values, expectations, and motivations. It may also list their

challenges and obstacles in their life. If the research team is focused on design thinking, and therefore problem-solving, they may use personas to define the problems they intend to answer.

There are several types of Personas. For this project we focused on a type called fictional personas. “The fictional persona does not emerge from user research (unlike the other personas) but it emerges from the experience of the UX design team. It requires the team to make assumptions based upon past interactions with the user base and products, to deliver a picture of what, perhaps, typical users look like”(Dam & Teo, Persona, n.d., para. 11). As Dam & Teo point out, these types of personas can be flawed if the research team has minimal experience with the user group. Because we also had limited experience with teachers in Northeastern Nigeria, we sought local help in developing personas, turning to our Nigerian colleagues for help. Rather than having them focus on their individual, lived experiences, the purpose of fictional personas was to encourage the Nigerians to work together and create collective personas that portrayed their common experiences, allowing us to gain broader insight into the shared experiences of teachers in Northeast Nigeria. By creating fictional personas we were providing a confidential way for our Nigerian colleagues to share their collective experiences. This made the activity more of a storytelling experience, and less about personal stories.

The goal of the teacher personas was to build a valid, reflective, and accurate representation of the Nigerian teacher, one that was based on collective knowledge of Nigerians in order to provide context for the research team and to inform the design of the educational materials that would be created over the next two years of the grant. We wanted to understand their “workflow and work procedures, routines, teamwork, and other aspects of [their] work” (Spinuzzi, 2005, pp.167). These personas also served as a way to understand the classroom situation and the students. This aspect was particularly important because we were limited in the number and variety of Nigerian schools that we could visit because of safety, cost, and time.

3. Methodology

As a part of our broader co-design strategy in the project, we held co-design sessions with educational stakeholders in Northeastern Nigeria who were asked to create personas with the objective of answering the following overarching and sub-research questions: How can using personas in co-design studies with educational stakeholders inform the development of educational materials for Nigerian schools?

1. How do educational stakeholders portray the experiences of being a teacher in Northeast Nigeria?
2. How do educational stakeholders portray the environment and resources that exist in Northeastern Nigerian schools?
3. How do educational stakeholders portray the experiences of the students in their schools?

3.1 Co-Design Persona Sessions

Co-design sessions took place in November 2019, at AUN in Yola, Nigeria. The co-design participants included teachers and SBMC members, who had traveled from within Adamawa and Gombe states, and had been recruited by colleagues from the local university. The approximately 50 people in attendance were organized into eight groups of men and women, with between six to eight people per group. The session plan was authored by a design researcher who has a focus in interaction design and a literacy expert and had approval from KSU's Institutional Review Board. The co-design session was implemented by four researchers from the partner institutions. Together they provided information, supplies, directions, and fielded questions as they arose. The room was large and had long tables where the groups could easily collaborate with each other and on the poster.



Figures 1,2 Workshop participants working on personas of Nigerian teachers. Participants were initially organized into groups of men and women, but many chose to re-organize themselves into single-sex groups.



Figures 3-5 Researchers walked around answering questions. Workshop participants worked in groups to create teacher personas, discussing the values and needs of the typical Nigerian teacher. They used local newspapers and art supplies to create visuals.

Each group was provided with the following prompts at the start of the 45-minute session:

01 Welcome: The session began by welcoming the teachers and educational managers from the Northern states. We informed them of our goals and mission and explained why we needed their help.

02 Prompt: We asked the group to create personas of "the Nigerian Teacher." Working in small groups, participants were asked to answer the following questions:

- Describe your educational work space using text, sketches, and diagrams
- What things or objects do you use to teach your class?

- What books or textbooks do you use for literacy and math education?
- Where do you teach (describe the space)?
- What resources do you need most?
- Do you use any technology or extra resources at home to prepare for class?
- What languages are spoken in your classroom?
- What is the English ability of the students (if any)?
- How do you assess your students' understanding?

03 Persona: Using paper, markers, and notes, participants were asked to create a poster of a fictional "Nigerian teacher," based on the reality they know. We asked them to define this persona by explaining this "teacher's'" interests, values, challenges and needs. We encouraged them to express their ideas in whatever way was easiest: by drawing, writing, using notes, pens, pencils, and markers. Local staff at the host site provided newspapers, photos, and graphics for use in posters and collages. The materials were limited to what would be readily found in Northeast Nigeria.

04 Present the Persona: As a team, please present your persona to the group. The presentation should be around two to five minutes in length.

Participants worked independently while researchers walked around, answered questions, and offered feedback. The activity took time to get started, as this was a new experience for the groups, and many participants did not understand what was expected of them. After 30 minutes the groups had moved from quietly talking amongst themselves, to loudly making posters. At the end of the session the groups presented their finished personas. The presentations were recorded for later review and analysis.



Figures 6-8 Workshop participants presented their personas as teams. They explained the images they selected and how they were relevant to the persona.

4. Data Analysis

The dataset that emerged from the persona activity consisted of two parts: 1) the personas and 2) the videos of the groups presenting their personas. The personas were considered the primary dataset. Because each group created two posters, there were sixteen posters in the persona dataset. These posters contained existing images from newspapers, hand-drawn images, and text. The videos of the groups describing their personas were used as a secondary dataset, mainly to provide additional detail and insight into the groups' depiction and intent. A video was taken of each group resulting in a dataset of eight videos.

Due to the multimodal nature of the dataset, we analyzed the personas looking at both the content of the persona as well as the visual aspects of the persona. The goal of coding the content of the personas was to understand the message stakeholders were trying to convey and understand more about their lives and experiences as a teacher, in the classroom, and interacting with their students. Given the multimodal nature of the personas, we used a multi-phase coding strategy where the goal was consensus rather than intercoder reliability. The first coding phase consisted of holistic coding methods (Saldana, 2016) to help identify

broader topics to guide the second coding phase. Three researchers engaged in detailed, in-depth discussions while looking through the personas to identify broad themes that were present throughout a majority of the personas. The broad themes that emerged from these discussions were teacher aspirations, challenges teachers face, challenges and improvisation with resources and the environment, hopes for students, and challenges faced by students.

In the second coding phase, two researchers took the broad themes and completed a thorough coding of each persona, identifying detailed, discrete chunks of data in each persona that fit under each theme. The videos of the groups presenting their personas were used as supplementary data to provide insight into each group's intent and the message they were trying to convey. Each chunk of data coded under each theme was described in a spreadsheet so that the researchers could view all instances of where and how that theme emerged in the personas. A cycle of descriptive coding (Saldana, 2016) was then applied to all of the data that was organized under each broad theme and frequency counts were done for each code.

During the second coding phase, the two researchers also coded the visual aspects of the personas. The goal of coding the visual aspects of the personas was to understand how the participants were trying to convey their experiences. To do this, researchers coded where the personas included the following: existing newspaper images, hand-drawn images, existing newspaper text, simple handwritten labels, short handwritten descriptions, long handwritten descriptions. These codes were analyzed using frequency counts.

5. Results

The data collected during the persona creation provides insight into the three sub-research questions guiding the study:

1. How do educational stakeholders portray the experiences of being a teacher in Northeast Nigeria?
2. How do educational stakeholders portray the environment and resources that exist in Northeastern Nigerian schools?
3. How do educational stakeholders portray the experiences of the students in their schools?

5.1 Teacher Experiences

All of the personas provided insight into teachers' experiences in Northeast Nigeria, which was expected given the prompt. While the personas portrayed a variety of experiences, most of them fit into the overarching categories of "challenges" or "aspirations." All of the groups portrayed a variety of significant challenges that teachers face in Northeast Nigeria, and five of the groups depicted aspirations or hopes for teachers' experiences. The data from the personas suggest that the teachers face a variety of challenges in their daily roles. Lack of pay and promotion was portrayed as the most significant challenge. The groups also depicted

lack of instructional materials and conducive learning environments as substantial challenges in teachers' experiences, but those responses have been consolidated under research question two. Lack of support in their teaching role and lack of professional development were two other challenges that were communicated in the personas.

Table 1 Challenges that were communicated in the personas.

Challenges	**Percentage of Total Challenges Teachers Face (N=16)**
Lack of professional development	11%
Lack of pay and promotion	56%
Lack of support	33%

While it is apparent that Northeast Nigerian teachers face substantial challenges, they also have aspirations for improving their teaching experiences. The groups indicated that teachers want to be active, competent teachers and they want their students to be successful. For the teachers to be successful, they felt that they need to have their basic needs met and they need resources and support from their schools, communities, and governments.

Table 2 Aspirations communicated in the personas.

Aspirations	**Percentage of Total Aspirations Teachers Have (N=10)**
Desire to be an active, competent teacher	40%
Support for education and schools from government and communities	30%
Teachers' basic needs are met	20%
Students are successful	10%

5.2 Environments and Resources

The personas also provided insight into how the groups perceive the environments and resources that exist in the Northeast Nigerian classroom. The personas conveyed considerable challenges around the classroom environments and resources. Seven of the groups included challenges around classroom environments in their personas, while six groups included challenges around instructional materials and resources in their personas.

Table 3 Challenges in the Classroom Environment

Challenges	Percentage of Total Challenges with Classroom Environments (N=19)
Inadequate or damaged facilities	50%
Classroom furniture and arrangement	25%
Lack of a conducive learning environment	25%

With the classroom environments, the personas predominantly focused on the facilities, highlighting damage (such as missing roofs) to the buildings and classrooms as a result of flooding or other disasters. They also touched on inadequate classroom environments due things like overcrowding and lack of desks and chairs. Finally, some talked about the assortment of challenges in the environment more broadly as a general lack of a conducive learning environment. For the education resources, some groups referred to a general lack of educational tools and materials, but other groups identified specific types of resources that were lacking in the classrooms. Of the specific materials, writing materials were mentioned most frequently, followed by textbooks and technology.

Table 4 Challenges with Classroom Materials

Challenges	Percentage of Total Challenges with Classroom Environments (N=19)
Lack of technology	14%
Lack of textbooks	21%
Lack of other reading materials	7%
Lack of writing materials	29%
Lack of educational tools and materials	29%

While the groups mostly focused on challenges in the classroom environments and resources, a few incorporated references to teachers being resourceful and working with what they had. One group depicted a teacher holding class under a tree as a way of dealing with challenges in the classroom environment. Others described using leaves and sticks in the classroom as manipulatives and measurement devices. This suggests that the teachers are resilient and resourceful in finding ways to continue instruction regardless of the challenges they face with the classroom environment and lack of resources.

5.3 Student Experiences

Through the personas, the groups also provided insight into how they perceive students' experiences in Northeast Nigeria. For the most part, the personas depicted students' barriers to success in school. Perceptions of students' experiences were fairly evenly distributed. First, a majority focused on students' basic needs and showed that when their needs are not met, their ability to learn is compromised. In addition, a few of the groups touched on how

students with too many chores at home and an overall lack of support from their families can also interfere with students' success in learning. Finally, student personas brought up the dearth of resources and adverse school environments.

Table 5 Barriers students Face

Barriers	**Percentage of Total Barriers Students Face**
Lack of support outside of school	13%
Distressed emotional state	20%
Hunger	13%
Poor health and hygiene	20%
Responsibilities outside of school	13%
Struggles in learning due to lack of resources and adverse school environments	20%

5.4 Personas, Co-design, and Educational Materials for Nigerian Schools

The findings discussed under research questions one, two, and three also offer insight into the overarching research question guiding the study: How can using personas in co-design studies with Nigerian teachers inform the development of educational materials for Nigerian schools? Overall the personas have provided our research team with important insight into the overall educational experience in Northeast Nigeria that will inform the development of educational materials created in the grant.

The personas have already informed specific decisions that we are making about the educational materials. While we had not originally planned to have textbooks or workbooks as a part of our materials, we recently adjusted the materials plan to incorporate literacy and numeracy workbooks. This change was justified in the personas with the emphasis on lack of textbooks. Furthermore, we had planned to incorporate fewer but more advanced tablets in the materials package, but the emphasis on lack of writing materials has led us to consider incorporating a greater number of e-writers as a replacement for more advanced tablets. Even though we are considering limiting the amount of tablets, we still plan to include some tablets, and will include a writing-focused app to help children learn letter writing and letter sounds in a digital platform that integrates video and feedback.

Finally, to meet the teachers' desire for professional development, we are exploring the possibilities of creating scripts for instructional videos that can be recorded and used by Nigerian teachers for professional development. Ultimately, the personas have already begun to inform our development of the educational materials for schools in Northeast Nigeria, and we anticipate that they will continue to do so as we move forward in the grant.

5.5 Limitations

The findings presented here provide valuable insight into the perceptions of educational

experiences in Northeast Nigeria. However, there are limitations to this data that need to be considered. The participants were from two states in Northeast Nigeria, and therefore the experiences described here may not apply to all of Northeast Nigeria. In addition, the limited amounts of newspapers and existing images that were provided may have restricted the participants' ability to fully communicate their perceptions in the personas.

6. Conclusion

The use of co-design methodology and design thinking helped the research team to pinpoint and understand the most significant challenges faced by Northeastern Nigerian teachers. And while these challenges, including building government support for funding for schools and significant improvements to infrastructure, are overwhelming and far beyond the scope of our grant, the team was astonished at the resiliency and positive outlook demonstrated by the teachers. Despite low or late pay, a lack of the most basic educational resources, and poor facilities, these teachers return to work day-after-day.

The results have informed our planning of educational materials that will be delivered to classrooms in Gombe and Adamawa states in 2020. As this grant moves forward we plan to use co-design and design thinking strategies with the Nigerian teachers again. The activity was insightful and provided user-defined data. While our study was qualitative and small scale, it provided much information about teachers in an area known for a decade of civil unrest and terrorism. The co-design sessions allowed us to gather information and communicate with Nigerian educational stakeholders in an informal and creative manner. The personas provided them with a data-rich artifact, which allowed them to present a narrative about issues faced by teachers in the region to the research team.

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Collecting People's Preferences in Immersive Virtual Reality: A Case Study on Public Spaces in Singapore, Germany, and France

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Abstract: In the design of urban public spaces, the inclusion of diverse voices enhances the development of products and services by synchronising designer expertise with people's preferences. Multiple participatory methods exist, each with their respective benefits and drawbacks in terms of the quality of results, time and cost needed for preparing and conducting studies, and knowledge required for participation. Providing more concrete representations of abstract or intangible design concepts would be beneficial for laypeople unfamiliar with design or the case study. We propose a Virtual Reality (VR) platform to discover subjective preferences on public waiting rooms through immersive design experiences. The VR platform was tested with 463 participants with variety in age and cultural background. Following a qualitative data analysis, we discuss the suitability of our VR platform for fostering inclusive participation and how it impacts the role of the designer, as well as propose design guidelines for future VR studies.

Keywords: virtual reality; participatory design method; user preferences; design guidelines

1. Introduction

Current participatory design approaches let people express their needs and wants by Current participatory design approaches let people express their needs and wants by generating, elaborating, evaluating, and challenging solution approaches (Kohler et al., 2017). However, some of these approaches involve a considerable amount of time and cost. Furthermore, using abstract methods for studies of hypothetical nature could lead to wrong design directions caused by a potential lack of comprehensibility and imagination of the study context for participants (based on Ableу, 2000; Hirsch, 2014). Consequently, participants' stated preferences could show great discrepancies compared to their actual preferences due to a lack of imagination and experience of the study context (Bann, 2002; Murphy et al., 2003).

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Immersive Virtual Reality (VR) could be a game changer for designers to solve this issue. Especially when scenarios or prototypes are too expensive or not feasible for manufacturing, the technology of VR enables immersive experiences that convey a desired message in a realistic and tangible way (Mihelj et al., 2013). However, this technology might be inaccessible for societal stakeholders such as seniors. Furthermore, aspects such as gender, place of living, and prior experience with VR could also have an influence on technology savviness.

Considering the aforementioned aspects, in the present study, we propose a VR platform for collecting people's preferences based on immersive experiences. As our research objectives, we want to explore i) if VR is a suitable tool for designers to collect preferences while considering people with various demographics, age groups, and prior knowledge with VR, and ii) how this method changes the role of the involved designers during the application development process and data collection.

2. Related Work

Current approaches in product development including the creation of meaning and value are shifting from company-centred to user-centred approaches (Prahalad and Ramaswamy, 2004). Thus, designers increasingly involve people into the design process for shared value creation activities since this involvement leads to the identification of people's needs and wants and increases the efficiency of product development while creating relationships with people (Prahalad and Ramaswamy, 2004). Variants of participatory practices are participatory design, co-design, and co-creation (Sanders and Stappers, 2008, 2012). A whole landscape of methods for participatory activities exist including methods such as paper prototyping, collages, diaries, card sorting, questionnaires, and interviews (Bartl et al., 2010; O'Haire et al., 2011; Sanders et al., 2010). While these methods show great benefits such the capability to facilitate collaboration and establish dialogues, they also show limitations such as a lack of comprehensibility for hypothetical studies, high involvement of time and cost, and low motivation for participation (Bann, 2002; Murphy et al., 2003; O'Haire et al., 2011). Nelson and Towriss (1995) investigated the accuracy of people's preferences in consideration of visual representation and concluded that individuals had problems making choices based on abstract attributes presented in textual form (based on Abley, 2000). Farooq et al. (2018) conducted a study to collect people's preferences in VR in the domain of pedestrian research. The researchers conclude that VR has the potential to improve the collection of people's preferences based on the establishment of experiences as a foundation for participants to express themselves. Farooq et al. (2018) further points out limitations such as requiring a considerable amount of expertise for the development as well as a great amount of effort for developing such a tool.

The usage of VR for data collection can also be challenging due to the uncertainty to which extent the technology is suitable for diverse people in consideration of aspects such as gender, age, societies with varying access to and perception of technology in general, or prior

knowledge regarding VR (Pick and Azari, 2009; Stadler et al., 2019; Venkatesh and Morris, 2000). O'Brien et al. (2012) discuss experiences of technologies considering age and prior knowledge. The researchers conclude that designers need to understand the targeted user group's prior knowledge with technology to facilitate the usage for participants with little training or instruction. Gregor and Newell (2001) state that seniors have different capabilities in terms of physical, sensory, and cognitive functionality compared to younger people. Thus, seniors for instance have different needs than children, especially in terms of accessibility to technology.

3. Method

In order to answer our aforementioned research objectives, we share our experiences, observations, and statements from our stakeholders throughout the process of VR platform development and data collection. We describe our experiences while testing our application with a diverse group of people and highlight the impact of developing and using our VR platform based on a predefined criteria set, including aspects such as validity and reliability of our results, time, costs, the complexity for the involved designers, as well as the complexity for participants.

3.1 General introduction to the case study

The case study dealt with the collection of spatial preferences of waiting rooms for public transport (e.g., metro or bus) for the development of future transport infrastructure. Local transport authorities were stakeholders in this project who were interested in considering a wide range of people's voices for creating future public transport waiting rooms. Therefore, the aim was to collect data from 400+ participants from Singapore, Germany, and France.

The VR platform was created to enable participants to configure an indoor waiting room based on the variables of room proportions, wall colour schemes, brightness of the room, and crowd level. A VR indoor environment was chosen to minimize the risk of distraction for participants, caused by independent influences from the outside environment (e.g., its visual representation or animations of traffic and/or crowd).

3.2 Development of the VR platform

During the development of the VR platform, we explored how our designers engaged with other fields for interdisciplinary collaborations and how the role of our designers changed during this phase.

Since one requirement from the transport authorities was the consultation of the public that includes diverse participant groups, events such as trade fairs, public exhibitions, scientific events, as well as community centre events were chosen for the data collection. Therefore, a low-cost stand-alone Head-Mounted Display (HMD), called Oculus Go, was used due to its flexibility and independence of high-performance computers and wiring. One benefit of using the Oculus Go device was the ensured privacy for participants throughout the

whole experience since their first-person-view was not visible to anyone else. We decided against offering a locomotion option for participants in VR via the touchpad since this would have needed an extended introduction and could have led to motion sickness. Therefore, we decided to offer teleportation points inside the configurator that allow participants to experience the room selections from a range of position points and perspectives.

To achieve a centralized collection and categorization of data, we decided to include a consent agreement form as well as the background questionnaire in the VR application. The background questionnaire asked participants for their age, gender, place of living, as well as prior experience with VR. Since we conducted the test in three different countries, we included three languages modes (i.e., English, German, and French) from which the participants could choose one language at the beginning of the VR experience.

The interactive configurator in VR constituted the core of our VR application. It consisted of an adaptable indoor environment that was visually similar to underground metro stations. The participants could change the variables of room proportion, colour scheme of the wall, brightness of the room, and crowd level with the help of a user interface that could be hidden when it was not in use (Figure 1). When the participants changed a variable, the surrounding automatically updated accordingly, thus allowing participants to directly experience a certain configuration in VR in an immersive way.

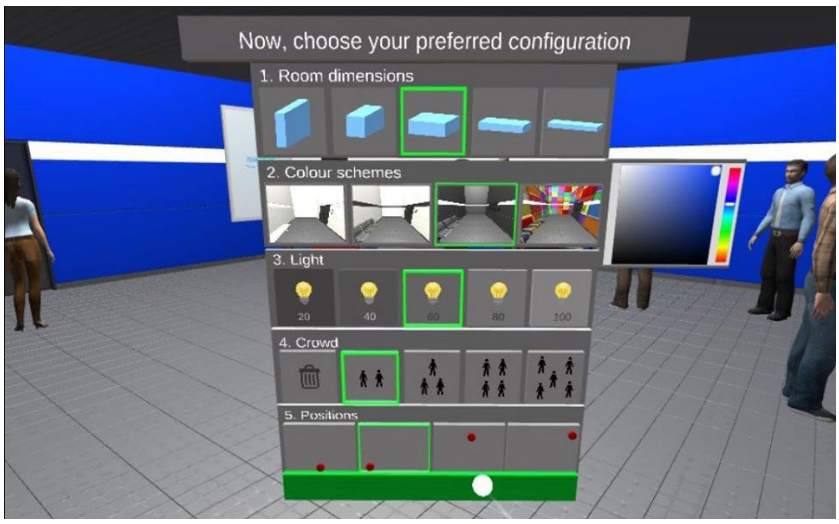

Figure 1 User interface of the interactive configurator

The participants interacted with the VR system by aiming at an option with the input raycast and select the respective option by pressing a button. This interaction technique was maintained throughout the whole VR experience.

The application was internally developed using the game engine Unity (version 2018.3.0). The timeframe from initiating the project to the completion of application development was four months, involving the continuous effort of two designers, two software developers, one 3D visualizer, and a team member with a degree in psychology.

3.3 Data collection and test of the VR platform

Besides gathering preferences about public spaces, the data collection concurrently enabled the testing of our VR platform. We explored the impact the immersive experiences had on the participants for expressing their preferences. Moreover, we investigated the role of our designers during the data collection with the VR application.

We tested our VR platform at public events in Singapore, Germany, and France at a trade fair, an open exhibition, a science event, a university information day, as well as two data collection events in community centres. Thus, we reached out to exhibition visitors, passer-by, students, families, children, and senior communities to include a diverse group of participants in terms of age, place of living, and prior experience in VR. Since the aim was to collect data from a large group (400+) of individuals from different backgrounds and test to which extent VR can be used by all, the only inclusion criterion to participate in the study was the ability to read in English, German, or French. During the data collection, we documented participants' feedbacks, comments, and stated excitement or disappointment.

At least one researcher per VR device was continuously present during every event to allow efficient data collection.

3.4 Evaluation of the VR platform

We qualitatively assessed our results considering a predefined set of criteria that was relevant for carrying out our project (based on Stecher et al., 1997). The considered criteria were as follows:

- Validity of collected results in terms of identifying preference patterns
- Reliability of results by comparing the similarity of data among one participant group (i.e., senior communities) that was collected during two independent events
- Time for developing the VR platform, for conducting the tests, and for data analysis
- Costs for the development of the VR platform and for the data collection
- Complexity for the designer during the development of the VR platform and for participants to conduct the test

The criteria set allowed us to qualitatively compare the development and usage of our VR application with other methods that designers usually would consider for this specific case study (e.g., conducting a pen-and-paper questionnaire or using physical prototypes).

4. Results

4.1 Development of the VR platform

During the development of the VR platform, we noticed that a wide range of expertise was required to ensure a rigorous and successful development of the application. Therefore, two

designers, two software developers, one 3D visualizer, and one team member with a degree in psychology were involved in the project. We noticed that, due to the interdisciplinarity of the team, the designers' role changed to being the project coordinators during the development of the application. This included aspects such as staying on schedule, establishing and maintaining a continuous dialogue among the team members, defining the methodology for rigorous data collection together with the team member with a degree in psychology (including the definition of the questionnaire and variables of the configurator), sharing CAD work with the 3D visualizer (i.e., model the required 3D models), and working together with the software developers to ensure a usable and comprehensible interaction with the VR application (i.e., define the inputs for making selections in VR, define the interfaces, and ensure usability). This interdisciplinary way of working and the collaboration led to the opportunity for all stakeholders, but especially the designers, to acquire expertise from other fields.

Figure 2 shows two examples of participants' room configurations.

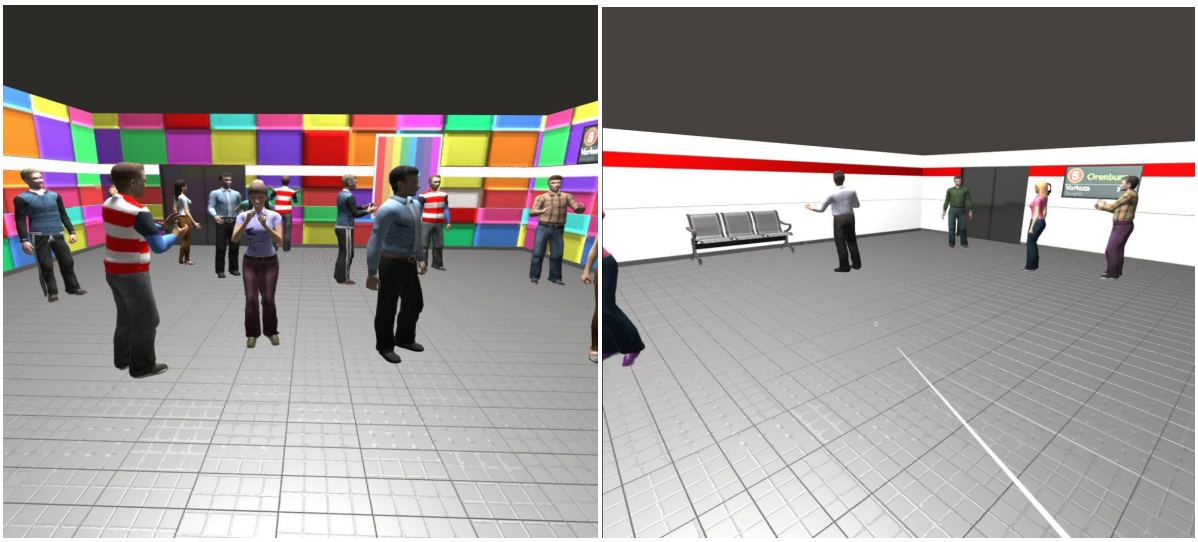

Figure 2 Two examples of possible room configurations

4.2 Data collection and test of the VR platform

We collected data from a total of 463 participants (50% female, 49% male, 1% prefer not to say) with an overall age range of 8 to 89 years (M=39.88, S.D.=19.96). Figure 3 shows the age distribution of all participants in consideration of place of living.

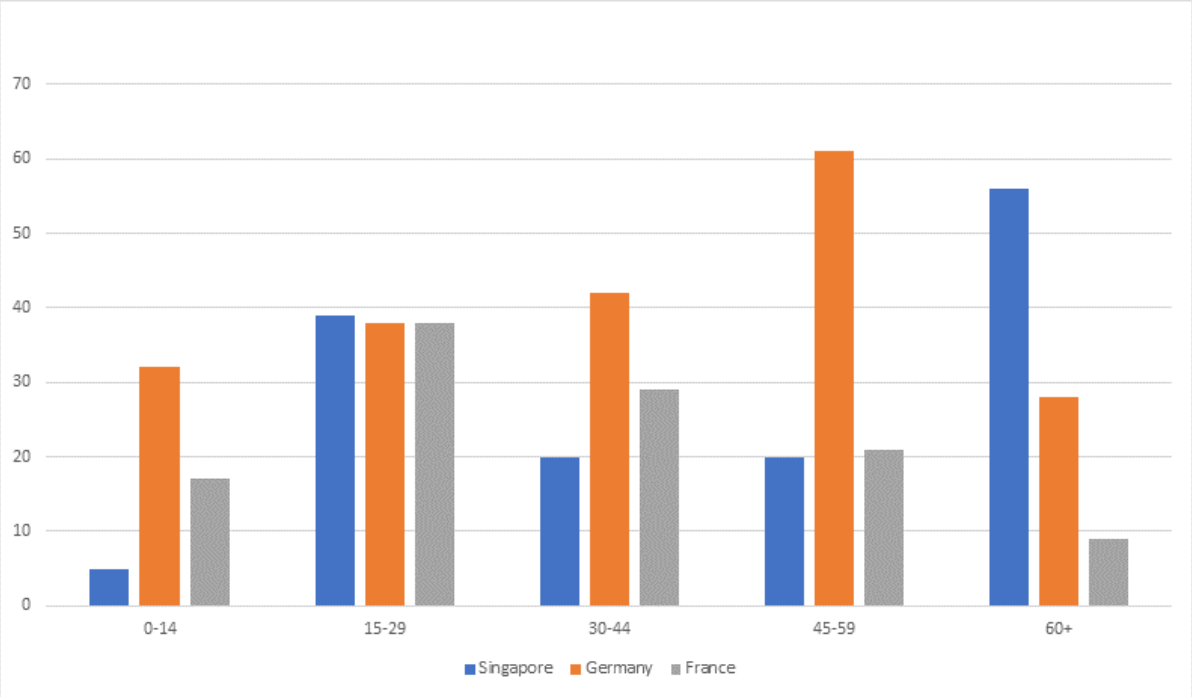

Figure 3 Age distribution of participants in consideration of place of living

We collected data from the following participant groups:

- 201 passer-by, families, and school classes during a public trade fair in Germany
- 122 visitors of an exhibition about new mobility forms in France
- 57 seniors from two community centres in Singapore
- 22 passer-by during a public science event in Singapore
- 61 students during an university information day in Singapore

As the aforementioned participant groups show, we could establish great diversity of participants. However, no homogenous age distribution across the 3 places of living was established (except for the participant group between 15 and 29 years of age). Figure 4 shows pictures from the data collection events.



Figure 4 Data collection events in Singapore, Germany, and France

Firstly, we want to highlight that the motivation for participation during the public events was unexpectedly high. Especially at public events such as the trade fair and the mobility exhibition, the VR devices attracted immense attention. In contrast, at the scientific event in Singapore, the VR devices apparently appeared intimidating for passer-by, which led to a more cumbersome data collection compared to the aforementioned public events. In general, we observed that during almost all data collection events, the majority of participants approached the researchers out of curiosity regarding the VR devices. This applied especially for young people such as school classes and families with young children who approached us with the motivation to try out the VR devices and with the expectation to experience a game or a virtual roller coaster ride. After introducing the visitors to the study and explaining the purpose of the VR experience (i.e., a research study and not a VR game experience), we expected less motivation from people and especially children to participate. Nevertheless, the majority of visitors were still motivated to participate in the study. For the data collection events at the senior community centres, we observed that the senior citizens saw it as their responsibility to register for the data collection session, with an intrinsic motivation to state their preferences and to help us develop a future public transport station that fulfils the needs and wants of people. In conclusion, the usage of VR highly motivated people to participate in the study. Furthermore, we were able to involve communities in our study consisting of seniors who have never tried VR before. Even though some seniors encountered problems while interacting with VR, the guidance of our designers led them to successful data submissions.

Secondly, regarding the changed role of our designers during the process of data collection, we noticed that throughout all events, our designers became facilitators and guides. Their

main task was to brief the participants and be available for questions and guidance. From the introduction onward, our designers motivated and guided the participants through the whole VR experience. Therefore, we observed that our designers bridged the gap between people and the technology of VR. Our designers encouraged the participants to experience all available variables of the configurator before submitting their preferences. Since some participants (and mostly seniors with no prior VR experience) faced problems with interaction with the system, our designers accompanied every participant to ensure a successful experience and data submission.

Thirdly, based on our observations and dialogues with the participants, we were able to explore the impact that the immersive experience had on participants to express their preferences. Due to the continuous guidance of our designers, the experience for all participants was tailored according to their needs. This fact distinguished our data collection method substantially from conventional surveys since all participants had a unique experience to find, verify, and express their preferences. Nevertheless, we anticipate that this individualized experience for every participant decreased the comparability of the collected data. A large number of participants emphasized after the data collection that the VR platform helped them to experience the room configurations and choose their favourite specification based on the immersive comparison. Our researchers also observed that almost all participants explored all available variables and took a considerable amount of time before submitting their preference. Furthermore, several participants even highlighted that they were not happy with a certain room configuration after seeing it in VR and then changed specific variables based on that experience. This indicated that the possibility to experience the room configurations and preferences in an immersive way allowed people to verify whether their stated preferences resembled their actual preferences.

Lastly, during and after the VR experience, many participants were talkative and described their experiences and impressions to our designers. Thus, a strong exchange from participants to designers and also among participants was established during the data collection events. Furthermore, the participants shared their opinions regarding the VR platform, its visual representation, and the interactivity with mixed statements. While some participants expressed their excitement regarding the virtual environment, representation, and interactivity, others expressed disappointment (e.g., the visual representation of the crowd was not convincing).

4.3 Evaluation of the VR platform

The data analysis and qualitative assessment in consideration of the predefined set of criteria shows a range of advantages and limitations for using the VR platform for collecting people's preferences in comparison to other design methods.

The main statements of the qualitative criteria assessment are summarized below.

Validity: Regarding the case study, which aimed at unveiling people's preferences regarding public spaces in dependency of demographics, we were able to collect significant data

showing an effect of age on room proportions and wall colour preferences, as well as an interaction effect of age and place of living on preferences in room brightness and crowd levels. This shows that VR was able to effectively capture the different preferences of individuals from different culture and age group, a further support in the validity of the tool. These results helped us to formulate recommendations for local authority stakeholders for the design of waiting rooms for public transport. Furthermore, statements from participants who claimed that the real-time immersive experience allowed them to reflect on their configurations support the validity of our method compared to conventional methods such as picture-based questionnaires.

Reliability: Comparison of data collected from both community centre events with 57 participants was conducted to see if there are any significant differences in preferences among participants from similar demographic background (all Singaporean elderly participants). Results revealed that the preferred room configurations from the 2 community centres were not significantly different, suggesting high reliability in the data collection tool.

Development time: We observed that the creation of the VR platform through the interdisciplinary team was more time consuming than preparing user interviews or questionnaires. Nevertheless, the development time for creating all room configurations in real-life conditions (e.g., a showroom) to allow participants to experience each configuration in an immersive way would be linked with tremendous efforts and appears rather infeasible to us. Therefore, we see VR as a trade-off to allow immersive experiences without the need to create environments in real-life conditions.

Data collection time: Based on our experience, the time consumption for participants to undergo the test with VR is comparable to other methods such as interviews or questionnaires. However, we noticed that the data collection for some participants and mostly seniors required additional time to clarify the interaction with VR.

Data analysis time: The centralized and digital data collection greatly facilitated the task of processing and analysing our collected data since all submissions were directly collected and categorized by the automatized back-end of our VR application and compressed into one data file. Thus, in contrast to a pen-and-paper questionnaire, no manual transcription was necessary. The data analysis time was comparable to digital data collection methods such as online surveys.

Costs: In terms of costs during the development and conduct of the study, we experienced disadvantages compared to questionnaires since the development of the application required a considerable amount of effort and expertise. Furthermore, even though we decided to use low-cost Head-Mounted Displays, the cost for conducting the study with VR devices is more expensive than conducting questionnaires (either pen-and-paper or digital). However, in contrast to real-size prototypes, our VR platform constituted an advantageous alternative in terms of costs.

Complexity for designer: Since the expertise of 3D visualizers, software developers, and a team member with a degree in psychology was required for the development of the

application, we experienced that the creation of the VR application led to increased complexity for the involved designers compared to the preparation of questionnaires or interviews.

Complexity for participants: The usage of VR for the data collection was challenging for some participants due to the lack of experience with VR. Thus, in comparison to face-to-face interviews or written questionnaires, we experienced an increased complexity for some participants to conduct the test.

4.4 Recommendations and design guidelines

The qualitative criteria assessment underlines that the process for the development of the VR platform as well as the data collection is linked to considerable efforts, which can only be addressed by a multi-disciplinary team. We recommend using a VR platform especially if an emphasis is placed on people's experiences. Further, if the goal is to create a link between the designers and people, the data collection process with VR can lead to strong connections.

A set of design guidelines has been compiled based on our experiences throughout the process. For developing a VR platform, we recommend the following guidelines:

- Ensure availability of the required expertise within the team.
- Establish a continuous dialogue within the development team (e.g., through frequent development meetings).
- Adapt the degree and complexity of interaction with the VR system in terms of usability and interactivity according to the identified participants' skill level of operating such a system (i.e., exciting enough for tech-savvy participants but not overwhelming for people unfamiliar with the technology).
- Prioritize interactivity over representation: An accurate and usable way of interacting with the system is more important than its visual representation.
- The implementation of aspects that might be influenced by technical limitations of VR (e.g., limited resolution) should be avoided since it could bias participants' preferences.

We recommend the following guidelines for using our VR platform for data collection:

- Make sure that at least one researcher with good knowledge about the hardware, software, and context of the study is present for each VR device. If needed, participants should be guided through the whole VR experience. This ensures trust from participants and allows a smooth process for the data collection.
- Take precautions to comfort participants in case of motion sickness.
- Ensure a protected area for the data collection (e.g., a quiet space) and privacy for participants (e.g., do not publicly stream the participants' first-person view).
- Establish context: Holistic experiences allow participants to fully understand the case study and the context to form an opinion on it.

5. Discussion

In the present study, we shared our experiences during the process of developing and carrying out an international large-scale study with the help of a VR platform for deriving people's preferences of public waiting rooms based on unique immersive experiences and the inclusion of individuals from diverse backgrounds - in terms of age, place of living, and familiarity with the VR technology.

Firstly, we found VR to be suitable for collecting people's preferences for our case study. We observed that the unique and immersive experience for each participant led to increased comprehensibility of the study context and allowed participants to verify whether their configuration resembled their preferences before its submission. Thus, we see an immense potential in using VR to collect people's preferences since it could bridge the gap between stated preferences and actual preferences. Researchers such as Farooq et al. (2018), List and Gallet (2001), and Murphy et al. (2003) conclude that preferences that are expressed based on experiences are more accurate while preferences that are based on hypothetical estimations can lead to discrepancies considering the participants' actual needs and wants. Our experiences support this conclusion.

Secondly, using public events as a data collection platform allowed the inclusion of participants with great diversity. We were able to collect data from 463 participants with an age range from 8 to 89 years including passer-by, families, students, and seniors. This showed us the potential accessibility of using VR even for participants without prior VR knowledge. Nevertheless, we experienced challenges for some participants and especially seniors to interact with the VR system. We observed that children and seniors have fundamental differences regarding their needs and accessibility to VR. This is consistent with findings of Gregor and Newell (2001) who conclude that designers have to detach from the mindset of designing for "typical users" and consider inclusive design. Billis et al. (2010) lists guidelines for improving the accessibility for seniors to use VR applications. These guidelines include aspects such as sufficient object and letter size, simple interfaces, and sufficient guidance. Our designers experienced similar phenomena especially regarding the simplicity of user interfaces and the required guidance for seniors.

Thirdly, we experienced how the role for our involved designers changed throughout the process. During the development, our designers were project coordinators who engaged with other stakeholders. During the data collection, our designers were facilitators and guides who accompanied every participant to ensure a unique experience and successful data submission. Thus, our designers bridged the gap between non-tech-savvy people and technology. Furthermore, our designers were the point of contact for the participants to share their experiences and opinions. Researchers such as Sanders and Stappers (2012), Hirsch (2014), and Ehn (1993) state that the role of the designer in participatory activities changes from creators and translators to facilitators and coordinators, allowing people to express themselves. Our study experiences imply the same transition. From a holistic point of view, we observed that during our project, synergies between our designers and

stakeholders were made: Firstly, during the development the available expertise of our interdisciplinary team led to a collaborative basis that allowed the creation of a usable VR platform for rigorous data collection. And secondly, synergies have been established between our designers and participants since the data collection with VR caused active participation and initiated vivid dialogues between participants and designers. This fact was particularly insightful for our designers since these dialogues provided insights to which extent the immersive experiences had an impact on participants and how our application could be improved.

Lastly, we were able to define design guidelines for developing and carrying out a study for collecting people's preferences with the help of a VR. We noticed similarities to the guidelines from Carlsson and Sonesson (2017) for developing VR user experience studies in vehicles, which also emphasize on the technology of VR and the interactivity of the application. In addition, we noticed parallels to the prerequisites of Sanders and Simons (2009) in the context of co-creation on establishing diversity of participants, a continuous dialogue, and holistic experiences.

By qualitatively comparing our method to other design methods such as digital or manual questionnaires and surveys, we conclude that our VR platform requires more time, involves more costs, and increases the complexity for designers and participants. However, the immersive experience that it enables leads to a valid and reliable data collection. On the other hand, in comparison to real size prototyping, our method was more efficient regarding time and cost while still ensuring immersive experiences. Thus, we consider our VR platform as an advantageous trade-off between these methods.

In regard to limitations of the VR platform, we noticed that its usability has space for improvements. Even though we tried to make the interaction in VR as simple as possible, we learned that people without previous experience with VR (often seniors) tended to have problems while interacting with the system. A further limitation was the guidance of our designers throughout the data collection. Since our designers accompanied every participant to ensure a successful experience in VR, we decreased the comparability of our collected data since the procedure from participant to participant was not fully standardized. We anticipate that this may have impacted the collected data. In future studies, we want to investigate how standardization could be established while having guided and unique experiences in VR for participants. Furthermore, we will apply our platform to other application domains to prove its transferability (e.g., collecting preferences of people who regularly use public transport such as Metro or Bus) since our guidelines are currently based on literature research and the experiences in the field of public waiting rooms.

6. Conclusion

Including people in the design process enhances designers' understanding of subjective preferences during the development of products or services. Such inclusion is essential in the context of urban public spaces, which are shared by diverse groups and so should be shaped

by diverse voices. While participatory methods offer benefits such as the shared creation of value and relationships, drawbacks include the considerable amount of time and cost involved for the development and data collection. Furthermore, a lack of subject knowledge or experience and contextual information hinders participants from concretely expressing their preferences. To address these issues, we explored the process of developing and using a VR platform for collecting preferences through simulated, immersive experiences and tested it with people from diverse cultural contexts, age groups, and prior knowledge with VR. The immersive design experience of designing a public waiting room created with VR saw positive impacts on participant motivation and interest in our studies, in addition to more precise data on user preferences. We encourage designers to consider using VR platforms for such hypothetical studies when physical prototypes are unfeasible or too expensive. We also propose design guidelines to facilitate the development and conduct of studies involving VR platforms for data collection. The findings contribute to the body of knowledge and tools available for participatory processes and form a basis for further research in enhancing participatory processes.

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SEAMLESS JOURNEYS TO WORK: A multifaceted approach to exploring daily journey to work experiences of young people with disabilities

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Abstract: Technology advances extend our opportunities for social participation by enabling our ability to establish actual and virtual connections. While these changes prompt new forms of social engagement beyond physical mobility, such advances seem to not have truly augmented the ability of young people with disabilities to self-determine their access to places for work, health or play. This paper reports the creative synergy of four disciplines through co-creation and mixed methods approach that extend our understanding of young people experiences of journeys to work. From relevant policy to surveys and field work, our three-stage research investigated the limiting factors and enablers that make their daily journeys. The results informed our scenario approach to representing current and desired future seamless journeys, as a tool that brings together transport end-users and stakeholders views. Findings from our research aim to inform the design of a more smoothly transition of young people into the workforce.

Keywords: mobility; scenario design; transformative services; policy; disability

1. Introduction: it is not only about transport or employment

In 2018, 4.4 million of Australians —17.7% of the population— reported having a disability (ABS, 2018; 2015). Achieving economic independence is a fundamental right and aspiration of young people with disabilities, yet in Australia, 45% of all people with disabilities live near or below the poverty line (ACSS, 2016). Australian Government funding exists to support people with disabilities find a job and assist employers to hire them, yet almost 38% of all people with disabilities main source of income is a government pension, and up to 70% of workers with disabilities do not keep their jobs beyond the initial six months of employment (Commission, 2017). An example of this growing problem is represented by figures of

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people with disabilities in the public sector. For example, in 2008 Queensland Public Service workforce of people with disabilities was estimated at 10 percent, and to date it has decreased to 2 percent. (PSC, 2018). This significant decline in the public sector workforce seems incongruent as the population of people with disabilities in the workforce will tend to increase due in part to an active ageing population. With this as a point of departure, in this paper we report a study that was set out to investigate the mobility practices of a person with disability, to uncover context dimensions of those mobility experiences of going to work. Extant studies demonstrate that in Australia, young people with disabilities work participation is one of the highest rates of unemployment in the OECD (Soldatic & Pini, 2009). Our research suggests young people with a disability experience poor transitions to employment (Beatson et.al, 2019); and it demonstrates the complexity and multiple barriers hindering education to employment pathways (Stafford et al, 2017; 2019). In addition, our analysis of the main disability services systems reveals how these pathways are tightly prescribed and services are influenced by stereotypical views of disability (Marston et al, 2017). However, little evidence is found about the challenges young people with disabilities in their journey to work, including both their physical commute to work and introduction to the workforce.

From a pilot study of people with mobility related disabilities (Adkins et al 2015) we identified the formidable level of planning that is required of wheelchair users in order to get to work on time, which includes: ensuring they have sufficient support to get ready on time, booking appropriate taxis and ensuring the bus they want to catch is wheelchair accessible. Even when all these are planned for, experiences of being stranded are very common. The cases identified the sequence of supports that need to be in place simultaneously to make the work journey possible and the centrality of online and mobile resources in this process.

In the following sections we describe our research process, and demonstrate the methods we adopted to work from four different disciplines (Social Policy, Social Sciences, Service Marketing, and Design) and across two Universities and four Faculties, our scaffolded process for understanding the experiences of young people with disabilities journeys to work, the creative synergies through co-creation that informed our mixed method approach, and our outcomes so far. This research is conducted as part of the ARC Linkage project Seamless Journeys to Work (LP150100168), which seeks to explore the transition to work of young people with a disability and, the role that digital technologies can play in improving self-determination and employment. The project aims to extend our knowledge for policy and service delivery, and to inform the development of transformative services aimed to deliver online person-to-person (P2P) platforms that facilitate self-determination and seamless journeys for young people with a disability.

2. Young people with disability: mobilities and self-determination in their journeys to work

In this research, the concept of mobility is defined as people's ability to access social life

and services that support a productive life (Raja, 2016). In this notion, the social and built environment context shaping people's mobility experiences play a critical role in determining people's ability to connect the elements that enable their daily routines. The many obstacles that people with a disability experience to their routine mobility to effectively navigate the city as well as indoor spaces, reduce their ability to participate in employment (Lacrow et al., 1990; Moore Sohlberg et al, 2009). From this perspective mobility and self-determination are intrinsically related, as self-determination is the principle of self-direction and choice (Ryan & Deci, 2017). When a person with disability experiences limitation to effectively navigate to work, their self-determination is impacted, and their sense of wellbeing is negatively affected. In Australia, current services and infrastructure do not enable effective commute to work to for people with mobility-related impairments (Chamorro-Koc, Stafford, & Adkins, 2015) limiting their self-determination and positioning them in a situation of inequality.

By journeys to work we refer to the process that young people with disabilities go through in their transition from school to work, their pathway from pre-planning to their actual day experiences, in relation to getting to work. However, this journey to work is a fragmented and disconnected environment that entails complex and often difficult interactions for young people with disabilities with other people, services, infrastructure and systems in their day-day lives (Adkins et al., 2015; Chamorro et al., 2015). These observations are supported by organisational reviews such as the Productivity Commission, (2011a&b, OECD, 2011) that illustrated that people with disabilities experience fragmented support services to employment assistance, personal care, transport, aid and equipment; and all of these also act as barriers to participation in work (e.g. PDA, 2014). As a result of this fragmented system, people with disabilities often require different mechanisms and assistance to help them negotiate and understand how services can be adapted for them.

All the explained supports the notion that young people with disabilities experience poor transitions to employment and with low employment rates (Cocks & Thoresen, 2013; Meadows, 2009), despite existing strategies such as paid work at school (Hemmeter et al., 2009) and client focused approaches. Little is known about what is required and what works for young people with physical disabilities to effectively join the workforce. This gap in knowledge is problematic when attempting to improve the workforce participation rate for this large proportion of young people with disabilities.

Our research team set out to investigate this problem from a systems perspective and to contribute to the understanding of young people with disabilities journeys and transitions to work. We situate our research in the intersection between policy, service landscape (including stakeholders and employers) and the application of a design lens to the understanding of young people with disabilities needs. We address the DRS2020 Conference Synergy Theme by describing our research approach that involved a multidisciplinary collaboration and co-creation of mixed methods to expand our understanding of young people with disabilities journeys to work. To this effect, we present our approach to the development of scenarios illustrating the critical incidents that limit or enable young people's everyday journeys. This is described in the following section.

3. Exploring journey experiences: a mixed method approach

To address the complexity of the research problem described in section 2 and to understand person-environment interactions in young people's journey to work experiences, we conducted this research in three stages:

- Stage 1: Audit of the service and policy landscape
- Stage 2: Identify people's motivations, perceptions, and expectations
- Stage 3: Understand the experience of journeys to work

Each stage is explained in the next subsections.

3.1 Policy exploration and the concept of Creative Resistance

Our Stage 1 of the research analysed disability employment services and the intersecting service systems to understand: (i) how policy and programs influence on the transition to work for young adults with disabilities; (ii) how implementing organisations (e.g. service providers) experience, understand and practice the policy; and (iii) the potential implications and conflicts when supporting young adults with disabilities in their pathways to employment. We analysed the policy and conducted twenty-two in-depth interviews with participants from different organisations; each interview was of approximately 60 min duration each. Participants were personnel from service delivery and advocacy organisations (Stafford et al., 2019) Coding of the interview transcripts was assisted with the use of NVivo 11. Our analysis revealed policy and programmatic derived barriers that are significantly influential on young people's pathways to work because this is tightly prescribed (Stafford et al, 2017; 2019). Amidst this complexity, a key finding in relation to our understanding of the how young people with disabilities and stakeholders navigate the policy landscape, is the concept of *Creative Resistance* (Stafford et al, 2017). We applied this term to those service providers' practices finding ways to overcome prescribed service restrictions in order to help young people with disabilities build their employability. Moreover, our results indicate the need of young people with disabilities of being supported to self-determine their work goals and the support they need; and that this process should account for life experiences, personal characteristics, environment, and resources (Stafford et al, 2017; 2019). The next stage looks into gaining more detail of the factors influencing young people's ability of self-determination in their journeys to work.

3.2 Exploring Motivations and Attitudes: indicators of scenarios

Stage 2 focused on identifying motivations, perceptions, and expectations of young people with disabilities about journeys to work. Extant literature about what influence people's ability to move into the workforce identifies four key factors: socio-cultural factors (e.g. stereotypes and prejudices), environmental factors (e.g. the built environment), transition-policy factors (e.g. access to supported planning), and psychosocial factors (e.g. individual's self-concept, intrinsic motivation) (Abbott & Carpenter, 2014; Baker et al, 2009; Magill-Evans et al, 2008; Huang et al, 2013). However, it is unclear whether these factors influence

the journey to work for young people with mobility related disability. The Model of Goal Directed Behaviour (MGDB) posits that understanding affective and motivational factors of a decision making behaviour help explaining a person's pursuit of a goal (Perugini & Conner, 2000). We applied the MGDB to an online survey in order to examine the socio-cultural, psychosocial and environmental factors influencing young people with disabilities' journey into the workplace (Beatson et al, 2020a; 2020b). The survey was responded by a sample of 200 young adults with a physical and/or neurological disability aged 18–35 years; they were all employed or seeking employment; their mean age was 27.59 years of age; and 55% of the respondents were male. The participants were recruited from all states in Australia and the majority had a secondary education level (19.5%) or bachelor's degree (19%) qualification. 43.5% of participants were employed full-time, 21.5% were employed part-time, 13.5% were employed casually and the remaining 21.5% were employed in a different role or seeking employment.

The results revealed 11 factors influencing young people's motivations and attitudes about their journeys to work: attitude, subjective norms, positive emotions, negative emotions, risk aversion, past behaviour, perceived behavioural control, employer support, social support, desires and intentions (Beatson et al, 2019). Figure 1 shows the interrelations between the 11 factors and their influence in the young people with disabilities desires and attitudes regarding their journeys to work. It also shows that psychosocial, socio-cultural and environmental factors all play a significant role in people's desires and intention to independently commute to work and establish themselves in the workforce.

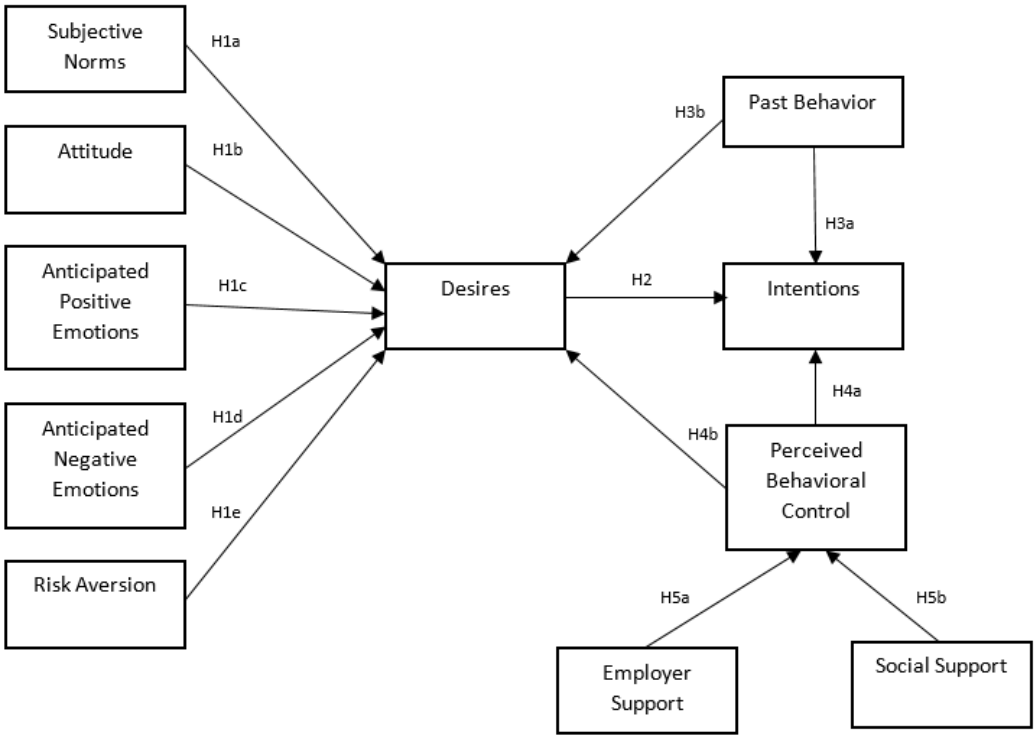

Figure 1 Factors influencing young people with disabilities intention to establish themselves in the workforce

Facilitators of journeys to work are not only the person's readiness for it (psychological factors), but it also requires available support from employers, friends and families (socio-cultural factors), and accessible transport that supports independence (environmental factors). These relationships and influence of these factors in people's journeys to work were more clearly identified in the results from a cluster analysis on the basis of gender, living status, education and employment status, applied to the responses to the online survey. The following table shows the interpretation of the 11 factors in four types of Personas created to demonstrate relationships and influences (names are fictional).

Table 1 Cluster analysis interpreted as four types of Personas and their intentions about their journeys to work.

	JOHN	**MIA**	**TIM**	**JACK**
Description	Male, lives alone, works full time, has a bachelor's degree, 32 years of age, lives in NSW	Female, lives with family, works part time, secondary education, 25 years of age, lives in QLD	Male, lives with family, works part time, secondary education, 35 years of age, lives in QLD	Male, lives with family, works full time, Post-grad education, 30 years of age, lives in NSW
Risk aversion	Moderate M=4.8 Cautious about new situations and taking chances	Very Strong M=5.8-6 Avoids new situations and taking chances	Moderate-Strong M=5.2 Cautious about new situations and taking chances	Moderate M=4.6 Cautious about new situations and taking chances
Perceived workplace discrimination	Feels people are generally treated fairly at work M=4	Feels people are treated fairly at work M=3	Feels people are generally treated fairly at work M=4	Feels people are generally treated fairly at work M=4
Satisfaction	Are satisfied with current job M=6	Are somewhat satisfied with current job M=5	Are somewhat satisfied with current job M=5	Are somewhat satisfied with current job M=5
Supported to gain employment	No	No	Yes	Yes
Employer support	Employer occasionally checks whether I understand tasks and offers to help if needed M=4.29	Employer occasionally checks whether I understand tasks and offers to help if needed M=4 and 4.43	Employer occasionally checks whether I understand tasks and offers to help if needed M=4	Employer occasionally checks whether I understand tasks and offers to help if needed M=4
Transport	Passenger in car	Car as driver	Passenger in car	Train
How found job	Online	Online	Word of mouth/ friends	Online

Find transport apps easy to use	Moderately easy M=4	Very easy M=6	Moderately easy M=4	Easy M=5
Invited to work related functions	Frequently M= 5	Frequently M= 5	Occasionally M=4	Occasionally M=4
Family and friends help me get ready for work	Occasionally M=4	Frequently M=4 and 6	Occasionally M=4	Very frequently M=5 and 7
Disability	Chronic regional pain syndrome	Cerebral palsy	Autism	Limb difference

MGDB has been useful to understand the different factors influencing people's behaviours and attitudes towards pursuing a goal: commuting to work as a necessary component of young people with disabilities transitions to work. We applied then design narratives approach to construct a scenario that can flesh out people's experiences of journeys to work in a more relatable way. Scenarios are a design tool that can be successfully employed to: (i) understand people's everyday practices in context, and (ii) reveal stakeholder relationships in the provision of services within current everyday practices (Chamorro-Koc et al, 2012). For example, consider the following scenario narrative based on Table 1:

> Mia is a 25-year-old female who lives with her family in QLD. She works full time and has a Bachelor degree. In the morning Mia wakes up and gets ready for work with the occasional support from her mum. She drives herself to the train station where she parks and transfers to her wheelchair to catch the train. Her workplace is quite supportive and her boss occasionally checks in on her to see how she is going and offers help if required. Mia is somewhat satisfied with her job and feels people are generally treated fairly at work. After work, Mia is frequently invited to join her colleagues for after work drinks. Because Mia is extremely cautious about new situations, she often avoids attending those events. When Mia needs to go to new places on her own, she researches where they are going to ensure the place is suitable for her and that she can travel there safely. She finds easy to use transport apps to assist with this.

This scenario narrative provides an explicit account of a Persona (Mia), her characteristics, personal views, routines, and challenges that facilitate the understanding of how the 11 factors influences her attitudes and motivations towards her daily journeys to work. It shows that there is much more than just using transport to get to work, and it demonstrates a support system of family and friends, as well as infrastructure, and of technology that she relies on in order to 'get to work'. Building on this scenario, the following section explores in more detail how does a young person with mobility disabilities experiences enablers and navigates barriers in a routine journey to work.

3.3 Exploring people's perspectives: critical incidents and journeys to work experiences

Having identified in Stage 1 that service providers implement creative resistances where possible, and in Stage 2 the factors influencing young people desire and intention to get to

work, our focus in Stage 3 is to identify what enables people's self-determination in their journeys to work experiences. To this end, we employed self-reported field observations and interviews, as key components of a Critical Incident Technique (CIT) method approach. CIT is a method of inquiry that supports the observation of human behaviour by triggering participants to recall stories that can be positive or negative experiences (Flanagan, 1954). Our participant recruitment in this stage was opportunistic. In our research, more than 200 CITs were identified from eight participants, most of them were wheelchair users. Seven participants were employed at the time of the interview, their journey experiences were different, some of them commuting daily while others in rare occasions. In addition, for this part of the research, we tighten our concept of journeys to work as: the activities that people perform before and during a commute, including planning, familiarisation with the route, getting from one place to another, and any other activities included in this process (Sartori, et al, 2019).

Our use of CIT consisted of asking participants to describe memorable examples of limiting situations or support strategies that impacted their self-determination during journeys. We started by asking participants to describe a typical journey that they usually undertake. The participants described their journeys from the moment they prepare to leave, to the moment they arrive at their destination. They were also asked to describe how they adapted or dealt with unexpected events during journeys and if online services or digital platforms helped them to prepare for or during the journey. During interviews the participants self-reported critical incidents about their journeys to work and also about other moments when they felt like their mobility was limited and self-determination was impacted; for example, when going to restaurants and booking hotels. All the interviews were audio recorded to include all the details of the incidents reported and to avoid data collection bias. The audios were later transcribed and prepared for data analysis with ATLAS.ti software. In total, 65 usable incidents during people's journeys to work were identified using this process.

A thematic analysis of the 65 critical incidents generated 5 categories and 22 sub-categories of limiting situations and support strategies that impact on participants' self-determination. The largest limiting situation identified across all CITs was about the use of digital platforms during journeys for planning and decision making (29.1%). The second largest limitation situation was transport options (26.6%); this was followed by technology (19%), policy and standards (15.2%), and communication (10.1%). The following is an exemplar of a participant's CIT of a routine journey:

> You can't just be like, oh, well this place is a bit tricky or different. Like planning is so much more key to life now that you just feel like even if you're going somewhere you don't know, you can't be like, oh, we'll just find a hotel when we get there and we'll just grab a taxi from here. But it definitely avoids a lot of, not disasters, but a lot of complications.

Through this categorisation of limiting situations, Stage 3 extends our understanding of factors enabling or disabling self-determination of young people with mobility-related disabilities in journey experiences. This is illustrated in the form of journey to work experience maps, which we present in the following sections.

4. Actual and Desired Scenarios of Journey Experiences

- Design can play a transformative role in this complex system of enabling and limiting factors, because it brings a human-centred approach and recognises service users as experts of their experiences (Cottam & Leadbeater, 2004; Lundkvist & Yakhlef, 2004). From this perspective, our design approach helped bring together and interpret findings from the 3 stages of the research into a holistic understanding of young people with disabilities journeys to work experiences. The CIT study provided insights into participants' journey experiences, including the process of planning and undertaking routine and non-routine journeys. This information was used to generate journey maps that illustrate the activities that participants reported during the interviews. A journey map is a tool used to represent how a person interacts with a service by synthesising information into a step-by-step representation of service touchpoints (SDT, 2019a).
- The maps generated for this research are an adaptation of a classic journey map because they include a representation of the entire service system involved in people's journey experiences. These journey maps also include sample quotes from participants of critical incidents associated with specific steps of the journey. Figure 2 shows an example of a routine journey map from one of the participants' journey to work routine experience (from Stage 3).

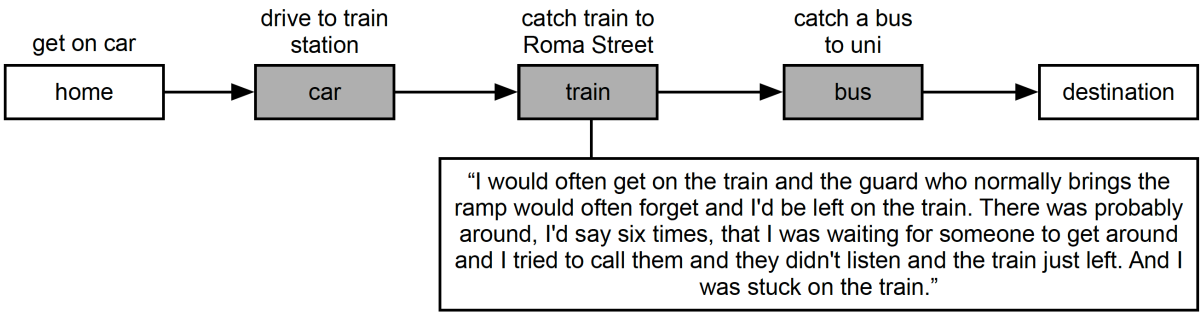

Figure 2 A person's routine journey to work

The Persona example in Figure 2 has similar traits to the Persona presented in the example demonstrated for Stage 2. The illustration reveals the steps that a young person with disability experiences in her journey to work that include driving herself for one part of the journey.

Figure 3 illustrates the journey map of the same Persona, this time the Persona's journey is different, a non-routine journey. It shows the different enablers as well as limiting factors that the Persona encounters at different touchpoints of her overall non-routine journey. It tells that when the Persona engages in a journey to a new destination, her routine planning does not necessarily prevent delays or unexpected challenges. It also shows the moments in which this Persona engages with mobile technology as a way to overcome the challenges,

sometimes successfully.

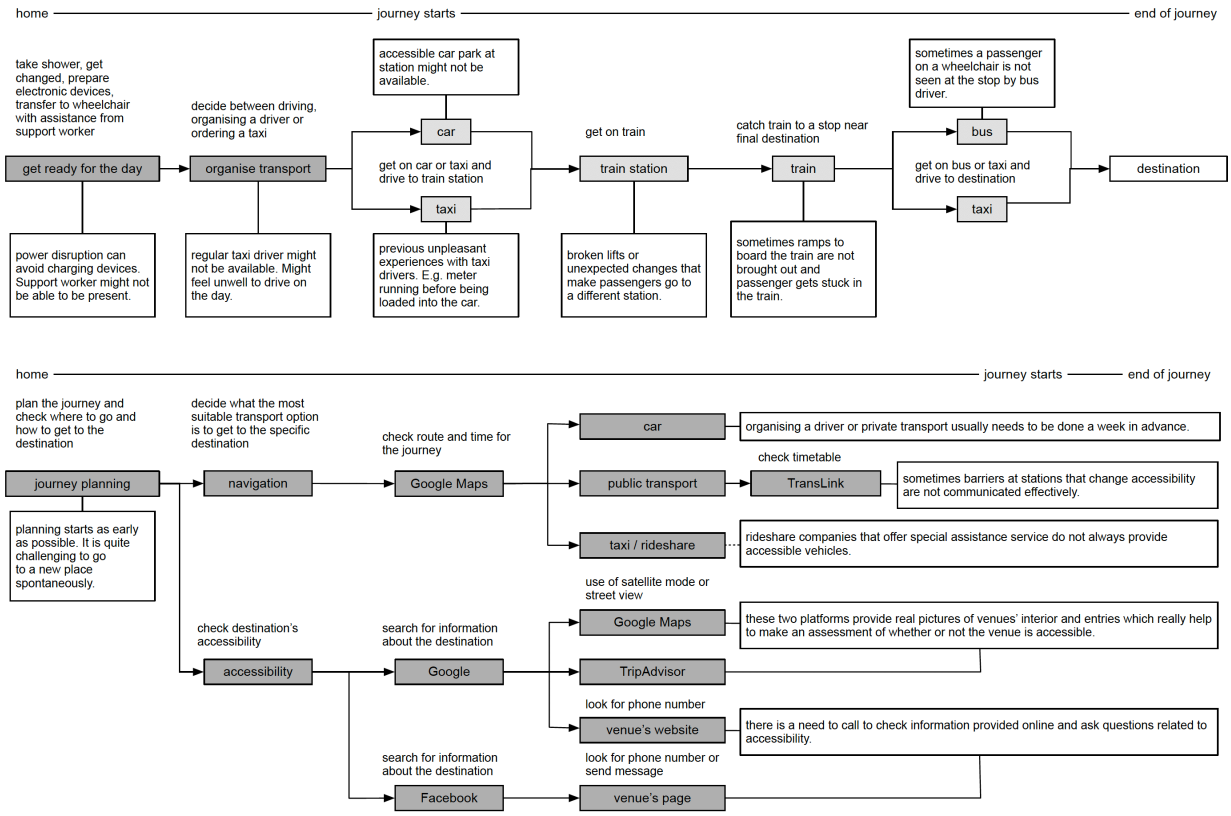

Figure 3 A participant's non-routine journey

In our research, this representation of journeys is helpful to illustrate the different problems that a person with mobility disabilities might encounter. It provides a design narrative for designers to work with stakeholders (end users and transport service providers), to work across design teams, and more importantly, to identify moments of the journey experience where a design intervention is clearly needed. We tested this approach at a workshop with stakeholders, focused on gathering their views about the service delivery needs, and opportunities to support their creative resistance, as well as proposing ways for them to collaborate with service users. Figure 4 shows a participant using a scenario journey map.



Figure 4 A participant's using a scenario journey map

Participants for this study were stakeholders involved in providing services for young people with disabilities representing areas of the service system that supports their journeys. These participants were purposefully recruited to represent the five categories found from CIT events, these are: mobility planning, transport option, technology, policy and standards and communication. The following is an example of one of the service stakeholder's comments when working with the journey map scenario:

> This is one thing, like if you're going to go into public transport, one of the biggest issues I hear from my clients is I can't reach up and touch on. Or it's at a really good height, but I can't reach there because it's an awkward position and my power wheelchair or my mobility issue, whatever it is, I can't get into the right position to do it. So, I've got to ask the bus driver who's never happy to help or you've got to ask that person who's sitting in the front seat. Sorry. Do you mind just touching my go card? It takes away your independence once again.

This approach provided further insights into service delivery participants ideas of creative resistance. They stated that in order to be able to genuinely work around some of the rules, they need to have a vast knowledge of all the options available to the people they are working with. However, a small number of people would know all aspects of the service.

The journey maps provided an alternative form of a scenario that was useful to identify and discuss a number of issues about the services, and also about their own needs as services providers. Their comments revealed possibilities and desires of what a better or desired scenario of a seamless journeys would be. The idea of a person-to-person interactive and collaborative web platform to inform both end users and service providers of people's everyday journeys emerge as a required solution to make those journeys easier to navigate and more seamless.

6. Discussion: towards seamless journeys

Improving workforce participation of people with disabilities of working age is a key policy priority (policy 3) of the COAG endorsed National Disability Strategy 2010–2020 (2011). This

is because Australia has a particularly poor record for employment rates for people with disabilities, ranking 21st out of 29 OECD nations (OECD 2011).

Our multidisciplinary collaboration and co-creation of mixed methods to expand our understanding of young people with disabilities journeys to work have provided a more holistic perspective to the research problem. It has also broaden our understanding of the different factors that enable or limit people's journeys to work. This is clearly evidenced in our use of critical incident interviews with a Human-Centred-Design approach, which allowed the identification of issues that people with mobility-related impairments face in their journeys to work and in other aspects of their lives. This approach has also helped to illustrate in much more detail how young people with disabilities manage to overcome these barriers.

In this paper we have explored: the connections and disconnections that are most important for the participant's participation in society and in employment, and we have uncovered a greater level of detail about people's needs: those from end-users and service providers. Our findings enabled by our co-created methods, have been demonstrated in the form of journey maps scenarios portraying: (a) daily practices of going to work, (b) the connections/ disconnections on this journey to work, (c) the points where support services (physical and online) do not match expectations. The use of scenarios provides a conceptual framework to position a visual or written narrative identifying typologies of journeys to work and the experiences of people's interactions with current services delivery. We have employed these maps in a workshop with service providers in order to gather their views about current and desired journeys to work for young people with disabilities. These results will inform the design of future scenarios of seamless journeys to work – that is, the points of intervention required to develop actionable strategies that can be utilised to increase the independence of young adults with physical disabilities in their travel to work. Before this study, there had been limited investigation into this area of research and how these strategies could assist with the transition into the workforce. This paper described a mixed method approach from the perspectives of four disciplines across three Faculties. Beyond the results from each method, we demonstrated how Design provides the vehicle to collaborate and bring together all findings, creating value from this collaboration, leading to synergy through collaboration and co-creation.

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An exploration on influencing factors for personalized music selection in recreational fitness running activities

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Abstract: With the implementation of China's national fitness program, recreational fitness running has become one popular activity. Since there are less restrictions on the location for running, many runners like to listen to music during exercise to reduce the boringness or fatigue of running. Although it is supported that music can elevate mood for athletes, improve their athletic ability and enhance the effectiveness of training, it is also subject to different factors such as people's psychological state, education level, hobbies, and personality. In this vein, how to plan personalized music to fit various conditions of leisure fitness running became an important issue. From the users' perspective, this research explores behavior of runners in the process of running, observes and interviews the personalized selection of music, and sorts out the framework and dimensions that could be further explored in the future, including interactive convenience, environmental factors and running state.

Keywords: personalized; music selection; recreational fitness running

1. Research background

With the rapid development of the economy, people have higher and higher requirements on the quality of life and begin to pay attention to physical and mental health and figure management. In accordance with the goals of the "13th five-year plan for sports development" implemented by the general administration of the sport of China, the national strategy of national fitness has been further promoted, and the development of mass sports has reached a new level. China's National Fitness program (2016-2020) has been effectively implemented, and the public service system for national fitness has been increasingly improved. On the basis of policy encouragement, economic development, popularization of national fitness awareness and promotion of consumption ability, China's leisure fitness has been greatly developed. Running is a kind of sport with a low threshold of participation and high popularity, which has a high participation basis in mass sports activities in China.

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According to the 2014 National Fitness activity survey bulletin, running is the second most popular activity for users over the age of 20 who regularly participate in physical exercise.

Studies have shown a marked shift in runners' attitudes toward running or running events. The number of runners who used to focus on competitive sports and take running seriously has become less and less, and the number of runners who now focus on entertainment for the purpose of experience has become more and more dominant. Another report found that nearly 300 million runners use running as a form of physical activity, regardless of frequency or intensity. The report also pointed out that in 2019, China's running b-end service pain point is a lack of professional running services, and the upgrade direction is to improve professional sports services. Therefore, the runner's experience should be studied and analyzed from a more specialized perspective.

In running training, there are mainly two kinds of situations that cannot achieve the desired effect: one is to blindly increase the intensity of exercise and damage physical health; the other is weak willpower, thus reducing the amount of exercise. None of these behaviors can meet expectations such as improving one's physical fitness or losing weight. Therefore, to find a reasonable way to guide, to ensure the exercise effect, while ensuring the body's healthy function, has become an important issue in running training. Many runners today like to listen to music during their running workouts to reduce the boredom or fatigue associated with running. Mobile Internet platforms have also spawned a number of music apps for running workouts, showing music as a possible solution.

From a psychological point of view, different physical exercise methods can produce a good state of mental balance benefits. The state of mind of individuals participating in physical activities generally develops towards a benign direction and helps to improve and reduce the negative state of mind and improve the overall psychological benefits of emotions (Yang Jian, 2003). Physiologically, the incidence of arthritis was 13.3% among competitive runners, 10.2% among sedentary people, and only 3.5% among fitness runners. The journal suggests that running is beneficial to joint health for people who run for general fitness (JOSPT, 2017).

Recreational fitness running is simply a kind of non-competitive sport that can achieve the effect of physical fitness, but at the same time can make people enjoy themselves in running. The area restriction of recreational fitness running is not strong. People can choose indoor running or outdoor running, which is a relatively free exercise way. Recreational fitness running is very popular in China, and fitness software, music software and related industries related to fitness run have developed rapidly. According to this context, the main purpose of this study is to improve runners' sports experience by studying the influence and mechanism of personalized music selection on leisure fitness running. It is hoped that this study can reduce the adverse influence of runners on the overall process of leisure fitness running and guide runners to improve their running ability and physical quality. For Chinese runners, the mainstream fitness app commonly used in running is Joyrun, while the general population is more inclined to use KEEP. By contrast, KEEP is more suitable for people in leisure fitness running. In terms of ability, it can be divided into K1 zero basis, K2 beginner, K3

progression, K4 reinforcement, and K5 challenge. The main action mechanism is the change of motion speed, so as to achieve the purpose of motion intensity change. According to the effect of exercise, the main mode of exercise is usually to reduce fat and improve the level of exercise according to the demand. The corresponding running mode is mainly variable speed running. The speed range varies from person to person. Its action mechanism is to improve cardiopulmonary endurance and muscle endurance through the change of movement speed and moderate acceleration, so as to achieve the corresponding exercise effect. Compared with speed change, the common application software does not provide the option of running at a constant speed. Using a constant speed running mode in a marathon can make athletes run farther. Whether the same model is suitable for recreational fitness running, and whether these runners are willing to use uniform running for recreational fitness running, remains to be explored.

2. Literature review

2.1 Introduce music into the leisure fitness running

In recent years, many experts have introduced music therapy into the field of sports training, Music plays an important role in psychology. Different kinds of music can evoke different emotions. Regulate negative emotions can listen to stimulating music, the second is to choose calm music, finally is meditation. There are many researches on music therapy in the aspect of psychological emotion. Yung et al. (2002) used music to interfere with preoperative anxiety in patients undergoing urethral prostatectomy, and found that the preoperative blood pressure, heart rate and anxiety state of patients receiving music intervention were significantly lower than those without music intervention, indicating that music intervention could alleviate preoperative anxiety. Barrera et al. (2002) conducted a music intervention experiment on hospitalized children with cancer and found that children receiving music therapy experienced a decrease in anxiety and a significant increase in comfort. Many scholars believe that the theory of involuntary attention and the filter theory of selective perception are the main mechanism by which music relieves exercise fatigue. They believe that the central nervous sensory transmission ability will limit the processing process of sensation into consciousness (Yang Feifei, 2013).

Research in the field of introducing music into sports shows that music can improve athletes' mood, improve their athletic ability, reduce the subjective sense of fatigue in the middle and low-intensity sports training, and enhance the training effect (Yang Feifei, 2013). Wei Huilin et al. (2017) believe that music has four positive effects on mass middle-distance running, including alleviating negative emotions, reducing fatigue, enjoying the process of running, and facilitating the recovery of fatigue. The Rating of Perceived Exertion is often used to investigate athletes' feelings of fatigue during exercise. Victor b.waite (1996) used 24 college students to cycle in a fast-paced music environment (140-150 beats/min) and a quiet environment. The results showed that subjects who exercised to fast-paced music had lower RPE scores than those who exercised to quiet music, and the subjects felt less tired.

Studies have shown that some patients with diseases such as stroke or Parkinson's can adjust their body posture through music (Tao Lei, 2017). Some scholars have also used different research methods to explore the influence of music on body posture. Liu Ruibo (2016) on aerobic exercise to promote the inhibitory function of music intervention behavior characteristic experiment of sub-components on executive function inhibition function on experimental research, the experiment using the GO reaction and NOGO accuracy both behavioral indicators for monitoring inhibition function changes of the indicators, confirmed the conclusion music intervention to improve sports aerobics. At the same time, he monitored the changes of brain nerves by means of ERP technology. In the ERP characteristic experiment of music intervention aerobic exercise to promote inhibitory function, he showed that moderate-intensity aerobic exercise combined with music intervention was more efficient in processing cognitive resources, resulting in better behavioral performance. Tao lei (2017) studied the effects of music on muscle fatigue, heart rate change and psychological system from physiology, set up an experiment on the adjustment of music to running training, and obtained the corresponding functional relationship between music rhythm BPM and running speed V. In addition, the main modes and requirements of running were investigated in the study. Based on this, the functional design of the running assistant music playing system was designed.

In the academic research on the adjustment effect of music on sports, most of them only focus on the effect of music rhythm on sports. In order to study the professional nature of recreational fitness running, it is necessary to increase the influence of music volume and other multidimensional factors on sports. However, the categories of music are different due to different psychological states, educational levels, hobbies, and personality factors, so the selection of music needs to pay attention to individuality.

2.2 A form of motivation for recreational fitness running

Driven from the National Fitness boom, will China's five major domestic music player software including QQ Music, Kuwo, Kugou, NetEase Music, Xiami Music as well as the outstanding apps in running and fitness, such as KEEP, Codoon Sports, Joyrun, Mi Sport and NIKE RUNNING CLUB. Through comparison, it is found that most of the music for fitness software is used in combination with external application software, and the running music is presented in the form of playlists. The main behaviors of users are divided into creating playlists by themselves and choosing the recommended playlists by the system. The songs on the playlist are highly selective. The recommended playlists are mainly about passion, while the playlists created by individuals vary from person to person. Different people have different choices for songs. Therefore, in essence, users need to learn how to create their own playlists or choose their own playlists to help them maximize their effectiveness in recreational fitness runs. On a deeper level, users' choice of songs has personalized differences, so we need to provide users with personalized choice of music selection strategy.

A large number of patents are to first know the running state and then select the music with appropriate rhythm through certain means or ways for adjustment. The key process

is shown in figure 1. Zhang Jingling (2012) disclosed a music instrument that can adjust the rhythm with the movement rhythm. During the movement, the instrument is held in the hand, and the ball balls in the instrument move with the body's up and down, striking the wall set inside the instrument to form the rhythm point. Meanwhile, the rhythm point will be stored by the music player of the instrument. With the acceleration or deceleration of the movement, the music frequency of the music player can be adjusted, so as to adapt the music to the movement rhythm and reduce the dull feeling in the movement. However, these patents only focus on the pace, vibration, speed and heart rate of movement, while other explicit physiological data that can help guide the selection of music, such as breathing level, need to be concerned.

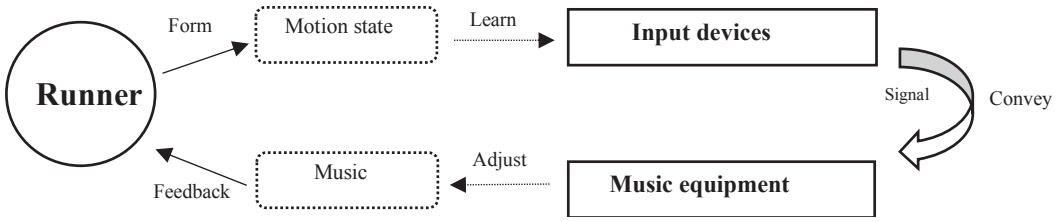

Figure 1 Music adaptation

Only a few patents attempt to drive the running rhythm through music rhythm. For example, Lin Xiqun (2017) provides a control method for the treadmill to control the speed through preset music BPM changes. According to the set music BPM information, the mobile terminal automatically selects the corresponding music, and feedback the music BPM information and speed information to the treadmill. During the speed change, the speed of the running belt of the treadmill accelerates or decelerates smoothly as the BPM of the music changes, so that when the runner runs, the runner's running speed synchronizes with the music. The mechanism of action is contrary to the above. The key process is shown in figure 2. This kind of music is driven mainly by the machine recognizing the rhythm of the music and then controlling the operation of the machine, indirectly guiding the runner to run. And the patent of music directly guiding runners to run is mainly through the APP end to the first choice in advance to achieve music guiding running.

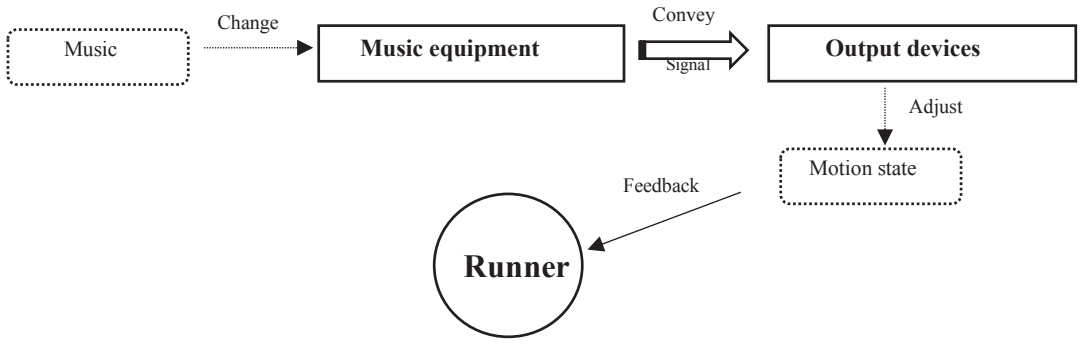

Figure 2 Adaptive adjustment of sports equipment

None of the above patents can analyze individual differences from the psychological of people. Moreover, the running mode needs to be set in advance, so it is unable to perceive the runner's psychological state of movement from the device, so as to adjust the music automatically and moderately to encourage or guide the runner to strengthen the running amount and improve the exercise effect.

3. Research Methodology

According to the above research purposes, the research process can be divided into three parts :(1) the investigation of runners' sports behavior; (2) runner's running experience; (3) establish the influencing factor analysis model. The research process is shown in figure 3:

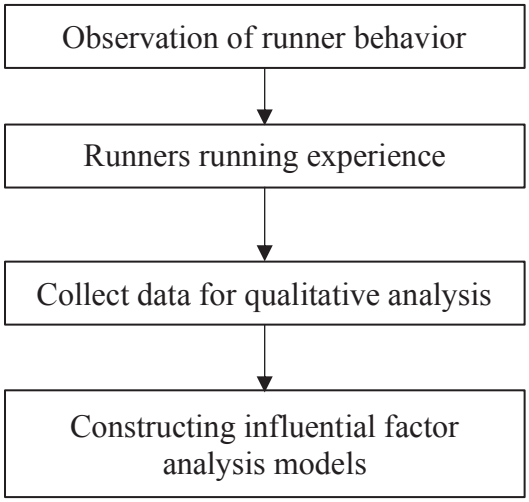

Figure 3 Research Process

In order to better study the influence of personalized music selection on leisure fitness running, the research and analysis are conducted from the user level at first. The methods used include user behavior observation method and user interview method. In the behavior observation of users, the running state of runners is recorded by taking photos and writing records. The time of observation is evening, the place is open track and field sports track for the masses and the surrounding path. The main contents of observation include users' social behavior, running equipment, running path and running state.

Based on the observation of recreational fitness running users, two semi-structured interviews were conducted with the users and recorded by means of sound storage. A total of 8 people were interviewed for the first time, mainly including undergraduate and postgraduate students in universities and those who have graduated within 1 to 2 years. The age group was 18-26 years old, with 50% male and 50% female. The sports venues of the interviewees mainly included the track and field stadium of Guangdong University of Technology and the nearby roads. Record the interview in the form of text. The identity of the subjects of the second interview was similar to that of the first. The identity of the subjects of the second interview was similar to that of the first. The influence and function

of the introduction of music into leisure fitness running were interviewed, and the recording and text records were made. The contents of the interview were as follows:

Table 1 Interview Guide

	The First Time	**The Second Time**
Interview purpose	Exploring runner needs	Exploring the use of music by runners during running
Content	What business are you in?	What are the goals and needs of running?
	What is the purpose of a recreational fitness run?	Do you listen to music during your run?
	What kind of place will you choose to run?	What applications are used?
	What's your age?	What songs are you listening to?
	What is the way to participate in recreational fitness running?	How to choose a song?
	How often do you run?	How are people in the running process?
	Are there any products or equipment used to assist running?	How does the rhythm and volume of music affect people?
	Is there any dissatisfaction in the running process? How will it be resolved?	
	Are there any specific running gear/ accessories?	
	Is there a psychology that doesn't want to run because of running fatigue?	
Interviewee	People who take part in recreational fitness runs	People aged 18 to 26 taking part in recreational fitness run

4. Summary

4.1 User behavior observation

Through the observation of runners, several main phenomena were found :(1) many runners will finish using mobile phones before running, and occasionally use mobile phones during running. But the majority of mobile phone users during the run were younger runners, and the faster runners seemed to be more focused on the run than most. (2) young runners are more likely to exercise as a team; (3) due to a large number of people on the track, attention should be paid to avoid collisions, among which the running route of runners and walkers overlaps obviously. (4) the overall running equipment is mainly light, with fewer people using professional equipment. The people listening to music during running are mainly young people. (5) the behavior of relaxation after running is mainly slow walking, and some people

relax in stretching; (6) by comparison, it was found that road runners, especially those on the side roads beyond the runway, seemed to be more inclined to play music outside, and the music was more cheerful, and the crowd was basically male. Therefore, when conducting in-depth user research on the music level, we need to pay attention to the difference between playing music outside and listening to music with headphones.

In this stage of user behavior observation, it can be preliminarily found that the group of people engaged in leisure fitness running, their labels are mostly light and relaxed. Alone for a leisure fitness run, will be more inclined to the auxiliary role of music, and the use of music for the crowd is mostly young groups. Therefore, when conducting user interviews, more attention should be paid to the views of the group of people who are doing leisure fitness running alone.



Figure 4 *A place where user behavior is observed*

4.1 User interview

A phenomenon based on the observation of the user's behavior. Two interviews were conducted with the selected users, and word frequency analysis was carried out on the results of the two interviews. This study tries to obtain the tendency and viewpoint of the people who do the leisure fitness running through the word frequency analysis. For the follow-up user research, this paper explores a kind of crowd behavior analysis dimension that can be used to analyze leisure fitness running. The top 30 with high word frequency were selected, and the results were as follows:

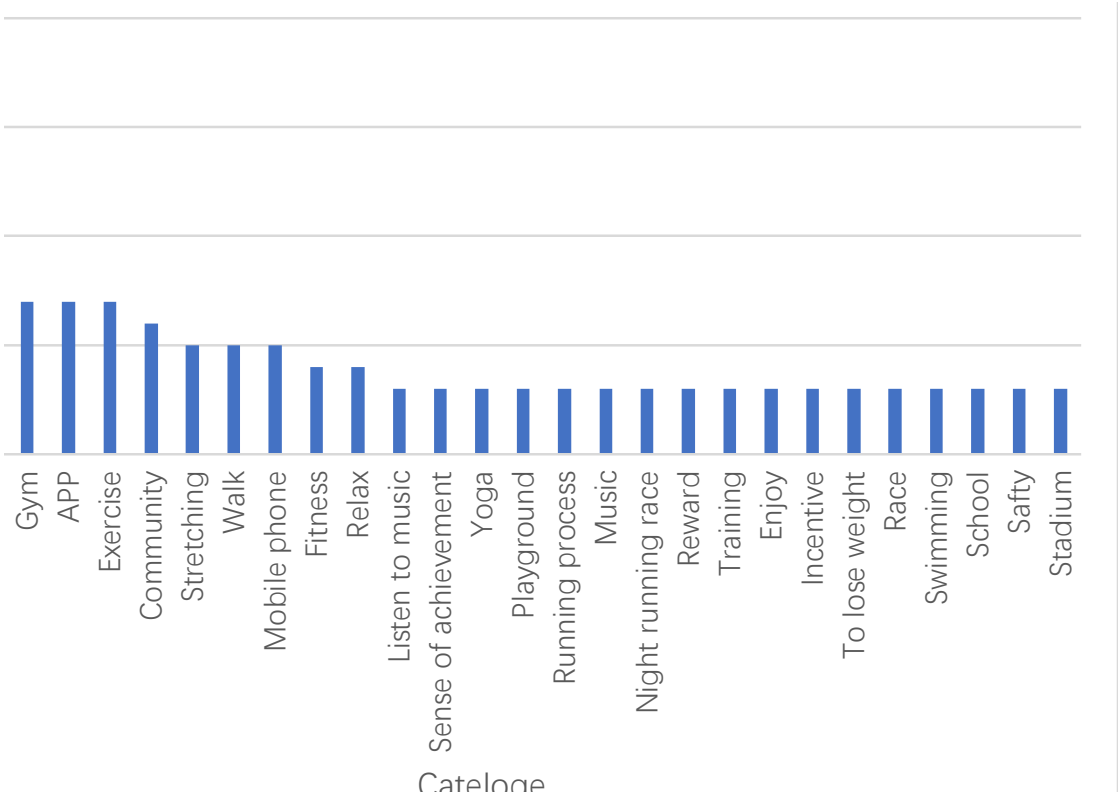

Figure 5 Word frequency analysis from the first user interview

From this figure can be observed directly, in the user interviews, although mainly around the observation and research on outdoor people, but can't deny that in the gym to discuss leisure jogging is still hot, therefore, from the area of research, should be an outdoor and indoor environment of the two main research. The analysis of mobile applications also needs attention. And will classify the words, mainly can be classified into action, place, emotion, equipment, and others. Combined with the content of the interview, the action words show that the main needs of participants in the leisure fitness run are training and fat loss, followed by learning and work-pressure oriented exercise. Equally useful types of exercise to meet these needs include swimming, yoga, and walking, among which walking and yoga are activities that most people enjoy in addition to fitness running, and which can be easily accomplished. Places mainly include gyms, communities, school playgrounds and so on. The common feature of these places is that only people are allowed to stay in. In terms of equipment, it is indicated that most of the mobile application software used by people during the leisure fitness run is the software with voice broadcasting function, including the mobile music playing software and the fitness software with voice broadcasting function. In terms of emotion, most of the words are positive feelings such as achievement and enjoyment, while the opposite is dull and monotonous feelings.

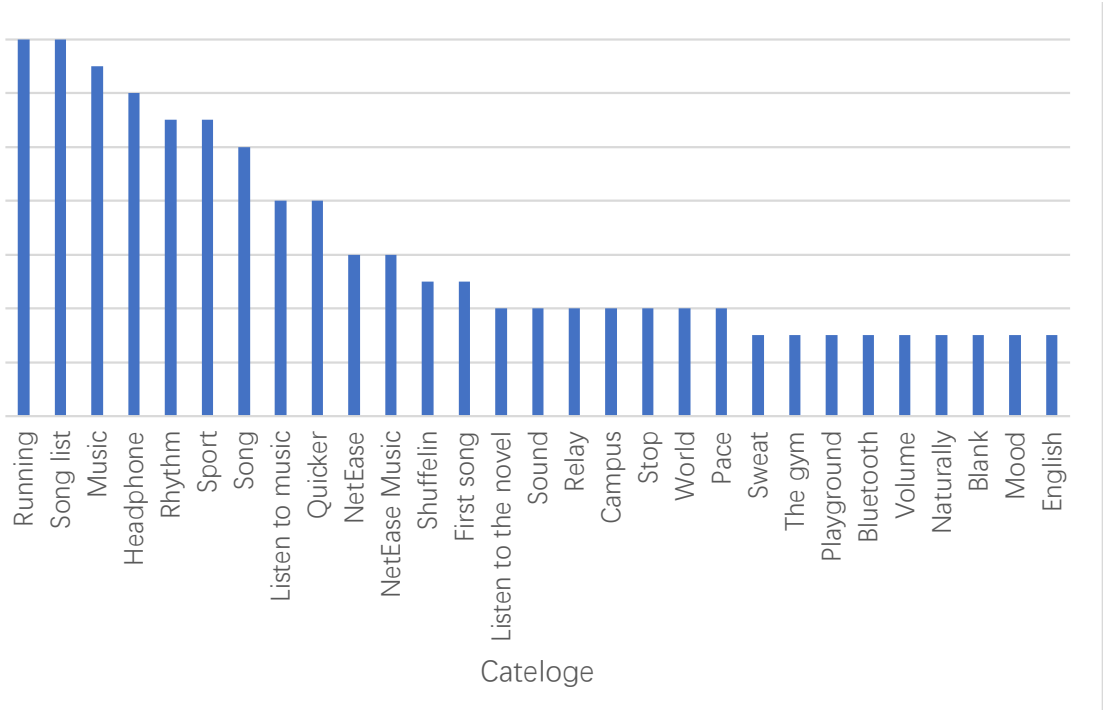

Figure 6 Word frequency analysis from the second user interview

When the participants aged 18 to 26 were interviewed about the use of music in recreational fitness running. It should be pointed out that since 2017, when colleges and universities in Guangdong province of China encouraged the use of the mobile software sports world campus, undergraduate students have been required to run for leisure and fitness every year because of the running index. When using such software, the majority of respondents expressed disgust. They generally agree that recreational running should be a personal choice rather than a supervised run. And this segment of the population cannot choose their own application software. However, in the process of running, many interviewees still use mainstream music player software to assist running, to solve the boring feeling in the process of running. At the same time, it is worth noting that after the completion of the running exercise index, the population still engaged in recreational fitness running is mainly in love with recreational fitness running. This kind of interviewees expressed that they enjoyed the feeling of sweating and believed that after running, they could allow themselves to complete the emotional catharsis.

In contrast, people other than undergraduates have more freedom of choice. However, few people are willing to choose fitness apps. They generally believe that using running fitness apps for auxiliary exercise, mostly intense exercise, is more likely to make people tired. Runners who had participated in the marathon were more likely to use fitness apps such as Codoon and Joyrun.

The majority of the respondents who used music for auxiliary running were single runners, and they said that when many people ran together, everyone's rhythm was not the same, and running would be restricted, resulting in poor running experience. At the same time,

when using music-assisted running, most people will choose personal playlists created by music apps such as NetEase Music and Xiami Sports, such as personal favorite music, or specially created playlists for running. Looking at their playlists, it was found that most of the songs were foreign language or RAP music, and the songs were generally light or exciting. Others reported listening to novels while running but speaking at a slightly faster pace than usual. Since the music selected by individuals is not planned, most of the respondents pointed out that when running, based on the running state at that time and the mood is not the same as usual, they will encounter some phenomena that they want to change songs even though they like them.

Respondents cited the lack of wheezing and footfalls as reasons for listening to brisk music in headphones as a way to run more smoothly, as well as the song being more melodic and the pace of the run naturally following the music. But the default playlist, which is generally based on excitement, doesn't apply to the entire run. Therefore, changing songs becomes an inevitable phenomenon in the running process.

4.3. Construct analysis dimension

Combined with the two interviews, it can be pointed out that in the research on the influence of personalized music selection on leisure fitness running, runners need to be explored in the following dimensions:

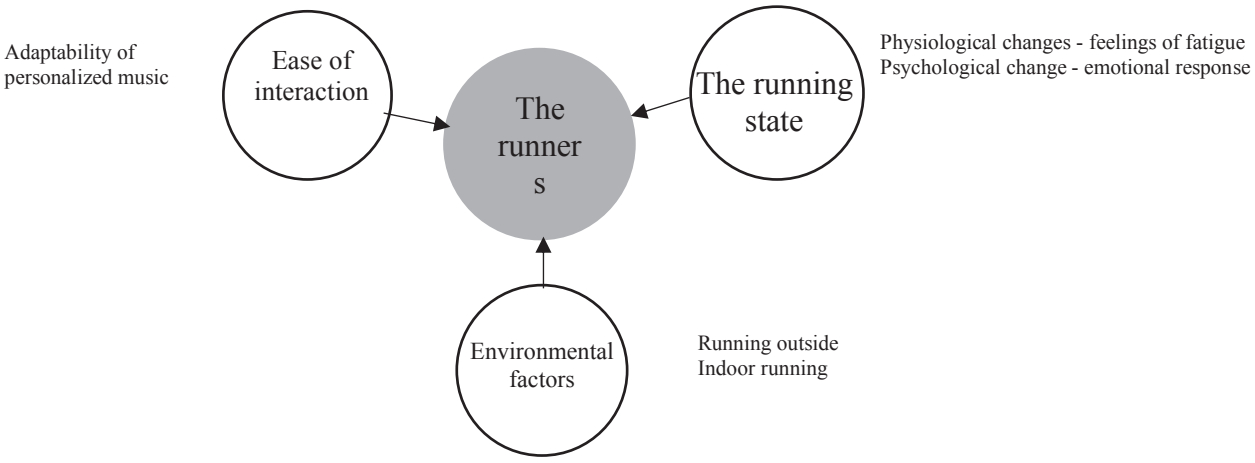

Figure 7 Research dimensions of recreational fitness running

When making personalized music strategy decisions, three factors need to be taken into account, including the ease of interacting with or operating the device, the runner's running state, and the impact of different running environment factors.

Interaction from the device and the convenience of operation, the selection of personalized music often unable to adapt to running the whole stage, resulting in song phenomenon is more, the design of the runner interact with the device need considering the convenience in song, devices need to fully cooperate with runners behavior or physiological state, according

to the perceived runners adjusted independently.

From the running state of runners, fatigue can make runners become lazy, its running behavior will automatically adjust itself, studies have shown that music can adjust the listener attitude-behavior, personalized music can also play the same utility, conduct strategic choice of music or strategic adjustment, to play the order of the music will be a need to consider the direction of the design. Music is also distracting runners on fatigue effect, different music is likely to be perceived fatigue was mixed, individual choice of music also needs to achieve the same effect, soft or the cheerful music also need to get a kind of auxiliary means, to make runners in the process of running, as much as possible to reduce the music of the impact of change on running.

In terms of environmental factors, different runners choose different places for leisure and fitness running, and the atmosphere brought by different places has different influences. For example, runners who run outdoors are more likely to sing along with music than those who run indoors. Therefore, the influence of the environment on the runner's psychological state should be taken into account when designing the classification of environmental factors.

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Wellbeing, Happiness and Health SIG

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Editorial: Design for Wellbeing, Happiness and Health

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Introduction

SIGWELL is the Design Research Society's Special Interest Group (SIG) focusing on Design for Wellbeing, Happiness and Health. The SIGWELL community has an interest in advancing knowledge, and the development and application of design research in the broadest sense to improve the wellbeing, happiness and personal and societal health of people.

In April 2019, SIGWELL organised a Colloquium on Design for Wellbeing education at TUDelft (The Netherlands). Here, we explored the latest insights in design for wellbeing education with a special focus on ethics. At the end of 2019, our first book was published (Petermans & Cain, 2019), bringing together insights from an international and multidisciplinary research community involved in research on design for wellbeing.

Design for Wellbeing papers at DRS 2020

Following the call for papers for DRS 2020, we noted a particular focus in the topics mentioned relating to wellbeing and happiness. After careful selection and programming,

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two sections were set up with papers, linking to our SIG's key themes and issues as well as to the DRS 2020 conference themes:

Theme 1: Co-creation - Wellbeing

For the first sections, papers that focus on self-training and activities of individuals in order to foster wellbeing, are brought together. Starting this section with a contribution (paper 287) of Eujeen Hwang & Youn-kyung Lim (2020), the design, implementation and arrangement of 'Tune-in' is explored, in order to investigate how and what self-therapeutic enablers support experiences of reflection and mindfulness. In the paper, the authors reveal how these enablers where accompanied with sound in order to let participants experience mindfulness in daily life, so as to contribute to their wellbeing.

Next (paper 152), Austin et al. (2020) discuss the importance of both evidence-based (top-down) and experience-based (bottom-up) input in co-design, especially in a healthcare context. They elaborate about a case study that was set up with cancer patients and oncology nurses in order to co-design an eHealth intervention focused on training self-compassion, and discuss practical strategies to merge top-down and bottom-up input in such a co-design process.

Finally, in their contribution (paper 281), Naqshbandi et al. (2020) focus on digital volunteerism, as all the more people make a transition from physical to digital platforms for volunteering. They investigate the use of generative methods and tools in two co-design workshops with volunteers in an educational program involving both online and physical modules, which enabled them to identify areas of design opportunities that foster relatedness and gratitude in online volunteering and reduce disparities between online and physical volunteering experiences.

Theme 2: Impacts – Human-centredness

The second section brings together contributions that have a human-centred nature and focus on societal impact, as these are key issues in design for wellbeing. First, Atherton's paper (2020) discusses artful design as a lens for achieving subjective well-being (paper 117). Artful design is described as a design philosophy, presenting both theoretical and pragmatic guidance to designers, offered via design principles intended to address human flourishing and humanistic values. In the paper, a case study of a virtual reality experience is discussed in order to show with this aligns with the goals of positive design.

Next (paper 274), the contribution of Nicholas et al. (2020) elaborates about the Integral Living Research Group (ILR). Lack of housing equity in the USA has incited this group to develop solutions to reduce housing-related stress and support enhanced well-being for urban families. The ILR Group uses generative and empirical design research and has focused all efforts on the development and deployment of five interconnected and interdependent principles for healthy urban housing. Their contribution elaborates about these principles via short case studies.

Finally (paper 282), Auernhammer (2020) focuses on human-centered artificial intelligence (AI), stating that the design of AI has been expressed as essential for societal wellbeing. Different philosophical perspectives and several human-centered design approaches are discussed from the perspective of how they contribute to the development of AI. The paper argues that humanistic design research should play a vital role in the collaboration with technologists and policymakers to moderate the impact of AI.

Reflections on the future

Due to Covid-19, the world as we know it has changed, and various of these changes will have a long-term impact on all of us, emotionally, socially and economically. Looking at the wellbeing and happiness papers brought together in these two sections at DRS 2020, it is clear that new and various design research approaches for addressing the 'wellbeing and happiness' challenges that lie ahead of us, are ready to inspire others in the field, academics as well as practitioners.

References

Petermans, A. & Cain, R. (Eds.) (2019). *Design for Wellbeing: an applied approach.* Routledge: London.

For more information on the Design for Wellbeing, Happiness and Health SIG, please visit the SIG's webpage at http://drs.silkstart.com/cpages/wellbeing-happiness-sig. To find out whether the SIG is organising a satellite event to the DRS2020 conference, or just to get in touch with members and see news on the SIG, please visit the SIG webpage.

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Tuning into the Sound: Discovering Motivational Enablers for Self-Therapy Design

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Abstract: The burnout society we live in demands the need for us to be self-therapists in our everyday lives. We describe the design, implementation, and arrangement of Tune-in, a cultural probe inspired seven-day diary study, to discover how and what self-therapeutic enablers support experiences of reflection and mindfulness. Findings reveal potent motivational enablers for self-therapy design in the form of sequential process and applicable means. The enablers were accompanied with mundane sound as a reflective material whereby the participants could experience in-depth reflections and mindfulness in everyday life. This paper makes two contributions. First, with a practical set of enablers that can bring self-therapeutic value to the design, and second, it provides new insights on how mundane sound can be used to influence mindfulness and perceptions of value and meaning for individuals.

Keywords: self-therapy; enablers; mindfulness; sound

1. Introduction

We are living in a digital era of voluntary exhaustion and fatigue, driving ourselves towards achievements until we burnout. The growth of the digital age throughout the century is ironic in the sense that it negates its original purpose of saving time and space as users voluntarily sabotage self to fill the void and keep up with the meritocracy nature of our society (Han, 2015). Rates of mental illness such as depression, anxiety, addictions, and overall decreased performance of individuals is increasing rapidly over time (Jean et al., 2019), and the nature of this voluntary burnout and the acceleration of this hustle life demands the need for us to be self-therapists in our daily lives.

Motivated by the substantive negative effects of the digital age, attempts to trigger reflectivity, mindfulness, and living-in-the-moment in everyday life has been explored through recent design research (Cox et al., 2016; Grosse-Hering et al., 2013; Höök et al., 2016; Odom et al., 2014; Pierce, 2012). Although such research shares a common goal of encouraging mindfulness by creating awareness through evoking a new perspective on the

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daily interaction, there lacks to be a study explicitly focusing on discovering a set of effective design enablers for the self-therapeutic experience to support experiences of reflection and mindfulness. While people are practicing more diverse ways of experiencing mindfulness, this paper focuses on the use of mundane sound, one of the most ingrained parts of life that its quality of experience is often missed. We use sound as a design material to discover sets of enablers for self-therapeutic experience through a diary study in support for self-reflection and mindfulness.

To investigate for the potential set of self-therapeutic enablers, we created *Tune-in,* a cultural probe inspired tangible diary that is used to make visual and written expressions of reflections from capturing meaningful sounds in a triggering moment. We then arranged this diary study with ten participants for seven-days, using it to open an in-depth dialogue with individuals about the experience of mindfulness with sounds and about the influence on self-therapeutic experience. The diary study revealed an interesting sequential process and means that enable self-therapeutic experience. Participants tuned in and recorded sounds that were meaningful to them to reflect on their present, past and future, and revealed to have experienced deep reflection from the therapeutic significance of the study.

This paper makes two contributions. First with a practical set of enablers (sequential process and means) that can bring self-therapeutic value to the design, and second, it provides new insights on how sound can be used to influence mindfulness, perceptions of value, and meaning for individuals.

2. Background and Related Work

The burnout society refers to the contemporary society we live in. As Han (2015) critically describes this society in their essay, *The Burnout Society*, we live in a dictatorship of positivity and therefore hyperactivity followed by burnout. Han (2015) suggest that “the complaint of the depressive individual, ‘Nothing is possible,’ can only occur in a society that thinks, ‘nothing is impossible’” (p.11), to accentuate the matter of self-exploitation, the paradox of positivity, and meritocracy which wrecks.

The above burnout society gets worse as it enters the digital-enhanced society, and more design research attempts to tackle these issues in a variety of ways to mitigate the consequences on the individuals. The increasing ubiquity of everyday living experiences affected by these issues, along with the growing interest in the design research field designing for contexts of everyday life, has influenced to a study exploring how mindfulness and reflection can be better supported in the design process. The theory of slow technology through the use of artefacts (Odom et al., 2014), negating technology in the form of undesigning (Pierce, 2012), designing necessary frictions (Cox et al., 2016), exploring how mindful interactions can lead to meaningful reflections (Grosse-Hering et al., 2013) and applying somaesthetic phenomenology on designs to deepen self-engagement, bodily sensations and internal reflective experiences (Hook et al., 2016) contribute to the theme of encouraging and exploring mindful interactions by creating awareness through a change

in perspectives. However, the design research applications mentioned do not target self-therapeutic options, and it is yet unclear how and what design applicable enablers leverage the self-therapeutic and mindful experience.

Today, time is a rare commodity affected by the frame of voluntary self-sabotage (Han, 2015), thus there is a need to research for accessible and effective ways in which the self can take care of oneself in their daily lives. Considering the adverse growing rates of mental illness in today's burnout society (Twenge et al., 2019), we see an opportunity to explore how and what can help individuals experience self-therapeutic experiences in everyday life. Self-therapy intends to help experience mindfulness, which is a term referring to a psychological state of awareness or practices that promote this awareness (Hopko et al., 2015). Several well-known self-regulating practices that cultivate mindfulness are meditation, yoga, and tai chi. These practices focus to gain attention and awareness in order to achieve mental well-being and complementary positive amplitudes such as concentration, calmness and clarity (Walsh & Shapiro, 2006), contributing to effective emotion-regulation strategies (Davis & Hayes, 2001).

We also see an opportunity to explore the role of sound as a meditative tool in the design process. Sound meditation uses vibrational instruments with typical repetitive sounds and has historical affinity with meditation and healing, known as a form to promote focused awareness (Goldsby et al., 2017). Sound therapy has been used throughout the history for the purpose of distraction and healing with the belief that sound can bring physiological changes, act as a mental guidance or aid to relaxation (Hobson et al., 2010). In other respects, sound is a form of language and a source of connection, comprehension and an emotional gateway. However, the presence of everyday sound is such an ingrained part of life that its quality of experience is often overlooked. We believe such accessible presence of sound can be a prominent factor in self-therapeutic experiences without the constraint of time or space, as well as draw one's attention to the present moment in a natural and immediate manner. We want to explore how sounds within mundane moments affect people's perception of ordinary sounds, and how it can be used as a design material for self-therapeutic experiences.

These areas of research open a space for exploration to understand how mindfulness can be experienced through self-therapeutic approach with the use of everyday accessible material such as sound. We describe in the following section how we integrated these considerations into our study.

3. Methodology

We designed the Tune-in diary study in order to explore what process, means and quality aspects of active reflection on mundane sounds can promote self-therapeutic experience. We intended to create a tangible design artefact for this drawing on reflective design (Sengers et al., 2005), cultural probes (Gaver et al., 1999; Wallace et al., 2013) and research through design (Hopko et al., 2015).

3.1 Process, Rationale and Implementation

The design process of Tune-in diary study consisted of reviewing theoretical literature and empirical studies mentioned in the previous section, and iteratively analysing the collected data to result with contributions and discussions.

The form and aesthetics of the Tune-in diary facilitate channels for creative reflections, and the tangibility of the diary structure reflection itself. The layout of each diary entries is named *Tuneinstagram,* inspired by the layout of the well-known Instagram user interface to evoke a sense of visual guide on a subconscious level (Figure 1).

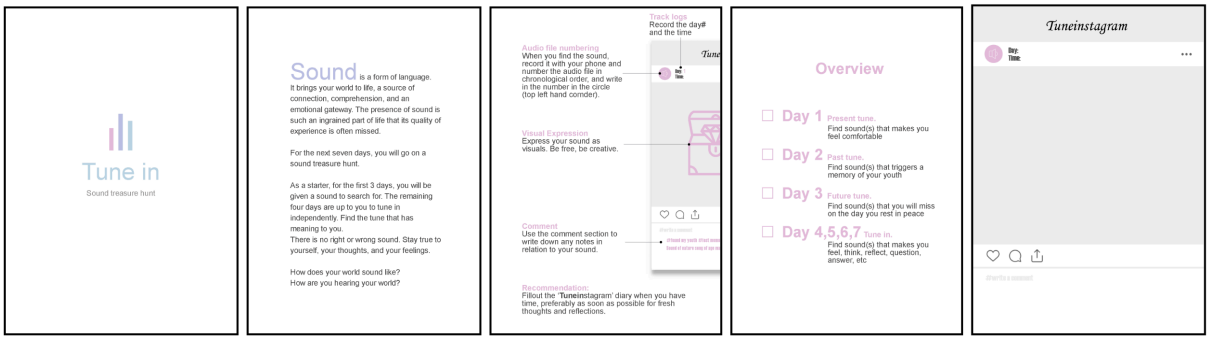

Figure 1 Several layout components inside the Tune-in diary (From left to right: Front page, positioning statement, directions, seven day guides, Tuneinstagram entry card layout).

Tune-in diary was given to every participant to go on a sound treasure hunt for seven-days and make entries on the reflections. The study was inspired by cultural probe (Gaver et al., 1999) although our study does not have the identical approach as we include the post interviews for the participants' explicit explanations of individual experiences. Regardless, the important aspect of the cultural probe was applied to trigger deep reflections and explore complex experiences of the individual participants. As Gaver puts it, the nature of cultural probes "disrupt expectations about user research and allow new possibilities to emerge" (Gaver et al., 2001, p.23). We regard Tune-in diary study as directed craft object study used for empathic engagements with the individual participants centered on genuine self-reflection.

Guides were given on the first three days out of the total seven to help the participants mentally exercise tuning into the sounds around them, experience being in the moment and reflect on the present, past, and future. The remaining four days encouraged the participants to search for meaningful sounds themselves (Figure 1).

We wanted to explore how might people experience cognitive reflection through behaviour, a technique profoundly used in Behavioural Activation (BA) procedures, which is an action-oriented brief structured treatment for depression that aims to increase rewarding experiences in life by addressing cognitions and emotions indirectly and bringing the individual into contact with more positive consequences through overt behaviour (Hopko et al., 2015). We intentionally designed the study to evoke genuine reflections and enable bona

fide experiences by encouraging the participants to put more focus on the physical activity of capturing sounds rather than on experiencing mindfulness.

3.2 Participants, Data Collection and Analysis

We recruited 10 participants with a mean age of M=21.8 (SD=3.0). Balanced gender was considered into the recruitment process; thus, five participants were female and five were male (Table 1). We recruited foreign international students (Ecuador, Finland, India, Kazakhstan, Sweden) between the ages of twenty to thirty for a few key reasons. First, the percentage of young adults experiencing certain types of mental health disorders has risen significantly over the past decade, with no corresponding increase in older adults, according to research published by the American Psychological Association (Twenge et al., 2019). Second, the situational stance of foreign students studying abroad exposes them to high levels of external and internal stress and pressure due to the additional factors such as the language barrier, cultural differences, monetary limit, time limit and homesickness.

Tune-in diary study took seven-days for each participant, during which the participants continuously tuned in to the mundane sounds and noted their genuine reflections. We intended to capture moments of reflectivity by examining participants' interaction between the diary usage and act of tuning in. Figure 2 shows examples of how the participants expressed their reflections in the diary.

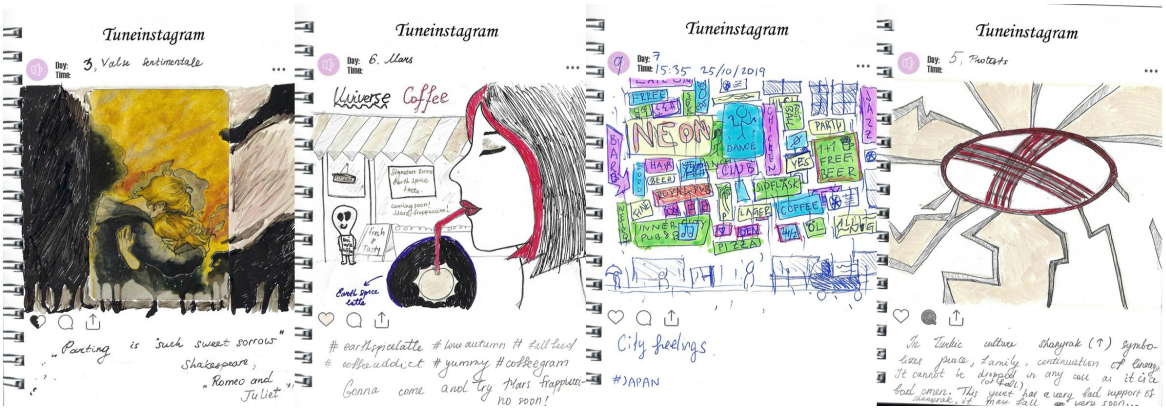

Figure 2 *Diary entries showing the visual expressions of reflections triggered by sound (From the left to right: P1, P3, P8, P10)*

At the conclusion of the study, we organized discussion sessions with each participant which lasted between 1-2 hours. A semi-structured interview approach was used, in which the researcher posed questions designed to prompt discussion on the overall experience rather than obtain specific answers. We aimed to understand deeper about their experience and of the specifics of their reflections for each diary entries assisted with the captured sounds. The discussion session served as an extension of the study as participants experienced a deeper quality of reflection and mindfulness through verbalizing their reflections. All of the ten interview sessions in total were audio recorded, producing 15+ hours of content.

To analyse the data, we applied qualitative analysis using open coding on the transcribed interview recordings, and searched for patterns across the diary entries to derive insights as well as underlying themes. We proceeded with several rounds of open coding where 400+ descriptive codes were generated from which two themes, sequential process and mean-based enablers, were found. We validated the descriptive codes followed with analytical coding and analysed the data through several iterations and revision sessions to discover implicit and implied meaning (Creswell & Poth, 2018). In response to our main objectives, the following sections present the results of our diary study induced to discover the motivational enablers for self-therapy design.

4. Findings on the Process Supporting Self-Therapeutic Experience

We discovered that the self-therapeutic experience is supported through the following sequential process: Tangible Entertainment, Unexpected Reward, and Moments of Epiphany (Figure 3). Each process serves a shared purpose of conveying motivation for sustained usage. Motivating factor helps create, strengthen and maintain engagement, which is a contribution factor in creating habits by time (Schunk, 2012). We describe the detailed findings of each case in sub paragraphs below.

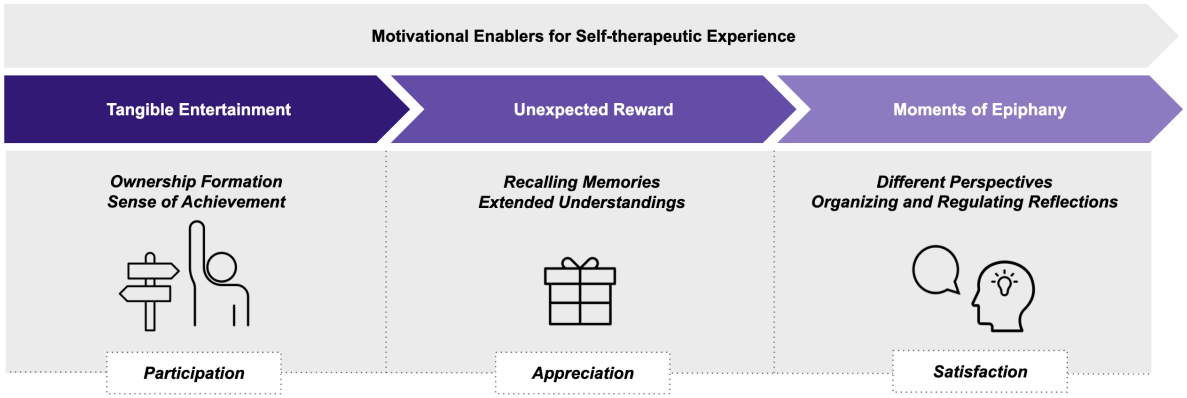

Figure 3 Sequential process unit for self-therapeutic experience

4.1 Tangible Entertainment

We discovered that entertainment through tangible design acts as a self-therapeutic enabler by forming ownership and sense of achievement, ultimately acting as a successful motivator to sustain participation and enhance self-therapeutic experiences.

Tune-in enabled personal space for voluntary participation of each participant throughout the study. Entertaining tangible tasks made it an attraction point, as the participants perceived the study as a treasure hunt activity. P1-20-female[1] said, *"It was like a fun game searching for something special…however if I was told to do it, I wouldn't have done it. I did it because I was interested in it, which makes me realize that you don't and can't really pay attention unless you pay attention."* Also, P3-21-male described how his actions were

spontaneously influenced by the engaging activity: *"I was leaving class and heard the birds in the woods, to which I could connect, and I just took the lead, running to the woods…picked up my phone and I was so determined to have this."* Participants emphasized the importance of having independent control throughout the design experiment as they realized the initial step of decision making for participation activated ownership, which operates as a motivator, thus enabling self-therapeutic experience.

Finding for sounds acted as an entertainment factor from which the participant engagement increased with the sense of achievement. We discovered that the sense of achievement sustained participants' interest and increased motivation. Participants realized that the tangible entertainment were essential for self-therapeutic experience as it sustained their attention and led to subtle changes in their routine to find meaning from mundane sounds: *"I acknowledged myself for finding them…I like how it made me go out of my routine and search for sounds…that thrill when I find one is amazing"* (P7-20-female). Collectively, these reflections helped highlight how entertaining tasks and guides of the study evoke a sense of achievement and completion with each sound collected, assisting the self-therapeutic experience.

"I felt that this was like an award…I completed a piece of work I was in charge of" (P10-30-male)

4.2 Unexpected Reward

Unexpected reward mechanism within the design acts as a self-therapeutic enabler through the meaningful and personal memories recalled, thus evoking new meaningful realizations. We define unexpected reward as a motivational element for self-therapeutic experience, given in recognition of achievements without regarding the likelihood to happen. Overall, the nature of unexpected reward acts as a powerful motivator in creating self-therapeutic experiences through appreciation. Below, we explain how the unexpected reward performs as a motivator for self-therapeutic experience by recalling memories and through extended understandings.

Unexpected rewards helped appreciate the unexpected sets of personal memories recalled and restored connectivity on a personal and social level. Participants were pleasantly surprised with the quality and quantity of the reflections triggered from mundane sounds, reminding them of their youth, transporting them in time, and triggering intimate memories: *"Sound of the coffee pot in the morning triggered memories of when I used to sit on the kitchen floor next to my mum as she was cooking"* (P9-20-female). Also, P4-21-male reflected back and described the liveliness of the triggered memories: *"When I heard the sound, it was not only the memories or the emotions I felt, but also the smell…the long-forgotten memory as a whole just suddenly struck me."* In further reflecting on the recalled memories, he noted how unexpected rewards weren't necessary immediate responses from sounds as some sounds took time to form a meaning: *"At times, after thinking about a sound for a couple of days, I realized that it makes me feel something and recall on a specific memory."*

Unexpected rewards helped gain appreciation in the moment through unexpected new realizations that deepened and broadened one's understanding of self. The more participants discovered new meanings from mundane sounds, the more they grew appreciative about their life in general, thus were motivated to continue tuning in: *"I've never realized before this experiment, but the sound of turning pages is actually very beautiful…I have now become more sensitive to sound and can appreciate much more sounds than before"* (P7-20-female). Participants also commented on the formation of new meanings of sound: *"…now I realize, every sound is a memory and a meaning for me. It's part of my life. I start noticing everything around me..."* (P6-20-female). Additionally, new realizations were personalized as it was densely reliant on individual's values and interpretations: *"From sound of waves crashing back and forth to create another, I realized they influence the things that are behind them as well as in front of them…it's like my life…just like the life cycle and its consequences*." (P1-20-female) Collectively these quotes highlight how the realizations from unexpected moments and sources enable self-therapeutic experiences.

4.3 Moments of Epiphany

Moments of epiphany experienced, such as through the designed questions given to participants during individual discussion sessions, deepened the level of reflection and insights that are personal and meaningful. It shunned different perspectives onto a thought and supported the organization and regulation of the reflections, resulting in an increase of satisfaction level.

External input, such as the questions given to participants in discussion sessions, triggered reflections from different angles and thus helped experience deeper levels of self-therapeutic experience. During the discussion sessions of the study, participants commonly described the therapeutic quality of the questions leading to moments of epiphany, and regarded the session as an extension of the self-therapeutic intended study of Tune-in: *"I would have never thought that I was being mindful…this discussion was a different experience. Now my understanding of things would be very different than what it was an hour ago"* (P7-20-female); *"The questions really made me realize something about myself from a perspective never thought before…a great insight"* (P8-22-female).

Expressing reflections from auditory experience with visuals and finally in verbal format opened opportunities for organizing and regulating reflections. Participants described how the scattered reflections were connecting together through the discussion session: *"The questions really helped me make sense out of what I was thinking as a whole…"* (P8-22-female). Also, P1-20-female described the necessity of verbalizing thoughts despite its difficulty: *"I felt and experienced a whole lot of stuff and emotions but sometimes it's really hard to express what you really feel about…deliberately putting it into words organized it so much more."* These examples highlight that verbalizing thoughts stabilize and organize one's reflections on a confident level.

Collectively, these sequential process help illustrate how the Tune-in successfully provoked

the participants to experience self-therapeutic experiences in their everyday lives and experience the increases in motivation of participation, appreciation and satisfaction in consecutive order of the sequential process.

5. Findings on the Means Supporting Self-Therapeutic Experience

We discovered that analogue tangibility, tangible accessibility and mundane sound performed as enabling means that support the self-therapeutic experience. Each mean contributed a unique set of characteristics which were found to be effective for supporting mindfulness through reflection when incorporated into the sequential process of the design. We describe the detailed findings of each enabler means in sub paragraphs below.

5.1 Analogue Tangibility

Analogue interaction is different with that of the digital as it involves an additional preparation process for optimal usage, such as sitting down and grabbing a pen. Participants experienced the preparation process promoting reflective depth as it put one into the mode for deep reflections: *"When I sat to write or draw, it was more comprehensive. I needed to dive into it and really think about it"* (P4-21-male). Also, the participants reported that the preparation process created a metaphorical pause to reflect: *"When drawing and writing, I needed to pause and sit down…I felt really focused on completing this"* (P9-20-female), which triggered deeper and more comprehensive reflections as if the act of physical preparation also performed as a mental preparation for reflection. Collectively, these reflections helped highlight how physical preparation ultimately can assist the reflection process.

The friction caused from the inconvenience of analogue also enabled reflection. While the participants initially experienced frustration by the relative inconvenience of the analogue tangibility of the diary, referred to as *paper-ness*, overtime they appreciated how the inconvenience provoked quality reflections: *"I think that 'uncomfortable' helped me because I started focusing on the reflection itself, isolating the reflection from the situation. It was instructive. The friction helped"* (P2-22-male). Additionally, P10-30-male reflected on his changed preference of analogue over digital regarding the nature of reflectivity by inconvenience: *"If this was an app... It would've been so much easier. But because I had to express it on paper, it took much more time…but thinking does take time. I was so used to the speed of everything that I thought thinking could be done like so."*

Expressing the auditory reflection into visual expressions by hand enabled unique and abstract self-expression. During the individual discussions, most of the participants described how drawing on paper provoked them to tune into themselves and express their reflections uniquely. P7-20-female participant described that the act of visually expressing her reflections and emotions on paper positioned her to feel authentic about her reflections: *"Sketching is a different experience…emotions come mostly while I sketch. I don't feel photographs and digitals fully represents my authentic abstract thoughts in that moment."* Additionally, P6-20-female perceived analogue visual expressions as a portal to her inner self:

"It's like my own world…when I sketch I forget about other things and I'm in my own world."

The separate tangibility acted as a unique individual object which behaved as a powerful reminder. One of our designer participants reflected on the role of tangibility as an essential mean for self-therapeutic experience: *"I thought combining designs inside the phone was a way to go for maximum accessibility and user participation. However, I realized the separateness and uniqueness other than my usual phone engages attention…subconsciously"* (P5-22-male). Additionally, P2-22-male reflected on the forgetful experiences with the digital: *"…because I had this diary, I was reminded to do it again. As an app, it would have been forgotten among the many other."* Collectively, these reflections highlight the influence of analogue tangibility on sustained self-therapeutic experience.

5.2 Tangible Accessibility

Tangible accessibility supported capturing the genuine reflection of the moment. Participants voiced the necessity of having a platform to make immediate entries as they experienced the temporality of reflections alternating at a fast and unpredictable pace: *"When I recorded the sound and filled in the diary later, I did not feel the same about that sound and moment a while ago"* (P1-20-female). P6-20-female similarly described her experience with the inconsistent nature of reflections: *"I had a reflection in a typical moment… but I didn't have the diary with me and I forgot what I wanted to note."*

Reflections come and go randomly and the accessible nature of the design can capture unexpected and unplanned moments throughout the day as the participants commonly experienced reflective moments in unplanned and unexpected times: *"Reflecting on the sound of the flattering of the bird was very unexpected…It happened when I was just walking by...I tried to catch their sounds but it was unexpected and momentary"* (P10-30-male); *"Usually finding sound was really unexpected to me because regardless of my location, sound triggered memories at random times, catching me off guard"* (P1-20-female). Collectively, these examples highlight the need for tangible means to help capture the genuine reflections and unplanned moments.

5.3 Mundane Sound as Self-Therapeutic Material

Sound awareness enabled self-therapeutic experience as it naturally prompted attention on the present moment and triggered reflections: *"Sound was a medium that helped me understand things I couldn't see visually in the moment. When I focused on a sound, I was becoming more observant of the environment beyond this vision of mine"* (P7-20-female). Additionally, P1-23-female described how sound enhanced quality of the moment and the depth of reflection: *"There are more fantasies, thinking and imaginations involved in reflecting with sound…it adds more depth into the present moment"* (P1-20-female). Collectively, these examples highlight that sound is ultimately successful at opening up imaginations and triggering rigorous reflections.

Reflecting on mundane sounds not only helped the participants experience being in the

moment but also acted as a memento, building appreciation and meaning over time. During the discussion session, participants were able to recall most if not all of the emotions, reflections and other complementary details of the context: *"I can remember the details of that moment when it triggered memories and emotions of my grandpa…and what I felt through sound back then"* (P10-30-male). The participants referred to tuning into the sounds and recording it as means to recall back on the moment later in time: *"Recording sounds are necessary for recalling memories later in life…. It's like a diary, but also with visual and audio…we sometimes rely too much on human memory but we tend to forget basic things"* (P6-20-female).

Collectively, when these enabler means are used together as a design material within the proposed sequential process introduced in the previous session, it successfully supports the unobtrusive and emotional self-therapeutic experience for the individuals in their everyday life routine.

6. Discussion and Implications

A key contribution of our study is to discover the process and means that can be applied into the development of self-therapy design. The Tune-in was ultimately successful at providing a platform for participants to reflect through the use of sound which enabled participants to experience being in the moment. Translating reflections from auditory trigger (tuning in) into visual (diary entries) and verbal (deep discussion) expressions supported deeper reflective experiences. The self-therapeutic enablers highlight the potential of designing for mindfulness and reflection on an intimate level. In what follows, we present several research and design considerations.

6.1 The Relevance of Motivation for Self-Therapeutic Experience

A core aim of our study was to explore how and what enablers can evoke self-therapeutic experiences. It appeared that the sequential process and means was effective. Participation through motivational impact of the enablers was a key necessity to build and sustain self-therapeutic experiences as the motivating factors help create, strengthen and maintain engagement, and contribute in creating habits by time (Schunk, 2012). Motivation appeared throughout the sequential process in the form of tangible entertainments which initiated voluntary participation, unexpected rewards which built appreciation, and moments of epiphany which triggered reflections from new perspectives and increased satisfaction. Also, the means of analogue tangibility, tangible accessibility and mundane sound helped experience meaningful reflections in the moment by supporting the motivational effect of the sequential process. While these means ultimately led to self-therapeutic experiences, they were also the source of inconvenience as participants struggled at first to appreciate the analogue in a digital society, with which they were more accustomed with. This highlights the complexity of balancing the multiple set of enablers and thus accentuates the need for harmonious design.

More generally, the topic of mindfulness and reflectivity has been of consistent interest in research through diverse ways (Cox et al., 2016; Grosse-Hering et al., 2013; Höök et al., 2016; Odom et al., 2014; Pierce, 2012), yet there lacks direct exploration on what specific set of enablers provoke self-therapeutic experiences and how they are sustained through the leverage of motivation. With the burnout society demanding the need for us to be self-therapists from moment to moment (Han, 2015), our study contributes to this potentially important area of DRS research.

6.2 The Role of Sound as a Design Material for Self-Therapeutic Experience

The study has also revealed how tuning into mundane sound played an important role in influencing mindfulness, perceptions of value, and meaning for individuals throughout everyday life routine. Unlike sounds designed specifically for therapy sessions (Goldsby et al., 2017; Hobson et al., 2010), mundane sounds appeared to be an effective design material for unobtrusive but immediate trigger in situating the individuals in the present moment. Reflecting with mundane sound enabled participants to better experience their everyday life and incorporate meaning into their lives without the limitations of time and space. Interestingly, participants described how tuning into mundane sounds also connected them to other sensory experiences for deeper and richer reflections and imaginations. Clearly there are opportunities of sound for increasing the chances of self-therapeutic experience.

These findings suggest a future opportunity for the DRS community to explore more diverse ways sound can naturally and smoothly be imbedded into the design as primary tools and enhance ways to experience self-therapeutic experiences in daily moments. We imagine that sound as design material could be applied across different kinds of archives and potentially be incorporated into everyday objects or interactions to support reflection on a moment to moment basis. Further, mundane sound being one of the self-therapeutic means found from this research, explorations on how to intertwine with the other means could evoke meaningful reflections that subtly and effectively enable self-therapeutic experience.

6.3 Self Therapy Future Research Considerations

The Tune in assisted participants to reflect and experience self-therapeutic experiences moment by moment, and throughout the study participants experienced subtle changes in their routine while capturing meaningful sounds. It is important to point out that the duration of the Tune in diary study for each participant (seven-days) poses several limitations. For example, it is unclear how the subtle changes and interactions overtime would have impacted the quality or the style of the self-therapeutic experience. Although the seven-day diary study followed with an in-depth discussion session was an appropriate scaling for this study considering the goal of the study was to explore and discover sets of surface enablers, if the duration of the study extends, we imagine the possibilities of new findings in relation with time, and habit formation which can be meaningful as future research direction.

7. Conclusion

We conducted a cultural probe inspired diary study to discover the set of enablers for self-therapeutic experience and contribute to designing for overall mindfulness on a moment to moment basis. The findings show that the enablers motivate self-therapeutic experiences in the form of sequential process and means. The sequence of the process was considered important as the process performed as a mental guide for the individuals to experience mindfulness in an effective way. Also, analogue tangibility, tangible accessibility, and mundane sound operated as means for self-therapeutic experience, ensuring smooth reflections to take place. Our study intends to contribute to the ongoing initiatives of research by exploring how the forms of interaction can be designed to shape people's enhanced experience and contribute in the articulation of how the use of self-therapeutic enablers betters the quality of everyday moments in this burnout society. We hope this research can inspire the community to explore design research in the future on the context of celebrating everyday moments.

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SYNERGY

When theory meets users in co-design: four strategies towards synergy between bottom-up and top-down input

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Abstract: In the co-design process, both evidence-based (top-down) and experience-based (bottom-up) input are important, especially in the healthcare context. While the risk of conflict is present, integration of both types of input can lead to synergetic design that encompasses the benefits of both worlds. By building on a case study in which we worked with cancer patients and oncology nurses to co-design an eHealth intervention focused on training self-compassion, this paper contributes to existing literature by exploring practical strategies to merge top-down and bottom-up input in the co-design process. The resulting strategies are: selecting (satisfy one need but not the other), combining (keeping multiple options in the design), integrating (designing a new and coherent functionality that serves both needs) and reframing (redefine perspectives in a way that dissolves the conflict). These bidirectional strategies can enable full co-creation, and further research could investigate their utility in other co-design spaces

Keywords: co-design; ehealth; evidence-based; experience-based

1. Introduction

In this paper we explore the merging of top-down and bottom-up input in the co-design process, as part of an ongoing research-through-design investigation. We draw insights from a case study in which we worked with cancer patients and oncology nurses to co-design an eHealth intervention, focused on training self-compassion skills. As design-researchers we investigate, on the one hand, what is needed to ensure that the resulting design artefacts will match and resonate with the daily experiences of the user. On the other hand, we also aim to create eHealth interventions that build on relevant medical or psychological theory. Sometimes, user requirements may collide with the theoretical evidence. The design may then be at risk of becoming a dilemma or power play between requirements that derive

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from theoretical evidence (which we call 'top-down input') and requirements that derive from acknowledging real-world, lived experiences and contexts of end-users (which we call 'bottom-up input'). When theoretical evidence-based elements are incorporated into the design, the design may be more likely to have the intended training effect by drawing from an existing knowledge base. For example, in our case we build upon knowledge of myriad benefits for well-being that training self-compassion can have, but also about what potential drawbacks or risks may be involved (thus facilitating responsible design for vulnerable groups). A research artefact should demonstrate a research contribution that is embedded in an existing field of knowledge (Zimmerman, Forlizzi, & Evenson, 2007). In our case, if the artefact does not contain substantial theoretical evidence-based self-compassion elements, then it is unclear what the artefact and its effects represent and what their meaning and contribution to the body of knowledge are. Moreover, since evidence-based healthcare is more and more the standard (Broom & Adams, 2012), evidence-based design becomes a societal design requirement in order to facilitate the financial and geographical availability of the design to users. At the same time, if the design does not match with the lived experiences of the user it is unlikely to be appropriated in daily practices (Carroll, Howard, Vetere, Peck, & Murphy, 2002) or to become part of ones' embodied and situated routines (Van Dijk & Verhoeven, 2016; Grönvall & Verdezoto, 2013). Dissatisfaction with the artefact and a mismatch of goals between the intervention and the user are common reasons for abandonment after limited or first use of an eHealth intervention. This mismatch may even illicit adverse effects such as frustration or irritation rather than generating positive emotions and feelings of accomplishment (Ludden, van Rompay, Kelders, & van Gemert-Pijnen, 2015). In that case it is unlikely that the design will have the intended effect regardless of the strength of the theoretical evidence. Therefore, a design should ideally encompass the benefits of both worlds.

Particularly in healthcare, the merging of top-down and bottom-up input is a common prerequisite. This is because its specialized knowledge-intensive context entails that solely considering user experience as the basis for design is insufficient. Both theoretical evidence-based (top-down) design approaches and experience-based (bottom-up) design approaches provide important benefits, while they each have limited merit in their isolated application in healthcare. It is in the integration of these different sources of input that a synergetic dynamic can be produced (Rosa, Borba, Vaccaro, & Leis, 2015). In recognizing that the value of top-down input depends on embedding it in the daily experiences of the users, it is necessary to foster a level of co-design that goes beyond consultation of and evaluation with users, in order to achieve integration (Carr, Sangiorgi, Buscher, Junginger, & Cooper, 2011). While the importance of integrating top-down and bottom-up input in the co-design process seems clear from existing research, not much is known about concrete, practical strategies to merge these different inputs - especially when they appear to be conflicting. In this paper we will build on our case study to explore practical design strategies for merging top-down and bottom-up input that support synergy rather than concession. The case study involved a nationally funded project by The Dutch Cancer Society with a consortium in which the University of Twente, the Medical Spectrum Twente, the University Medical Centre

Groningen and the Department for Digital Health Research from the Oslo University Hospital participated with the aim to develop a mobile self-compassion intervention for people with newly diagnosed cancer. Our main question is: what design strategies can be used to integrate top-down and bottom-up input in a design when their requirements appear to be conflicting?

2. Case study: self-compassion mobile health intervention for people with cancer

2.1 Top-down: theoretical background of self-compassion

Living with cancer entails not only physical complaints related to the disease or treatment (e.g. fatigue, nausea, pain and functional limitations), but also psychological problems (e.g. symptoms of guilt, anxiety and depression, impaired well-being, lack of acceptance) and social problems (e.g. loneliness/social isolation, absenteeism from work). While the incidence of cancer is rising (International Agency for Research on Cancer, 2019) the number of patients that need help with coping with these challenges is expected to increase. Current psychological interventions for cancer patients focus primarily on reducing distress in face-to-face settings (e.g. Van Weert et al., 2005). However, such programs reach only a small proportion of patients in need of support (Eakin & Strycker, 2001; Ryan et al., 2005; van Scheppingen et al., 2014). There is a lack of low-threshold interventions aiming to support patients in adapting to cancer and its treatment. Mobile health applications have the potential to surpass geographical and temporal barriers to care and thereby reach more patients (Silva, Rodrigues, de la Torre Diez, Lopez-Coronado, & Saleem, 2015).

Self-compassion refers to a warm, wise and kind attitude in times of difficulty and the ability to be sensitive to personal suffering (Neff, Kirkpatrick, & Rude, 2007). Self-compassion can be trained through compassion-based interventions, which usually have a modular, sequential structure and consist of core elements of psychoeducation about emotions and meditative, reflective and applied exercises. Most compassion-based interventions take place in a traditional setting of face-to-face meetings with a trainer (individual or in a group) with minimal use of technology (Austin, Drossaert, Schroevers, Sanderman, Kirby & Bohlmeijer, 2020). Key aspects of compassion training are reviewing self-criticism and shame-based thoughts/behaviours as safety strategies, developing compassionate acceptance and empathy for the origins and uses of these strategies, and developing skills such as mindful awareness and compassionate imagery to respond to difficulties (Gilbert, 2006). The intervention form or content may be adapted to the needs of the group of individual, while the sustainable cultivation of compassionate capacities and skills remains central (Gilbert, 2014). For example, people first learn to tune in to their emotions before they learn to develop compassionate acceptance towards them (Gilbert, 2006). Compassion-based interventions have been shown effective in various healthy and mental illness populations, as they yield reductions in anxiety, depression, psychological distress and increases in self-compassion and well-being (Kirby, Tellegen, & Steindl, 2017). Interventions for people with

long term physical conditions such as cancer are only emerging, though our recent review showed that they hold promise for this population (Austin et al., 2020). Furthermore, previous research at our department suggests that compassion-based interventions are also effective in self-help format (Sommers-Spijkerman, Trompetter, Schreurs, & Bohlmeijer, 2018). While the evidence is promising, it should be noted that some of these effects are still preliminary and other forms of compassion-based interventions are yet to be investigated.

A few key points from the top-down input for the design process are:

- Self-compassion requires a sensitivity to personal suffering, thus not seeing difficult emotions as 'a problem to be solved' but as an experience to have compassion for.
- Compassion-based interventions train self-compassion by using a sequential learning structure to continuously build upon acquired skills and knowledge. They rely on a mix of psychoeducation, meditative exercises and reflective exercises to cultivate self-compassion.
- While many cancer patients experience distress, few low-threshold psychosocial interventions are available and integration of technology is minimal. A self-help self-compassion intervention in the form of a mobile app may lower the threshold for cancer patients to accept an intervention.

2.2 In search of the bottom-up: a series of co-design workshops

To map the daily contexts, lived experiences, needs and wishes of our target group, we conducted four parallel rounds of co-design workshops with 3 oncology nurses and 6 cancer patients (predominantly with the same participants). Patients were 6 females and 6 males (aged 29-64 years), diagnosed between 6 and 24 months ago with a form of cancer (most commonly breast cancer and lymphoma). Nurses were 4 females and 2 males (aged 31-54 years), with 11 to 27 years of experience in working with cancer patients. The main motivation for participation was to be able to help future cancer patients. The modality of the design (smartphone-based) was determined in a prior pilot interview study with 11 cancer patients, who indicated during semi-structured interviews that their preferred modality for a self-compassion self-help intervention was smartphone-based. Since research funding was then obtained based on the premise of designing a smartphone app, the choice of modality was no longer part of the design process.

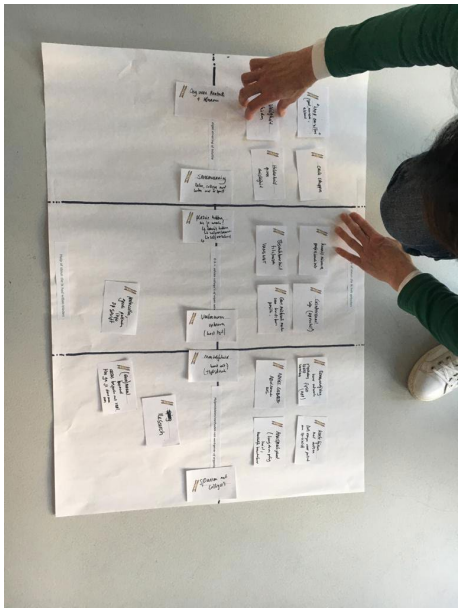
In the workshops we focused on co-designing application content (information in text, audio, video etc.), functionalities, visual appearance, and implementation and support structures of the application. The main goal of the workshops was to study the user experiences through co-design exercises. Each workshop lasted 3.5 hours and consisted of an introduction and discussion of output from the previous session, two-to-three co-design tasks and a general discussion. Further details on topics and co-design exercises are displayed in Table 1. The extent to which exercises were more structured or more open-ended depended on the objective of the co-design exercise. Moreover, co-design exercises were discussed and

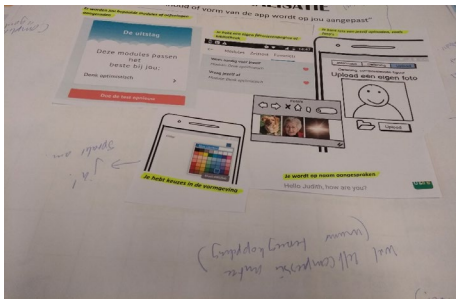
refined with our team of patient representatives before including them in the co-design workshops. Merging top-down and bottom-up input was explicitly part of the workshops, since we presented theory on self-compassion and then asked participants for their thoughts. The goal of these discussions was not just to educate participants about self-compassion, but to empower them such that they would be well equipped to contribute to the design process. For example, in the fourth workshop we presented five lessons learned from our literature review and five lessons learned from the participants' input and then discussed the resulting differences and similarities. Thus, the content of the co-design workshops was set up to facilitate the merging of top-down and bottom-up input.

A few key points from the bottom-down input for the design process are:

- Concrete, practical topics to be addressed within the context of self-compassion are valued, such as: lifestyle and taking care of the body, acceptance of the illness and functional limitations, communication with the social network (e.g. setting boundaries), positivity and appreciation of what is still possible despite physical/ functional limitations .
- Freedom to use the app in a way fitting with the personal situation and preferences is important, for example by skipping irrelevant parts and easily navigating to favourite parts.
- While personal(ized) feedback is valued, the busy and fluctuating nature of the care context precludes one-on-one monitoring of or responding to users by oncology nurses.

Table 1 Topics and co-design exercises for each of the four co-design workshops

Workshop no.	**Topic**	**Co-design exercises**	**Visual example of co-design exercise**
1	Problem exploration and exploration of self-compassion	-Mapping of individual obstacles and helpful tools in dealing with the cancer diagnosis, visualized as rocks and ladders - Mapping of support that was or was not present from oneself/own network/ professionals after the diagnosis, using a card sorting method - Identifying individual moments of self-compassion (on green post-its) and self-criticism (on blue post-its) in relation to the diagnosis, then categorizing them in groups	

2	Content of the intervention	- Trying out various self-compassion exercises on paper in the two weeks prior to the workshop - Building a desired app and an undesired app represented on paper smartphone models, by categorizing and altering the self-compassion exercises - Identifying additional topics and exercises to be addressed in the app, by adding and altering to topics identified in workshop 1	
3	Features, visual design and use of language	- Trying out other psychosocial apps in the week prior to the workshop - Presenting the used apps to each other in small groups, highlighting positive and negative user experiences - Creating a map of the similarities and differences in the experiences of functionalities in these apps, focused on: filling out and sharing information, motivational elements, feedback, personalization and mode of information - Exploring language use in the app by playing a card game in which the story of the app was presented with five different ways (based on metaphors) on five cards, where participants "played out" their preferences - Creating a diagram of the way the app could be offered and supported by nurses (when/to whom/how/how often)	

4	Structure and flow of the intervention	- Shaping the flow of and processes within the app, using cardboard boxes representing different app modules to write on and move around - Creating paper prototypes of parts of the app using both defined (e.g. printed buttons) and undefined (e.g. random stickers) materials	

3. Towards synergy: strategies for merging top-down and bottom-up input

The results of the workshops provided input for designing the content, functionalities and visual appearance of the mobile intervention. In this paper we focus on the design process and use the results of the co-design workshops to illustrate our design strategies. In some cases top-down and bottom-up input were aligned and could be merged effortlessly. In other cases top-down and bottom-up requirements mostly matched, but the content or functionalities required some modifications (e.g. making the content more concise or realistic). In other cases, top-down and bottom-up requirements did not match and appeared to be conflicting. These are the cases that required co-design strategies to facilitate synergetic design decisions. In order to arrive at these strategies, we used reflection, field notes and process evaluation. All co-design workshops were evaluated with participants at the end of the workshop via group discussion and anonymous feedback forms. After each workshop researchers further evaluated the workshops and the design requirements using field notes, feedback forms and transcripts of the workshops. Output of all workshops was analysed and clustered by the main research team, which included a designer and two psychologists, focusing on types of strategies as they emerged during the sessions, in attempts to resolve any apparent tensions between opposing bottom-up and top-down requirements. We concluded that the employed solutions in the workshops could be categorized into four main strategies: selecting, combining, integrating and reframing. We will discuss these now, based on examples from our case study. See Figure 1 for an overview of the strategies.

3.1 Selecting: satisfy one need but not the other

For our intervention, we envisioned that nurses would have an active role within the application, by monitoring patients' progress or giving personal feedback. We know from previous research that interaction with a caregiver can increase effectiveness of eHealth interventions in general (Kelders, Kok, Ossebaard, & Van Gemert-Pijnen, 2012) and compassion-based interventions in particular (Sommers-Spijkerman et al., 2018). However, in the co-design exercises with nurses that addressed their role in offering and guiding the intervention, it became clear that they found an active supporting role within the

application not feasible. Nurses described the chaotic nature of their work, the amount of information and questions they already have to process and the fact that the self-compassion intervention should only be a small part of their daily tasks. After considering the options we decided that an interactive communication function will not be part of the design, since the chances of nurses making use of a functionality that does not meet the reality of their work are slim. Therefore, despite the possibility of reduced efficacy of the design, we chose to satisfy bottom-up but not top-down needs.

3.2 Combining: keeping multiple options in the design

Having a modular learning structure is central to most compassion-based interventions, in order to build upon previously acquired skills and knowledge (see Austin et al., 2020). While intervention content can be adapted and the personal learning process is not linear, sustainable cultivation and building of compassionate capacities and skills are key (Gilbert, 2014). Compassion-based interventions often start with psychoeducation and basic awareness of the breath, body or present moment experiences before incorporating more specific compassion practices. Since self-compassion exercises involve an awareness of personal suffering, it is important not to start these exercises without the necessary preparation. On the other hand, in our workshops some end-users clearly indicated that they wanted immediate in-the-moment support or inspiration. They anticipated that they would open the application at a moment when they would want input, with the expectation that the application will offer this input promptly. Concurrently, they expressed doubts about having to go through a lot of material before accessing a relevant suggestion or about not having instant access to all relevant material. Since both the modular structure and the usage needs of end-user are important design requirements, we decided to combine both needs in the design by including a sequential structure of self-compassion modules to acquire skills and a homepage with directly accessible features for immediate support. These features are based on the needs of end-users and include among others a short daily exercise that does not require much preparation and a page with practical information and links. Thus, when accessing the intervention, the user will have the choice between exploring the homepage features or starting/continuing with the modular training. The modular training and the homepage features will be interlinked, since the homepage features will refer to module items for further information or practice and there will be a list of marked favourite module exercises accessible from the homepage. In this way, we combined different needs in the design by including separate functionalities, while interlinking these functionalities to provide coherence.

3.3 Integrating: designing a new and coherent functionality that serves both needs

Mood tracking can empower users to have a more active role in their wellbeing by enabling them to reflect on their mood (Caldeira et al., 2017). With self-report mood tracking, users are asked to manually enter their emotional state, usually on a text-based or illustrated/

animated scale. Mood tracking can serve creating greater awareness and may also facilitate behavioural change (Kanjo, Al-Husain, & Chamberlain, 2015). In our design we intended to include a basic mood tracker in order to facilitate greater awareness and self-regulation of emotions, which in turn can facilitate compassionate responding to these emotions. Since self-compassion requires a sensitivity to personal suffering without seeing the suffering (e.g. a bad mood) as a problem to get rid of, we did not intend to provide recommended actions based on the user input. However, when participants tried out different apps that included mood trackers, some participants posited that this functionality and the increased awareness of mood is only useful to them if a suggested action is coupled with the input. In addition, participants repeatedly communicated through discussion and through prototypes the wish to enter a negative mood in order to get a suggestion on how to handle the mood. Therefore we decided to design a different type of mood tracker were participants get personalized feedback that facilitates compassionate responding to the mood while also offering suggestions for further practice (e.g. offering a self-compassion exercise or linking to a module). In this way, we integrated a top-down need (mood tracking for greater self-awareness) with a bottom-up need (getting solutions for feeling bad) into a new functionality (mood tracking that offers compassionate suggestions based on input).

3.4 Reframing: redefine perspectives in a way that dissolves the conflict

Compassion-based interventions train self-compassionate capacities using a mix of information provision (psychoeducation) and various experiential exercises. These exercises enable participants to engage with their own difficult experiences and to practice with compassionate responding. In our workshops participants expressed a need for gathering and receiving a plethora of information about cancer diagnoses and treatments, local health care options and lifestyle tools and tips. It appeared that many patients go through a phase post-diagnosis where they try to gather as much information as possible related to their diagnosis. Seeking information can be a constructive strategy in response to illness (Campos, Besser, Ferreira, & Blatt, 2012; Grönvall & Verdezoto, 2013), however participants repeatedly mentioned that this action often made them feel overwhelmed. In addition to the fact that an extensive bibliography of information does not match the varied components of compassion-based interventions, it also seems that ‘getting more information’ is not necessarily what patients are seeking as such. We may *reframe* their desire for information as being a coping strategy through which participants attempt to regain grip on their situation, given their recent diagnosis, and that regaining grip is ultimately not achieved by consuming extensive amounts of information. With this reframing we were able to incorporate the need for getting a grip on the situation in other ways, such as by stimulating users to take moments to pause and step back from their situation, which did match the evidence-based aims of the application. Thus, by reframing a need we allowed for an alternative solution to be produced (Paton & Dorst, 2010).

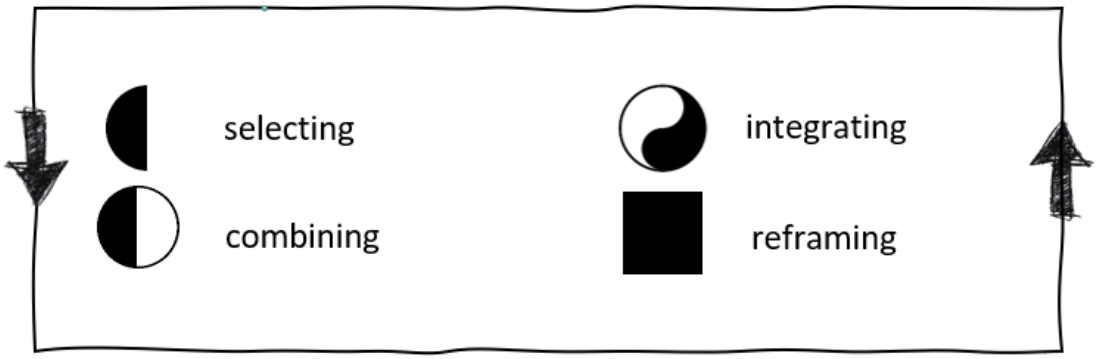


Figure 1 *Practical strategies for merging top-down and bottom-up input in co-design when requirements appear to be conflicting.*

4. Discussion

We started out suggesting that in co-design, it is important to merge requirements based on theoretical evidence ('top-down input') with requirements derived from mapping the lived experiences and everyday contexts of end-users ('bottom-up input'). Sometimes these requirements may be in conflict, thus posing a challenge to the design researcher to solve this conflict in a way that strengthens, rather than weakens the design outcome. Trade-off decision making is inherent to design (Howard, 1997). However the challenge is not just one of making a straightforward trade-off between requirements, because the requirements in question cannot be easily compared and ranked given their fundamentally different sorts of validity: grounded in theoretical evidence on the one hand, and grounded in the lived, human experiences of the co-design participants on the other hand. Analogously, we can look at the way merging top-down and bottom-up input has been investigated in health care research. The rise of evidence-based medicine on the one hand (using the best available evidence to inform healthcare), and shared decision making on the other hand (based on patient autonomy and enlarging the patients' control over health decisions) has created a complex dynamic (Barratt, 2008). For example, a patient may choose a medical treatment based on their personal lifestyle/life-orientation preferences, whereas empirical evidence shows that the chosen treatment yields suboptimal effects. In health-related and psychosocial interventions, a conflict between top-down and bottom-up input reflects, more often than in other design contexts, friction between what is healthy or beneficial for the patient in the long-term, and what is matching the needs and wishes of the patient in the short-term. For example, top-down input sometimes represents knowledge of beneficial behaviours or cognitions with delayed benefits (e.g. moderate alcohol intake, practicing acceptance of suffering), while bottom-up input then represents behaviours or cognitions with immediate gratification (e.g. enjoying multiple bottles of wine, avoidance of suffering) (Lawless, Drichoutis, & Nayga, 2013). On the other hand, bottom up factors can

also represent a long term benefit, sometimes missed by top-down generated intervention strategies. For example, in designing interventions for the elderly (Steen, 2012) or for people on the autism spectrum (Spiel, Frauenberger, Fitzpatrick & Keyes, 2019), we see how healthcare interventions may be effective 'in theory', but will in practice not have a long-term effect if this intervention if people do not appropriate the intervention within their everyday lives. As described in the RE-AIM framework for healthcare interventions, factors such as adoption and reach of the intervention are crucial in addition to evidence of efficacy in ensuring intervention success (Glasgow, McKay, Piette, & Reynolds, 2001). To ensure long-term benefits of an intervention, meeting both top-down and bottom-up requirements involves engaging the users with the artefact in the present moment, while also ensuring the evidence-based long-term benefits in a way that makes sense to the user and leads to sustainable appropriation of the intervention in daily life. To achieve a merging of top-down and bottom-up requirements, we have explored four practical design strategies based on a series of co-design workshops. These workshops represent a co-design context of down-to-earth exercises that remained close to the already determined modality of a smartphone platform (as opposed to, for example, fantasy-driven co-design exercises). Nevertheless, we expect that the four strategies are relevant in other healthcare co-design contexts in which friction between top-down and bottom-up requirements is common.

Our first strategy. 'selecting', is based on the question "*Can (or should) one of the requirements be satisfied but not the other?*" This is a common strategy, since the pragmatics of the design process often do not allow for a combination of functionalities (Howard, 1997). Designing means making choices, and thereby not leaving all the choices for the end-user to be made. In a study on trade-off decision making among designers, Howard (1997) found that designers often see alternatives as mutually exclusive while attempting to synthesize or otherwise manipulate them is much less common. However, the other three strategies we propose are more a matter of generating rather than choosing alternatives. The second strategy, 'combining', points to the question "*Can the perspectives be combined by keeping multiple options or aspects in the design?*". Combining different design elements is at the heart of creation, and can create novel solutions (Simon, 1995; Boden, 2003). By combining different requirements, multiple requirements and their associated benefits can be met in a single design. The third strategy 'integrating', points to the question "*Can the perspectives be integrated in a new and coherent functionality that serves both needs?*". This applies when conflicting top-down and bottom-up requirements share an apparent common ground or link that can be exploited to create a new functionality that serves both needs. The fourth strategy, 'reframing', points to the question "*Can one or both of the perspectives be redefined in a way that dissolves the conflict?*". Reframing allows for a problem to be seen in a qualitatively new way, which means to revisit some of the underlying assumptions and concepts, on the basis of which the situation was up to then conceived. It is often seen as a key step in design thinking (Paton & Dorst, 2010). By reframing the conflict between top-down and bottom-up input, the conflict can sometimes be dissolved, allowing for different requirements to emerge with their own associated design solutions. Which (combination of) strategies should be used most likely depends on the specific co-design process and the

context of technical, theoretical, social, financial and user-based requirements that have to be taken into account. Trade-off decision making greatly varies in the complexity or simplicity of the decision making and the key elements and arguments involved (Howard, 1997). We therefore suggest that there is no hierarchical structure to the proposed strategies, but that their use depends on the context of each decision to be made. What is crucial in each of the strategies, in our view, is to resolve the apparent conflict through design, exploring various options by using a variety of the strategies just described, rather than attempting to judge a priori which of the requirements, bottom-up or top-down, are 'most' important.

While the focus of this paper is on merging top-down and bottom-up input, this is not to suggest that top-down and bottom-up input are the only key sources of information, nor that they are internally homogeneous. The design context includes health care practices and regulations, governmental and insurance policies regarding healthcare interventions, project scope and requirements, differences between end-users, and various top-down theories (e.g. about participatory design, psycho-oncology, eHealth etc.). Furthermore, certain aspects of top-down theoretical input may not have been thoroughly researched yet, thus making it challenging to determine how important their implementation is in the face of opposing user needs and experiences. In that case, the co-design process may further inform the theory by trying out different iterations and monitoring their effects. The iterations can then serve as scaffolds to generate shared understanding (Van Dijk & Van der Lugt, 2013). Similarly, not all users have the same needs, values and experiences. Particularly in our workshops, differences between users' preferences were often present and these differences require their own resolving strategies. We speculate that our strategies could apply to apparent conflict between different end-users or other types of information sources. For example, when 'combining' different requirements in a design, designing for personalization may further cater to different user preferences. Thus what we have shown to be already a complex relation between top-down and bottom up, in reality expands into a much more complex network of information sources, most of which cannot be readily compared but must be integrated nonetheless into a coherent design. Further research could investigate the utility of these strategies in other types of co-design spaces as well as with other types of information sources. Furthermore, it would be interesting to explore whether designers using explicit co-design strategies create more feasible, creative or effective designs than designers who do not.

Noteworthy, the term evidence-based is sometimes misused as a demand for recognition of the validity or even superiority of protocols or procedures, thereby undermining the dependence on bottom-up input to allow for real-life implementation (Carr et al., 2011). If synergy is to be achieved, the benefits of both sources of input need to be integrated as part of a mutually informative process (Carr et al., 2011; Rosa et al., 2015). We would like to emphasize to approach the co-design process as such and to see the suggested strategies as bidirectional options. For example, when 'selecting' requirements, in some cases it may be prudent to choose an alternative based on top-down input and at other times bottom-up input may take prevalence. Building on the work of Sanders and Stappers

(2008), we illustrate our strategies as part of a mutual co-design approach (see Figure 2). Our work contributes to the ongoing movement in design research from the predominantly unidirectional user-centred design approach to a dynamic co-design approach (Sanders & Stappers, 2008). The suggested strategies offer applicable tools for design researchers in healthcare and other contexts to support their co-design practices.

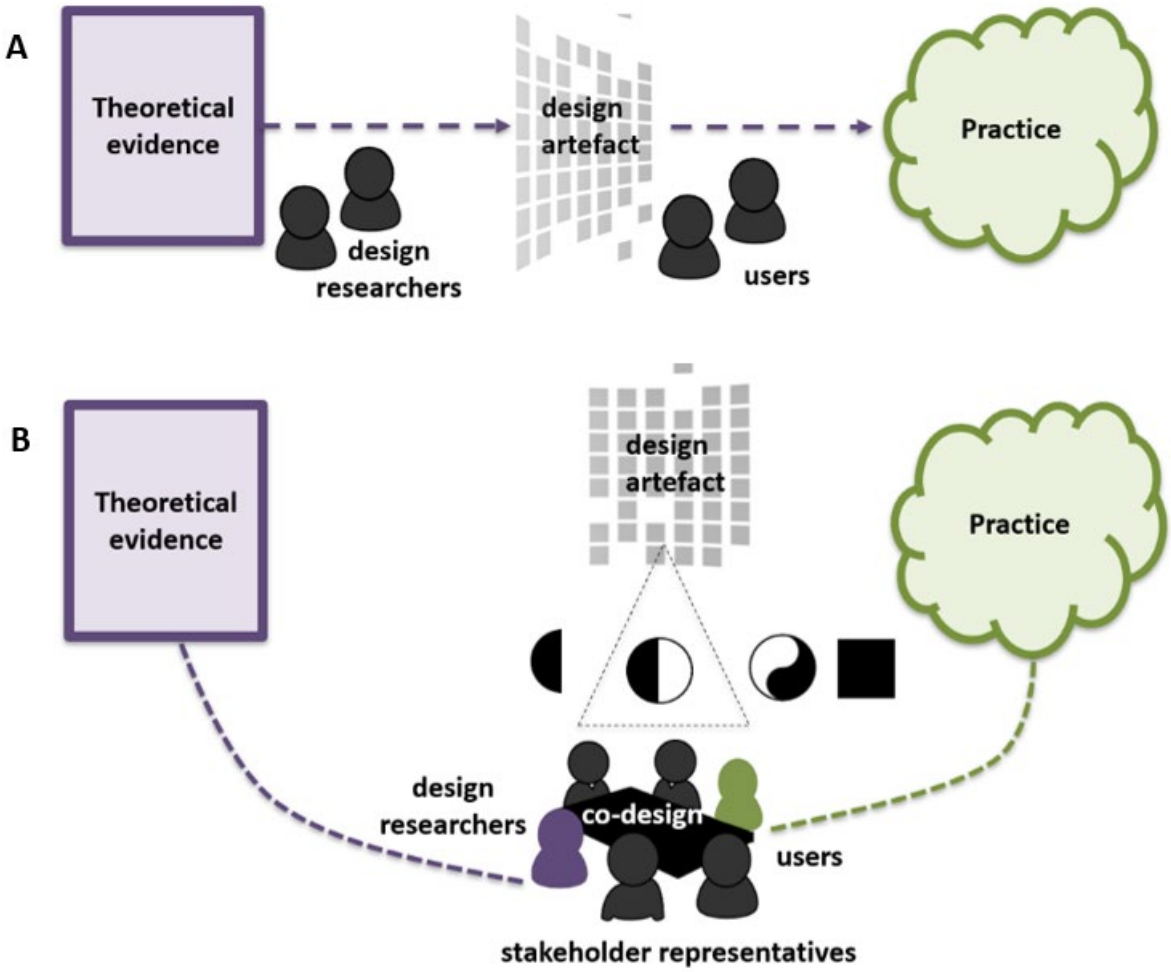


Figure 2 *A) depicts a user-centred design process, often presented as co-design, that adapts theoretical evidence to the user while B) depicts a co-design process in which theoretical evidence (top-down input) and user requirements (bottom-up input) are merged in a co-design process by using the four strategies.*

5. Conclusion

Based on a case study in which we worked with cancer patients and oncology nurses to co-design an eHealth self-compassion intervention, we explored strategies for merging top-down and bottom-up input in the co-design process. The strategies that we propose to

resolve apparent conflicts between top-down and bottom-up requirements are: selecting (satisfy one need but not the other), combining (keeping multiple options in the design), integrating (designing a new and coherent functionality that serves both needs) and reframing (redefine perspectives in a way that dissolves the conflict). These bidirectional strategies serve as tools to aid the co-design process in a way that promotes synergy rather than concession. Further research should investigate the application of these strategies in other co-design projects and explore their benefits and applications as well as other potential useful strategies.

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Designing for Helpers: Identifying new design opportunities for digital volunteerism

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Abstract: With the advent of digital technology, many individuals completely or partially transition to digital platforms for volunteering. Many of these platforms do not take volunteer needs, values and experiences into account in design. Additionally, many online experiences are different to face-to-face ones as volunteers find it challenging to relate to the beneficiaries or to express/feel gratitude. In this paper, we used generative methods and tools in two codesign workshops with volunteers in an educational program involving both online and physical modules. Based on findings relevant to the mode of volunteering, people, self and future desires, we identified four areas of design opportunities to foster relatedness and gratitude in online volunteering and reduce disparities between online and physical volunteering experiences. We contribute new directions for improving the design of digital volunteering platforms through personalised solutions that support gratitude, social bonding, better communication of shared experiences and goals, and community building.

Keywords: prosocial; volunteering; generative tools; codesign

1. Introduction

> "You have not lived today until you have done something for someone who can never repay you." John Bunyan, The Poetry of John Bunyan - Volume II

People engage in prosocial activities from time to time – prosocial behaviours indicate activities such as helping, that make a difference in the lives of others or support a cause that one purports to cherish for one reason or the other (Eisenberg & Mussen, 1989). Digital technologies are then designed to facilitate 'helping' through digital activism, charity, advocacy, humanitarian assistance and such. There are a variety of motivations for prosocial behaviours which are shaped by a person's needs and life experiences (Clary & Snyder, 1999). Incidentally, research also indicates that beneficence is important for a person's health and wellbeing (Martela & Ryan, 2015). As a discipline that aims to provide solutions

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to human problems, design research can provide new avenues for motivating these digital 'helpers'. Human-centred design can then realise the wellbeing benefits associated with digitally enhanced prosocial behaviour. In this paper, we explore new opportunities and design qualities through a case study and propose how those may be embedded in digital volunteering solutions.

1.1 Digital volunteerism

Digital volunteerism is technology-led volunteerism, which is increasingly popular due to availability of internet solutions. A report indicated 31% of Australian adults were involved in formal organisation-led volunteering in 2014, which is a drop from 34% in 2010. The Australian Bureau of Statistics suggested this may be due to the rise of informal volunteering aided by digital solutions (Australian Bureau of Statistics, 2017). Online digital platforms have transformed volunteerism (Liu, Harrison, Lai, Chikoto, & Jones-Lungo, 2016) in a range of contexts, such as natural disaster and crisis management (Cobb et al., 2014), collaborative online content creation on platforms such as Wikipedia (Kuznetsov, 2006), and hotlines which are considered 'emotional band aids' for individuals in distress (Gilat & Latzer, 2016). Organisations such as United Nations Volunteers have online platforms to help people volunteer their desired skills for various charitable projects all around the world (www.onlinevolunteering.org). These organisations are increasingly investing on improving the design of their digital products in order to enhance volunteer experience and engagement. ReachOut, a charitable organisation that helps distressed Australian youth, invests heavily in their online platforms to engage both volunteers and the young people in need of assistance (Naqshbandi et al., 2019).

Digital volunteering is consequently an important counterpart to physical volunteering in volunteer–involving organisations (VIOs), and is often used to improve overall efficiency of engaging volunteers (due to increased accessibility), as well as the delivered services (Amichai-Hamburger, 2008). The design of digital volunteering solutions, however, is predominantly focused on organisational objectives and values (Brudney, 2016). As a result, many experiences that we know are valued by volunteers, especially in physical volunteering, do not translate well in digital volunteering platforms (Liu et al., 2016).

In this paper, we investigate some specific experiences of digital and physical volunteers in a VIO in order to draw design recommendations for the digital volunteering platform. Thus, we further contribute to a volunteer-centric paradigm that has been previously investigated in a previous study on this digital volunteering platform (Naqshbandi et al., 2020). We use generative tools in codesign workshops to gain a deep understanding of volunteer experiences.

1.2 Generative tools and methods in Design

Sanders (2000) proposed that using generative tools for codesign is "a journey toward a future being made from the dreams of everyday people". Generative tools are effective for

capturing in-depth insights into what the user 'does', 'says' and 'makes' in order to envision a future (Sanders Elizabeth & Stappers, 2012). 'Do' techniques mainly involve observation methods to investigate participants' routine activities. 'Say' techniques include interviews and questionnaires while 'Make' techniques invite participants to perform creative activities that reveal connections and feelings as well as indicate desired situations and experiences. Making often requires designers to develop bespoke toolkits that are appropriate for the problem at hand, the context and participants involved. For example, Sanders & Stappers (2012) created a workbook probe followed by generative sessions where new parents created visual timelines to reflect on their childcare and relationship routines at home.

In the project presented in this paper, we developed generative tools based on our existing knowledge of volunteer experiences with a digital platform called Online Simulated Patient Interaction and Assessment (OSPIA). We had previously conducted research on volunteer motivations of this platform through questionnaires, workshops and experiments (Naqshbandi et al., 2020). In this project, we aim to gain a better insight into qualities, needs and values that shape desired volunteer experiences and improve volunteer motivation for engagement with the task. This insight is then expected to inform the design of new product features on OSPIA and similar platforms. Next, we introduce OSPIA and share existing research on its user experience.

2. Background

Online Simulated Patient Interaction and Assessment (OSPIA) is an online teleconferencing platform designed to support communication skills development of medical students at an Australian university. This platform allows medical students to conduct practice interviews with simulated patients (SPs) and receive feedback on these interactions. The simulated patients are volunteers who are recruited through online marketplaces like GoVolunteer, Seek volunteer. The volunteers play the role of a 'patient' based on a given script and then assess the performance of the medical student as a 'doctor'. In addition to OSPIA, there is a physical module of the same nature at the medical school on the university campus, where volunteers attend the simulated doctor-patient session in person. In the physical program, the medical students and SPs interact directly rather than through a teleconferencing platform. The online and campus sessions are similar in many ways, but a few differences exist. For instance, the online SPs' training and informational needs are integrated into the OSPIA platform whereas for the campus SPs, the organisation uses a combination of email, text messages, phone or postal service based on the preferences of the SPs.

2.1 OSPIA sessions

Volunteer engagement with the OSPIA program starts with registration on the website followed by an online training (using videos and text documents) on how to conduct the sessions. The volunteer then books appointments for interview sessions using the appointment-making process incorporated in the OSPIA platform. The interview session

occurs at the later date and time appointed by the SP and as selected by the student and finally confirmed by the SP. During the session, which lasts approximately 15 minutes, the SP roleplays a given scenario, providing details of the patient's history. For example, a SP volunteer may play the role of an easily distracted patient, whom is vague in descriptions of their symptoms. The SP then adapts these behaviours based on how comfortable the student makes them feel during the session. The aim is to help medical students develop effective and respectful communication skills for patient interactions, whether in person or via telehealth technologies. During the session, the SP can use OSPIA features to provide feedback on the student performance in real-time as the interview progresses. A formal assessment follows at the end of the session. Students see the assessment outcome at the end of the session and the SP volunteer receives an acknowledgement email up to a week later. Figure 1 depicts the chronology of the various steps involved in an OSPIA session for an SP.

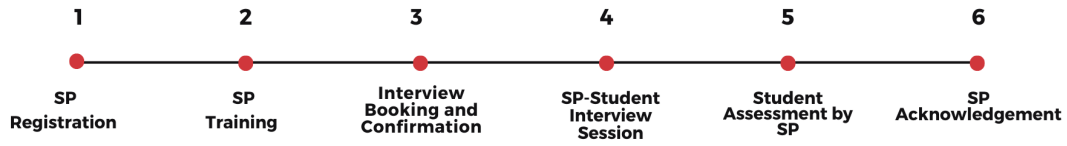

Figure 1 *Steps (in chronological order) involved in an OSPIA session for an SP, starting with SP registration and progressing to student assessment by SP followed by the SP receiving an acknowledgement email*

2.2 Prior related studies

In a previous study (Naqshbandi et al., 2020), we conducted a survey of 66 online and campus SPs. We found that campus SPs were significantly more engaged with the program and were more motivated compared to online SPs. The survey results were further expounded by the results from focus groups and interviews that were held with the campus and online SPs. Specifically, we found online SPs felt less connected to the overall OSPIA community and reported poor measures of relatedness, compared to campus SPs. Relatedness is one of the main psychological needs that impacts motivation (Ryan & Deci, 2017) and is defined as the need to feel meaningful social connections or being connected to others for a cause and through a task. The design of the tasks in online or physical environments can impact the sense of relatedness and other psychological needs in volunteers. We then conducted an experimental study on relatedness where we replaced the automated and generic acknowledgement email sent to SPs (via OSPIA), with a personalized gratitude message written by the medical students. We found that expression of gratitude significantly improved the sense of relatedness in online SPs. Thus, the previous OSPIA study focused on using gratitude as a mediator for improving relatedness.

In the study presented in this paper, we further explore the experience of relatedness and gratitude on OSPIA platform through generative tools. We aim to identify design qualities

that may inform future design features on OSPIA in order to foster relatedness and gratitude. Thus, we contribute further insight for designing similar digital volunteering solutions that cultivate such positive experiences.

3. Methods

In this study we invited online and campus SPs to share their experiences of relatedness and gratitude with us. We conducted two in-depth workshop sessions each with two participants in order to provide an intimate setting that enables meaningful discussions. The first workshop consisted of two online SPs and the second workshop consisted of two campus SPs. Participants had responded to an invitation sent to all registered volunteers of the online and campus programs. The study was approved by the ethics committee at an Australian university (ref HC16048).

The workshops were run as generative sessions. We created two activity worksheets that identified and marked all steps involved in a successful SP–student interview sessions. These steps are similar in the online and campus sessions. The worksheets facilitate conversations about volunteer experiences. At the beginning of the workshop, a moderator welcomed the participants and introduced the objectives and activities of the session. A short introduction of relatedness and gratitude was followed with specific examples from daily life. All participants gave written informed consent before activities began. Sessions were audio recorded and a research assistant took notes.

In workshop one with online SPs, participants were asked to think of an OSPIA session when they experienced a feeling of being close or connected with a medical student. Participants then used a ‘relatedness worksheet’ to indicate details of their experience step-by-step and in parallel with the OSPIA session timeline. As shown in Figure 2, the worksheet was a visual aid to help participants recall their experience. In addition to writing, participants used stickers (see Figure 4) provided to them to attribute emotions or feelings to each step. These stickers were conceptualised from our prior knowledge of the workflows and an understanding of the experiences of the SPs from the preceding studies mentioned in the previous section. A set of 40 stickers represented generic expressions of pleasure, displeasure, confusion, annoyance amongst others but also expressions that are symbolic of appreciation, community, helping and so on that are specific to the users of this platform and tailored to the context of this study. Next, participants completed a similar activity using a ‘gratitude worksheet’ to share their experience of a time they felt appreciated in relation to the OSPIA program (Figure 3). Each activity lasted about 15 minutes. After each activity, there was a discussion session where the participants recalled and elaborated on their experiences. In workshop two with the campus SPs, a similar method was followed. Figure 5 depicts the set up and progress of the workshops.

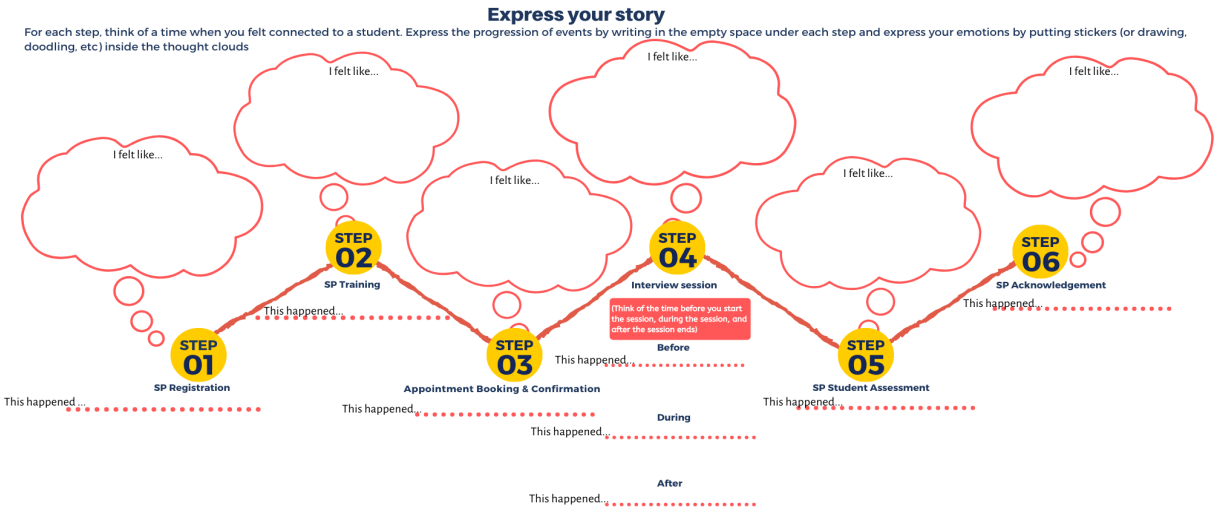

Figure 2 *Worksheet for relatedness activity for participating SPs in which they were asked to express a story in text and emotionally expressive stickers about a time when they felt connected to a student*



Figure 3 *Worksheet for gratitude activity for participating SPs in which they were asked to express a story in text and emotionally expressive stickers about a time when they felt appreciated through gratitude shown by a student*



Figure 4 *Context-relevant stickers for emotional expressions used in the workshops by the SPs*



Figure 5 *Workshops in progress depicting how the SPs used the generative design tools to recall and express stories of relatedness and gratitude*

4. Results

The workshops produced rich data based on the generative activities and discussions. Workshop one lasted for about 70 minutes and workshop two lasted for about 45 minutes. Figure 6 depicts the artefacts created during the workshops.

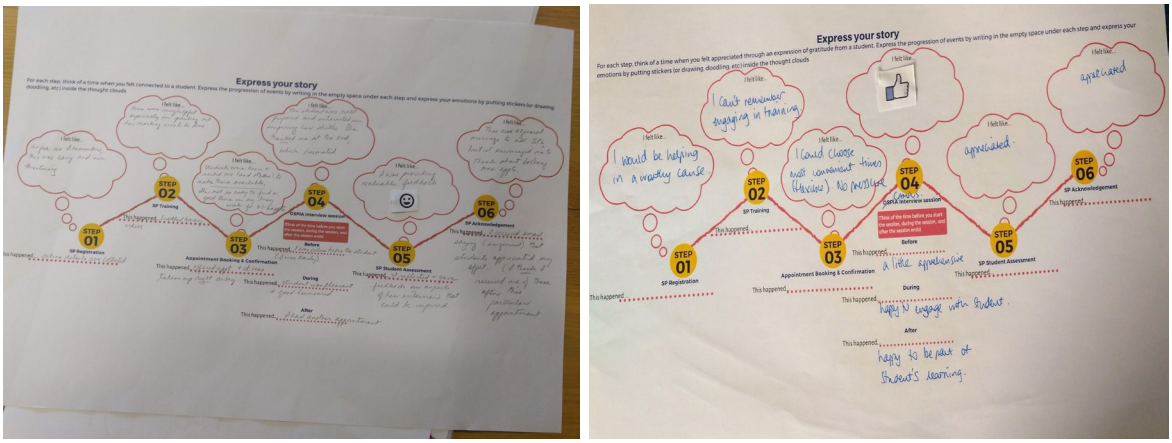

Figure 6 Collection of some artefacts produced during the workshops

Audio recordings were transcribed and thematically analysed, using the Grounded Theory method, which uses an inductive approach to coding and development of themes in analysing qualitative data (Strauss & Corbin, 1994). Accordingly, the qualitative data from the transcripts and artefacts was coded based on the ideas and concepts. The data was then categorised into broad themes which were used to gain further insights into the problem space. We combined the outcomes for gratitude and relatedness activities, as those experiences are inter-related as previously explained. We were interested in finding out the positive inter-personal experiences relevant to either, and identified five categories of themes, described as: System-centric to outline participant experiences with the OSPIA system; Program-centric to outline participant experiences in the campus program; People-centric to outline experiences with other individuals and groups of people involved in the volunteering experience; Volunteer-centric to outline personal volunteer experiences and motivations, and Future improvement category described the desired future of the programs. Details of each theme are discussed below. When quotes of participants are mentioned, we identify OSPIA participants by 'OP' and campus participants by 'CP'.

4.1 System-centric

Participants discussed features of the OSPIA design and their experiences with the platform. Participants expressed their emotional experiences such as appreciation and relief, and said they felt happy when students took appointments with them; "So, I was eager to get going and it was good to see some students were actually turning my things from green to other colour [referring to the visual design of the OSPIA feature for depicting appointment uptake]"-OP2.

A number of comments were related to the assessment tasks assigned to volunteers. They outlined their perception of the training sufficiency for assessing student. They suggested that the training did not prepare them completely as they felt too much pressure during the assessments, especially during the first few sessions. Additionally, they found the real-time feedback during the session interrupted their experience flow; "The main reason I hate it

is because I feel like they can see my hand. For the first many [sessions], there was no way I could think about clicking these [features] and concentrate on what they are asking me."-OP1.

Finally, participants mentioned the awkward phase at the end of the interview session when they come out of the SP character; "Cause you don't know whether you are supposed to be in a persona right now. For example, if you are in a doctor-patient [role] still or not. We could participate in something together, that would be nice."-OP2

4.2 Program-centric

The campus SP participants discussed the opportunities they had for informal conversations with other SPs and program organisers. These were generally considered desirable; "[Organiser 1 name] would greet us at the door and [Organiser 2 name] [as well]. She would introduce the other SPs. We would have a bit of food and it would feel quite welcoming" -CP2. The conversations usually occurred sometime before or immediately after the interview with the students. In these conversations, SPs talked to their peers (other volunteers) and program organisers which they claimed helped them get to know more about the program. These opportunities were a way for the volunteers to build empathy with the students and rapport with the organisers through casual chit-chat; "Nearly all the time, most of the best part is like in the last minute when we're waiting for the changeover and then there's a conversation between the supervisor and yourself then you've got the opportunity for them to say 'Do you feel that you're getting anything out of this?' and I'll come back and say 'Oh, yes!', you know".

4.3 People-centric

Both online SP participants mentioned their memorable experiences were associated with student's verbal appreciation; "I had a young man [on] Monday. I was totally floored, he said you have been a great patient, you have been so good. Before the interaction was assessed."-OP2. Both campus SP participants shared this sentiment. Additionally, the campus participants mentioned proud moments when the students performed well in their doctor persona; "I felt like I was contributing to the training."-CP1.

All participants also recalled memorable experiences associated with the organisers and their expressions of gratitude; "[organiser] took us to the other end, sat down with us and thanked us, which was really nice."-OP2. The campus participants in particular enjoyed the personal touch and feeling of recognition; "[Name] would greet us at the door [..] She would introduce the other SPs. We would have a bit of food and it would feel quite welcoming."-CP2.

4.4 Volunteer-centric

The volunteers discussed their motivation for joining the program. Three out of four mentioned retirement and associated that with 'feeling invisible'. They noted that volunteering allows them to feel 'relevant' as shown in the following statement.

> A potential problem for people who retire, it is quite an interesting concept, and it is called invisibility. People talk about it, which is not noticed. How do you have a voice? How do you have anything? …It is also to have a feeling of relevance and currency and these voluntary places, they help you to keep up with life and people. And I must say that I am very inspired by working with young people. -CP1

One participant was motivated by a prior bad experience with a doctor as a motivation; "I had seen two expert medicos who can't string two words together, and interpersonal skills and other skills were lacking. Is this what's coming out of university?" OP2.

Furthermore, two participants also discussed the notion of 'giving back to community' as their motivation; "Giving something back to the community and helping to be part of the student learning experience."-CP2

4.5 Future improvements

Participants suggested a few opportunities for improving the inter-personal experiences and enhancing the feeling of relatedness. For instance, they suggested having optional time to hold informal, small conversations with the student before the session starts. This, they believed, would help improve their 'bonding' with the student. They also wanted to have reflection time towards the end of the session, which may give the opportunity to both parties to express gratitude. A similar suggestion was noted about the volunteer relationship with the organisers and having the opportunity to appreciate their efforts.

> But also, I think both of us picked up that with the end of the session, a person comes sort of out of their mould. Says thanks for giving me your time, appreciate you being available and doing this for us. Even that means a lot, I think. I wonder if the technology could even build it! Usually it is [at the] end of the session that they press the button and you are cut. Maybe you could stop the interview part and there is a few seconds of slow wind down. - OP1

Moreover, the inter-personal relationships among volunteers, community building and peer feedback was mentioned.

> I am doing the assessment; nobody is saying to me your assessments are crap or your assessments fine or whatever. It would be really nice to talk to like-minded people to see. I thought it would be nice to talk to socially, but also find out where they are coming from maybe. When you take on something like this, you know you are on your own, but I guess attending one of those things [community gatherings] you realise you are reinforcing the issues that you are having is same as the other people.- OP2

Finally, participants discussed their relationship with the program as a whole and expressed a desire for being regularly informed about the program. "I had no idea about the enormity of the program. I knew that obviously a lot of students doing undergrad for medicine at UNSW, but I did not know how many of us there were."-OP2

5. Discussion

Relatedness has been linked to a range of benefits for the volunteers and the beneficiaries

in the literature. Relatedness is shown to be beneficial to the physical and psychological wellbeing of the volunteers, specifically with respect to depression and mortality risk (Ayalon, 2008; Musick & Wilson, 2003). This is mainly achieved through the social bonds and collective goals in the volunteering task (Creaven, Healy, & Howard, 2018). In academic environments, relatedness has been linked to improved learning outcomes (Beachboard, Beachboard, Li, & Adkison, 2011) and better learning experiences (Hung & Yuen, 2010) for students. In the context of experience design, Hassenzahl et al. (2013) described relatedness as one of the main user needs in order to generate positivity, meaning and happiness.

Gratitude is also shown to mediate social bonding and relationship maintenance (Gordon, Impett, Kogan, Oveis, & Keltner, 2012). It has been used as a design strategy to help beneficiaries to improve their sense of relatedness with volunteers (Naqshbandi et al., 2020; Grant & Gino, 2010). Gratitude is one of virtues discussed by Desmet and Pohlmeyer (2013) in a positive design framework for improving human happiness and wellbeing.

In this study, using generative activities helped us explore what these abstract concepts may look and feel like to the users in online and physical volunteering. This allows us to identify ways of creating more consistency in the two forms of volunteering particularly in relation to the experience of relatedness and how gratitude can be used to foster relatedness. Our participants revealed their desires and values in relation to the mode of volunteering (system versus campus), people and self, and future opportunities. In an attempt to formalize those in a framework, we propose a number of design opportunities as follows.

5.1 Gestures and personalised reciprocation

Our participants highlighted how small gestures of reciprocation from medical students or program organizers brought about feelings of happiness, pride and at times relief. It was clear that the most memorable moments for the SPs included sentiments of empathy and acknowledgement from others. Undoubtedly, participants desired a recognition of both their individuality and efforts. Personal touch was a sentiment voiced frequently as an identifier of a memorable moment. This may be achieved in design in many ways, for instance through sending personal messages of gratitude, as shown in our previous study (Naqshbandi et al., 2020). In another example, Morales et al. designed an online platform that included gamified mechanisms initiated by the volunteer managers to recognise volunteers' efforts (Morales, Mick, Lyell, & Fielder, 2017).

The findings also suggest the value of a multi-perspective design approach that recognises the roles of all stakeholders involved and not just those of the volunteer and beneficiary. There were various instances where the SPs recalled how the input and efforts of others in the program were valuable to them, e.g. when the system failed due to a glitch, some SPs personally contacted the program IT support personnel while others contacted the program manager. A multi-perspective approach in a volunteer-centric design of a system could better recognise the roles of the volunteering program organisers, the beneficiaries, the designers of the system, among others, in shaping the experiences of volunteers.

5.2 Bonding through informal interactions

Our findings highlighted that volunteers value bonding with each other, with the students, and with the program organisers in many ways, for instance, through informal interactions before and after the interview sessions. Informal conversations are shown to form an important part of developing interpersonal rapport in daily interactions (Coupland, 2014). A possibility to support informal conversations through design, as suggested by our participants, is to slowly wind down the interview sessions to help the SP and medical student to come out of their doctor–patient personas, and engage in a system supported reflection of their performance together.

5.3 Shared goals

Our SP volunteers referred to the goals they shared with other SP volunteers. Supporting volunteers shared goals can be achieved in a number of ways in digital volunteering platforms, some of which are outlined below in a set of indicative design strategies.

Effective volunteer performance: Our findings suggest digital volunteers value efficacy of training, sufficiency of information to support the task at hand, uninterrupted flow of the task, and ability to receive effective and timely feedback about their own performance. While feedback on volunteer performance can be generated in a few ways, e.g. system-generated feedback, our findings suggest that peer-feedback is preferred by volunteers. This could help fulfil their desire for self-growth and improvement, it would also help to foster productive and task-based peer-associations among them.

Benefiting the beneficiary: One of the ways the SP participants in our study expressed their relatedness to the students was while discussing their concerns about the impact of their contribution on them. This was mainly due to their uncertainty about how effectively they were able to help the students. The volunteers wanted to receive feedback on the impact of their volunteering on the beneficiary. As such, our findings suggest that there is value in designing a volunteer-centric system that builds upon a sense of relatedness between the volunteer and beneficiary by generating feedback on the impact of volunteer's efforts on the beneficiary.

Benefiting the Community: Another goal of the SP volunteers is to benefit the medical community with their volunteering work. Our SPs participants valued their contributions as a way to 'give back' to the medical community by taking responsibility for creating empathetic and competent future doctors. A designed system can respond to and support this goal. An example that reflects this design strategy is an online citizen science project Notes from Nature (https://www.zooniverse.org/organizations/md68135/notes-from-nature) which provides feedback and narratives to volunteers on how their work contributed to creating new knowledge in the specific area of biodiversity and biocollections (Hill et al., 2012). Therefore, this design strategy concerns with the features of the digital volunteering platforms that support the 'act of giving back' as well as communicating how the efforts of the volunteers are making a difference in the community, i.e. 'the reach of the giving back'.

5.4 Community building

Apart from wanting to give back to the larger community, our participants discussed their desire for being part of a volunteer community, build social interactions and feel a sense of closeness to their volunteer peers. This was easy to achieve in face-to-face interactions in campus program but required facilitation by the system for online volunteers. Many online platforms for customer relationship maintenance use moderated forums or chatrooms for building such communities. Similar features can be considered for volunteering platforms as well. In building such online communities, it is important to set norms for inter-personal interactions and enable volunteers to build and express identities (Morse, Cerretani, Halai, Laing, & Perez, 2008).

One limitation of our study is that it did not directly involve the medical students in the workshops. Their perspectives were previously captured in related work on this project (Liu, Calvo, & Lim, 2016; Liu, Lim, Taylor, & Calvo, 2019). Future work will aim to engage medical students in co-creation workshops where volunteers and students can work together and exchange ideas.

Another limitation may have been the number of participants involved in each workshop. While we hoped to recruit more participants, at the time of writing the paper, we were able to organise only two workshops with two participants each. Our exploratory workshops in a previous study with SPs (Naqshbandi et al, 2020) allowed us to capture some experiences of SPs and with the study presented in this paper, we aimed to conduct more in-depth exploration of SP experiences using generative tools. This meant inviting fewer participants given that our participants are used to intimate and smaller sessions (though the OSPIA program).

6. Conclusion

In this paper, we used generative tools and methods in two co-design workshops to explore a number of volunteer-centric design opportunities for an existing education program called OSPIA. The design process specifically focused on how the volunteers experience relatedness and gratitude through their inter-personal interactions. We identified a number of design opportunities on different levels to improve volunteer experiences of relatedness and gratitude. Those are aimed to close the gap between the online and campus experience of the volunteers. The findings suggest the design should enable expression of gestures by all stakeholders (volunteers, students, organisers) and recognise volunteers work and efforts through personalised solutions. Additionally, we found that bonding through informal interaction, ability to better communicate feedback and information to support shared experiences and goals, and community building are important to volunteers. These should inform the design of similar volunteering platforms in the future, in order to respond to and enhance volunteers' experiences.

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Artful Design for Positive Design: A Case Study in VR

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Abstract: This article presents the philosophy of artful design as a viable lens for achieving the aims of subjective well-being set forth by the framework of positive design. Artful design is a design philosophy that presents both theoretical and pragmatic guidance to designers, offered via design principles intended to address human flourishing and humanistic values. First, we present several artful design principles, organizing these into a few categories. Next, we provide a case study of a virtual reality experience. We first comment on how its design was motivated by the aforementioned artful design principles. Then, we show how the virtual reality experience aligns with the goals of positive design. We finish by discussing how artful design is aligned with positive design. This includes discussion on how artful design's methods can inform positive design where the two are already aligned. We also discuss how artful design might add nuance to some of the components of positive design, followed by a brief discussion of the tentative term "folk design" to describe human flourishing through amateur practice of the design process itself.

Keywords: positive design; artful design; design philosophy; aesthetics

1. Introduction

Positive design is an emerging design philosophy on how to design for subjective well-being. Desmet and Pohlmeyer have provided a promising framework for guiding design practice at a high level, but have noted that their design philosophy needs to develop methodology in order to be more pragmatically useful to design practitioners (2013). This article presents the philosophy of *artful design* as a viable lens for achieving some of the goals set forth by the framework of positive design.

Positive design is a design philosophy and framework for encouraging people to experience human flourishing through a lens of subjective well-being. Here, the term *design philosophy* indicates that the framework mutually infuses high-level concepts and values with pragmatic guidance for achieving those values. Positive design encourages the emphasis on and balance of its three components: design for pleasure, design for personal significance, and design for virtue (Pohlmeyer & Desmet, 2017). These are defined in turn as experiencing

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positive affect (though considering the balance of positive and negative emotions is also important), working toward personal goals (here, what constitutes meaning is highly specific to the individual), and acting with morality (a more objective approach with roots in virtue ethics). The framework encourages attention to the balance between the three components, since prioritizing one may come at the expense of another (Desmet & Pohlmeyer, 2013). It also emphasizes the importance of people being actively involved in realizing their own flourishing. While the philosophy provides a robust theoretical launching point for design processes, it also notes that much future work is necessary toward the development of methods to help designers in the process of designing, as well as the development of measures for empirical assessment of human flourishing outcomes.

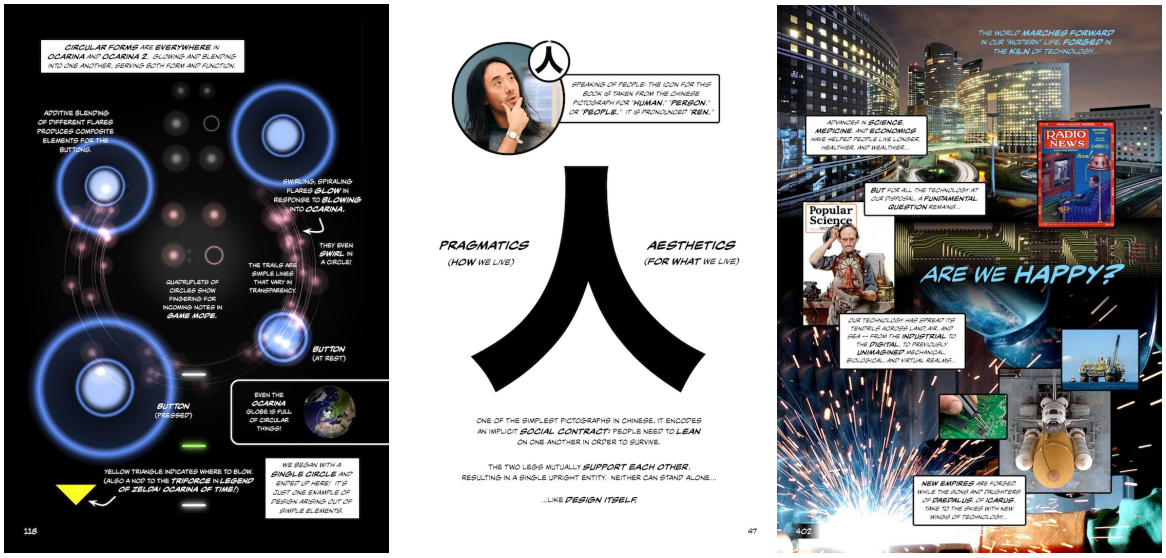

Figure 1 *Examples of the pragmatics, aesthetics, and philosophy presented in* Artful Design.

Artful design is a design philosophy that focuses on how to shape technology with craft, ethics, and aesthetics (Wang, 2018). It originates in the field of audiovisual musical design, but is intended to be generally applicable to most design contexts. The corresponding photo-comic book *Artful Design: Technology in Search of the Sublime* presents the philosophy through a series of design principles, which are aphorisms intended to be consulted during the design process in moments of ambiguity. The book covers significant ground, ranging from discussion of pragmatics to aesthetics to the core of the philosophy behind how to design artfully (Figure 1). The philosophy of artful design is not about creating art. Instead, it is concerned with the mutual interplay and radical synthesis of function and form, of pragmatics and aesthetics; it suggests that technology should transcend the "mere" functional and be *artful*. The philosophy is in some ways a response to the need-finding, "empathy"-based approach to "design thinking" that is currently popular in the United States, centered on the Stanford University d.School (Balcaitis, 2019; Dam & Siang, 2019; Fogel, 2017). As such, artful design also foregrounds designing for the human values underlying surface-level practical needs and focusing on broad "invisible" needs, such as

the need for self-actualization and the need to appreciate beauty. The philosophy makes frequent reference to the concept of the sublime, a deep aesthetic experience resulting from an articulation of clarity, truth, and a deep understanding of humanity. Overall, the broad goal of the philosophy is to encourage design that implicitly understands and supports humanistic aspects of life. Even though *Artful Design* invokes many aspirational, abstract concepts, the advice its design principles gives is often highly pragmatic and applicable to design processes, making it a potentially useful lens for designers of other practices to apply to their own process when contextually appropriate.

The rest of this article will attempt to show how the two design philosophies are aligned and how positive designers might make constructive use of the philosophy of artful design. First, we will present in more detail several themes put forth in *Artful Design*. Next, we will offer a case study of a musical virtual reality experience, first discussing how artful design was used to guide the design process, then commenting on how the resulting experience aligns with all of the aspects of positive design. We will finish with a discussion on how artful design might inform the work of positive designers, and how some of its concepts might add more nuance to the philosophy of positive design itself.

2. Principles from Artful Design

Here, we present several of the many themes from *Artful Design* (Wang, 2018), insofar as they are relevant to positive design and the case study presented below. Throughout the rest of this article, design principles from *Artful Design* are referenced by number (e.g. AD2.6). The text of each mentioned principle is presented in the Appendix for reference.

2.1 What is Design?

Artful design hesitates to provide an exact definition of what it means to design (AD1.1), since it maintains that design is what you do when there is no known, direct way of meeting some goal (AD1.8). Therefore, rather than specifying methods for design, artful design offers design principles that act as lenses to (re)direct thinking during a person's contextual design process. Nevertheless, it maintains that the process of designing is often creative and exploratory, that design should originate from a foundational understanding of what it means to be human, and that design should be performed with a sense of aesthetics that enables us to approach the sublime (AD1.2).

2.2 Ends-in-Themselves

Artful design makes extensive use of the concept of *means vs. ends*, or the duality and spectrum between means to an end, "that which serves an external purpose, use, or function," and ends in themselves, "something good in itself, whose value lies primarily in its intrinsic worth (AD1.5, p.34). The philosophy articulates that great design should approach the sublime by achieving a radical synthesis of these two modes (AD1.16).

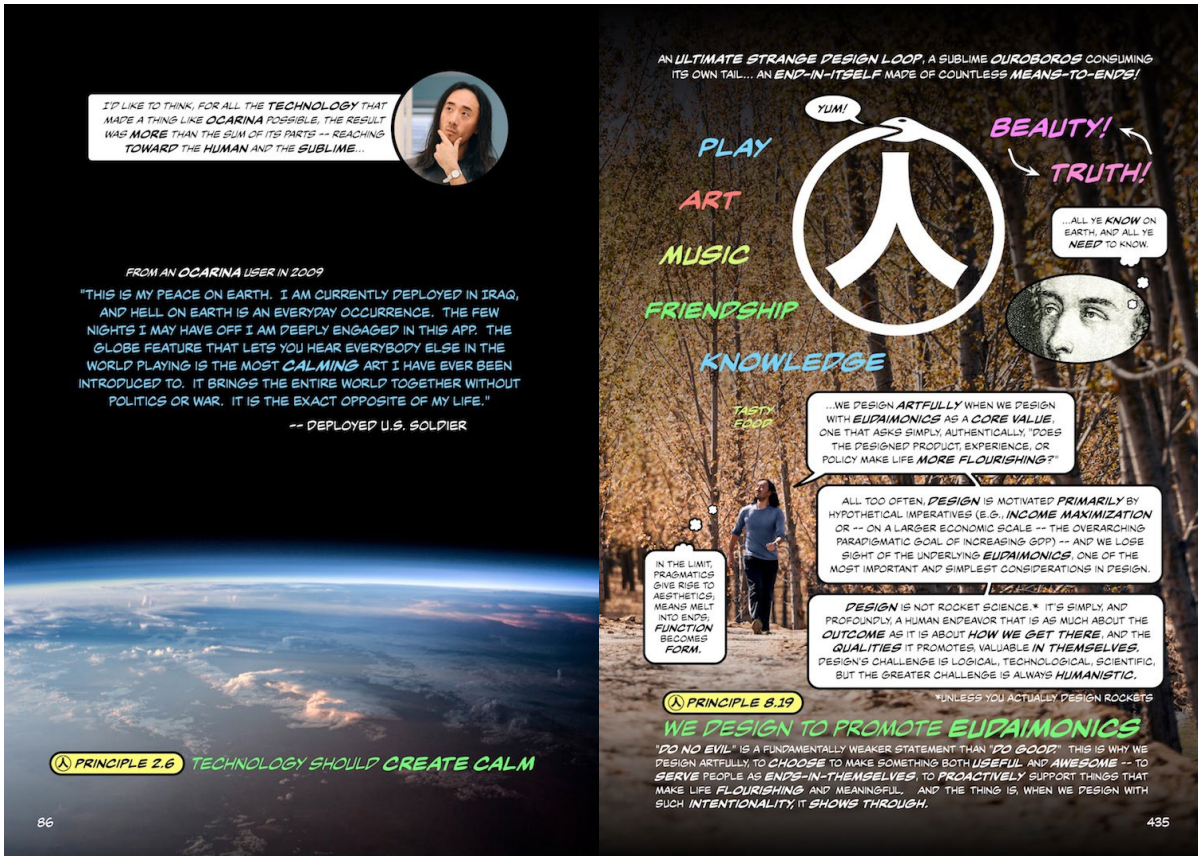

Figure 2 *Left:* Artful Design*, Principle 2.6: Technology should create calm.*
Right: Artful Design*, Principle 8.19: We design to promote eudaimonics.*

2.3 Needs and Values

Artful design resists the notion (popular in the U.S. Design Thinking movement) that design is fundamentally a process of finding and addressing human "needs" (Balcaitis, 2019; Dam & Siang, 2019; Fogel, 2017). It advocates that we must speak to needs, yet go beyond them, addressing deeper human values. Through its many case studies, it presents examples of such human values that can motivate design processes (AD1.15). Examples include calm (AD2.6, Figure 2), play and (amateur) musical expression (AD8.9), and "invisible" needs such as appreciation of aesthetics, self-actualization, and transcendence (AD8.10).

2.4 Aesthetic-driven Design

Artfully designing often means following a process of *aesthetic-driven design*: paying careful attention to authenticity, intentionality, how someone should feel, and how they should live with technology throughout all aspects of the design process (AD4.7, 5.2), at all levels: material, structural, interactive, emotional / psychological, social, and moral-ethical (AD1.3). It suggests that a nuanced, fundamental focus on aesthetics not only facilitates design decision-making in uncertainty, but also helps use ensure that our work is broadly humanistic in the way that it shapes technology (AD6.5, 8.6).

2.5 Play

Artful design asserts the importance of *play* as an "integral part of human life, having everything to do with purpose and a deep commitment to activities that have no extrinsic purpose" (Wang, 2018, p. 307), i.e. ends-in-themselves. It suggests we should design not only so that people can work, but also so that they can play, and in doing so, be free (AD6.1). Design for play must help people create a "separate space, isolated and protected from life" (AD6.9, p.330). One powerful way to access the mode of play is through encouraging users to be creative and artfully expressive (AD6.12).

2.6 Interaction and Participation

With its attention to design for musical performance and creativity, artful design pays special attention to the invisible dimension of interaction (AD7.6, 6.7). It reminds the designer that there is a "human in the loop" (Wang, 2018, p. 218), that participation and social processes are valuable, and that lowering people's inhibitions and enabling even amateurs to participate in a process instantly can be a virtue (AD 2.7, 5.7).

2.7 Embodiment

"Bodies matter!" (Wang, 2018, p.210). Within its focus on interaction, artful design stresses the importance of embodiment: considering how the design relates to its user through their body (AD5.4) and how designs that pay careful attention to the body can feel more like a part of the user (AD5.17). Our sense of embodiment shapes how we process and move through life.

2.8 Why We Design

Finally, artful design offers perspectives not only on how we should design, but why we, the designers, engage in this act, how it shapes us, and how we use it to promote human flourishing. We design to celebrate all the beautiful and imperfect aspects of life (AD 8.22). We design to promote human flourishing (AD8.19, Figure 2). We design to play and to express our humanity (AD8.17, 8.21). And, perhaps most importantly, we design to reach for the sublime and to transcend (AD8.25).

3. Case Study: *12 Sentiments for VR*

12 Sentiments for VR is an extended virtual reality (VR) experience in which users explore the emotional life cycle of a plant by making music. *12 Sentiments* was designed using a process of artful design, but the end result aligns well with many of the goals of positive design. First, we will explain the motivating design principles, which shaped how the experience was built. Then, we will draw connections between the result and the positive design framework.

3.1 Design Process

12 Sentiments for VR was designed by the author over a period of months, during which time the project's progress received bi-weekly critique from members of the CCRMA VR/AR Design Lab. The project's methods were seeded in aesthetic-driven design (explained further below), with active attention to the following high-level goals and guiding concepts.

Active Amateur Participation

The overarching goal for *12 Sentiments* was to create a long narrative that moves through a series of environments (each originating from an emotional aesthetic) and enables its users to create music actively in each environment (called a "movement," as in a movement of an orchestral piece). This goal derived from a consideration of the value of encouraging amateurs to engage with music (AD1.15, 8.9), and specifically of how *active* user participation in musical experiences promotes human flourishing (AD7.6, 8.19, 8.21).

Because the experience is designed with amateurs in mind, each of the movements gives the user high-level expressive control over the music, but the controls that the user has to master are relatively simple, only involving move their hands and pushing one button (AD5.7, 2.7). Importantly, neither the music nor the narrative can unfold without the user taking actions within the virtual environment (AD6.7). For example, in the second movement, the player acts as a young vine plant, and places their hands (rendered as virtual leaves) into beams of sunlight. The action of capturing sunlight causes slow chord swells to play in the movement's music, which also grows in complexity as the user captures more sunlight. The movement cannot end until the user captures a certain amount of sunlight.

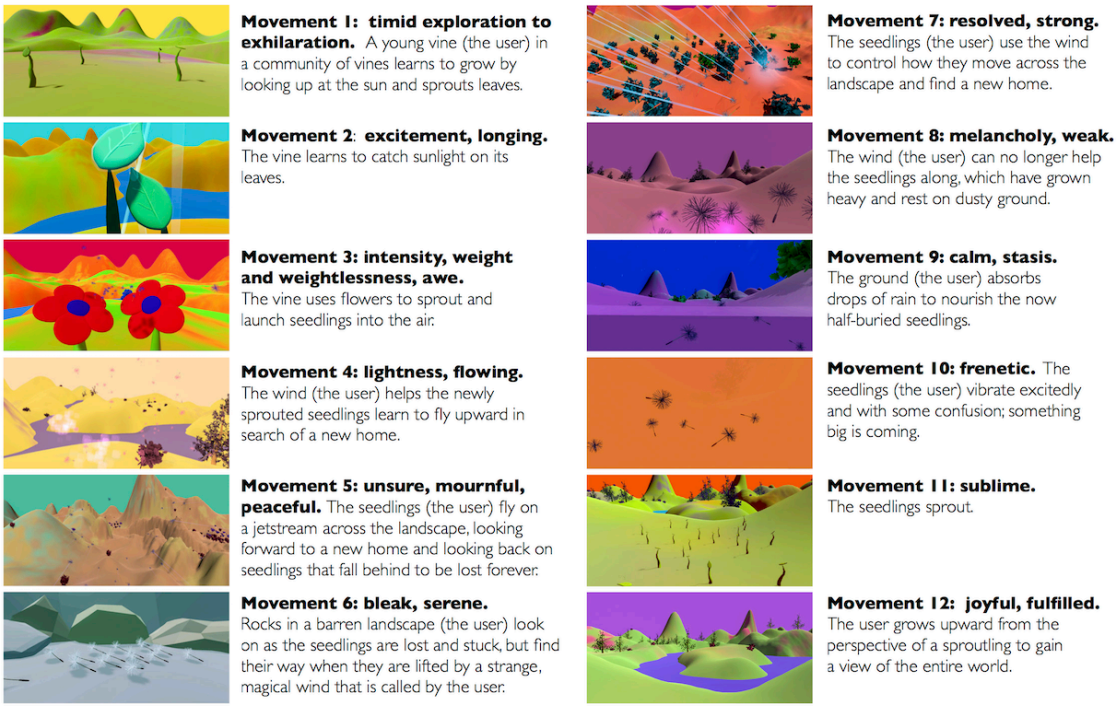

Figure 3 Descriptions of the driving emotional aesthetics and narrative of 12 Sentiments for VR.

Aesthetic-driven design process

Each of the twelve movements was designed from a particular emotional aesthetic, following a process of aesthetic-driven design (AD1.3: emotional / psychological level, 8.10: aesthetic needs). That is to say, at the very start of the design process, twelve aesthetics were chosen as guiding metaphors for the rest of the design decisions made in the crafting of each of the movements (AD4.7). The aesthetics chosen are presented in Figure 3. They were chosen to represent a broad spectrum of human emotional experiences, so that users could make music encompassing a variety of emotional feelings and spend more time in the movements that they feel aligned with (AD8.22). Once the list of aesthetics was finalized, we crafted a narrative that would fit this emotional path, deciding on depicting the life cycle of a plant. Then, for each individual movement, the color scheme, the music, the interaction design (AD5.2), virtual movement, and even vibrational haptic feedback were all designed with the movement's intended emotional aesthetic as a starting point and as a guiding metaphor for any ambiguous design decisions. This process resulted in a series of virtual environments that each strongly enforce a single emotional aesthetic (or so we hope), allowing the user to engage with it as they make music by existing and taking actions in the space.

Doing vs. being.

Another driving design goal for the movements was that they should enable users to engage in *being*, or a way of existing in the world where one takes the time and space for intentional and engaged stillness, reflection, and calm (AD2.6, 6.5). In virtual reality experience design, both *doing* (taking intentional and purposeful actions) and *being* can be considered essential for the creation of well-rounded experiences (Atherton & Wang, 2020). This emphasis was applied particularly in the interaction design of *12 Sentiments*. To name a few examples: the beams of sun in movement 2 fade in and out very slowly, meaning that a user who wants to absorb as much sunlight as possible will spend a lot of time standing still[1]. In movement 5, when some seedlings and the user are caught in a gust of wind, the virtual movement interaction allows users to control their direction only slightly, leaving space for the user to reflect on their environment as they are moved through it. And, in movement 8, when the seedlings have become too heavy to be blown by the user's gusts of wind, we slow virtual time to a standstill while the seedlings are in the air, allowing the user to contemplate the situation before time resumes its normal pace and the seedlings tumble back to the earth[2].

Embodiment

A powerful property of the medium of VR itself is *embodiment*, which in the context of VR means the ability for a user to feel and act as though a virtual avatar is their own body. *12 Sentiments* sees users embody a wide variety of virtual beings as they explore the course of a plant community's life cycle from one generation to the next: sprouts, vines, flowers, seedlings, the wind, and the earth. Each embodiment fundamentally affects not only how the user exists in the space, but also how the user makes music in the space (AD5.4, 5.17,

1 https://ccrma.stanford.edu/~lja/doing-vs-being/leaf-hands/

2 https://ccrma.stanford.edu/~lja/doing-vs-being/slowing/

6.7). For example, as a sprout, the user looks up to feel the (musical) sun on their face; as the wind, the user whirls their arms around to create (sonic) gusts that move virtual seedlings (and cause them to play a musical arpeggio); and as the earth, the user opens their arms wide to catch (musical) rain.

Play

One final lens that *12 Sentiments* engages heavily with is that of play. Since individual VR experiences involve isolating the user from the physical world, they can be conducive to play when users feel protected and safe (AD6.9). A number of aspects are intended to encourage play (AD2.1): bright colors, virtual physics that lets seedlings float and spin around in place, and high-pitched, tinkling music, to name a few. However, the most fundamental play experiences in *12 Sentiments* arise because the user is able to express themself musically (AD6.12), promoting their flourishing (AD6.1).

3.2 Alignment to Positive Design

Although positive design was not used as a motivating framework during the design of *12 Sentiments*, the resulting experience aligns well with many of its core tenets.

Pleasurable and meaningful experiences

In positive design, the central design challenge is "to create opportunities for people to have pleasurable as well as meaningful experiences supported by design" (Pohlmeyer & Desmet, 2017). *12 Sentiments* is designed for amateurs to participate in musical experiences that enable meditative *being* in a variety of emotional-aesthetically-motivated environments. This process (should) allow for users to have pleasurable, meaningful experiences, especially in movements with a positive affect such as movement 4.

Active participation

Desmet and Pohlmeyer have proposed that a person must play an active role in fostering their own flourishing (2013); they later wrote that "design for well-being is design that primarily focuses on activities and experiences" so that people can be active "creators of their own 'good' life" (Pohlmeyer & Desmet, 2017). The movements of *12 Sentiments* allow users to continually affect the creation of the music and the status of the world with decisive actions. In addition, the narrative of the work does not progress without active involvement from the user. Finally, design for *being* promotes active, intentional reflection—this is what promotes the user to a state of being instead of passively letting the virtual world wash over them.

Design for pleasure

The first of the three components of the positive design framework is design for pleasure, or enabling users to experience positive affect (Pohlmeyer & Desmet, 2017). Due to the importance of affect balance (Fredrickson & Losada, 2005), however, it may also be important to take a "holistic approach by accepting that negative experiences are part of

life and should not be abandoned per se" (Pohlmeyer & Desmet, 2017). The more positive movements of 12 Sentiments (such as movement 4, "lightness, flowing") can certainly act as a resource for users looking to experience positive affect. But, 12 Sentiments does not focus solely on emotional aesthetics with positive affects. The wandering path between movements from "bleak" through "resolved," "melancholy," "calm," "frenetic," and "sublime" to end at "joyful, fulfilled" makes the experience more heightened and humanistically meaningful than if the user were to only experience movements involving various shades of positive affect.

There can be a positive feedback loop when pleasure is derived from creative activities. While experiencing positive emotions can have a direct impact on a person's subjective well-being, it can also have indirect effects on enhancing "creativity, open-mindedness, flexibility, and resilience" (Pohlmeyer & Desmet, 2017, citing Fredrickson, 2001; Isen, Daubman & Nowicki, 1987). *12 Sentiments* allows users to experience pleasure derived from participating in a creative activity: making music. The pleasure from being creative may in turn increase users' willingness to openly participate in the activity, resulting in a cycle of increased pleasure and engagement.

Design for personal significance

The second of the three components of the positive design framework is design for personal significance. This component is most commonly discussed in terms of setting and achieving personal goals (Pohlmeyer & Desmet, 2017). While personal goals are useful to discuss and somewhat easy to observe, they are by no means the only method by which people can strive "towards actualising our personal potentials" via "seek[ing] out novelty and challenge, explor[ing] and learn[ing], [and] exercis[ing] and develop[ing] our capacities." We can find other approaches that reinforce some or all of these behaviors while still being activity-driven and intrinsically motivated through personally meaningful values. Specifically, active participation in music-making in *12 Sentiments* allows users to experience novelty, to explore, and to develop their capacity for thinking about and making music. Additionally, individual, ephemeral music-making is one of the most widespread and impactful forms of music-making (see the concepts of *holicipation* (Killick, 2006) and *folk art* (Gold, 2007)). Thus, music-making may also resonate with possibly-held personal values such as creativity, self-expression, the processing of emotions, and enjoying life, among many others. Meanwhile, the embodiment that users of *12 Sentiments* experience in a variety of virtual beings and circumstances allows them to explore new environments. It also allows them to grow through thinking about the world from new perspectives and on different time scales. All this to say: while users are unlikely to set and meet personal goals while experiencing *12 Sentiments*, many will still likely have meaningful experiences. Some may even grow in personally significant ways.

Design for virtue

The final component of the positive design framework is design for virtue, or how designs enable users to be moral people and contributing members of society (Pohlmeyer & Desmet,

2017). Pohlmeyer and Desmet note that while a person's character cannot be designed, they are "always situated in a physical and social context, which in turn can be designed" (2017). Designing virtual reality experiences allows the designer to temporarily control much of the user's context, which might make such experiences ideal for designing for virtue; see for example Rosenberg et al. (2013). Pohlmeyer and Desmet cite Peterson and Seligman's list of six core virtues and their lower-level character strengths (2004) as a potential source for this component. We will consider character strengths from that source in our discussion below:

Curiosity (wisdom). In *12 Sentiments*, users are able to explore new worlds (virtual environments) and explore what it means to embody new virtual beings.

Creativity (wisdom). In *12 Sentiments*, users actively participate in constructing and shaping the events of the world and the music itself, creating a personal song and narrative.

Perspective (wisdom). *12 Sentiments* offers users the ability to see a world from the perspective of many kinds of beings (e.g. plants, wind, earth). In terms of time and community, it offers the perspective of seeing a world through the eyes of a plant's lifespan; it also offers the perspective of life as a community that continues on beyond the life of a single plant. The beings that users are encouraged to empathize with and "become" are virtual and don't behave quite like they would in the real world, but the new perspectives may transfer somewhat into users' daily lives.

Vitality: zest, enthusiasm, vigor, energy (courage). In informal observations, users of *12 Sentiments* are often filled with a sense of energy and excitement after their experience. We propose that this is related to engaging with some of the other virtues: curiosity, creativity, perspective, and playfulness. (And indeed, Peterson and Seligman remark that vitality is not necessarily a distinctive trait (2004, p. 211).)

Humor, playfulness (transcendence). As discussed above, *12 Sentiments* offers many situations that encourage users to be playful, especially in the more positive and active movements 3, 4, 7, and 10.

Appreciation of beauty and excellence (transcendence). Several of the movements of *12 Sentiments* present massively large landscapes whose scale can only be understood through a virtual reality headset; the sensation of presence in such a world can combine with the fusion of visuals and music to create a sense of awe and wonder, and at times of the sublime. Movement 11 was designed specifically to attempt to convey a sense of the sublime through a sudden change in colors and music and the meaningfulness of the narrative of sprouting. Beyond this, all of the movements provide a different emotional lens that can allow users to appreciate the beauty of the journey of life in an embodied, subtle, personal way.

Spirituality (transcendence). The approach *12 Sentiments* takes to designing for *being* makes space for users to engage in intentional contemplative reflection and stillness, a state that is similar in many ways to the meditative practices of spirituality.

4. Artful Design for Positive Design

Above, we have discussed a subset of the principles of artful design, shown how they impacted the design of a VR experience, and shown how that experience aligned with the goals of the positive design framework. Now, we will provide some abbreviated comments on how artful design might directly inform designers looking to practice positive design. First, we will point out how the two design philosophies already align. Then, we will offer a few ways in which artful design might add nuance to the positive design framework.

Though the connection may seem obvious, both philosophies argue for the design process to be fundamentally based on human flourishing. *Artful Design* 8.19 argues that human flourishing should be central to all processes of artful design: "we design *artfully* when we design with eudaimonics as a core value, one that asks simply, authentically, 'does the designed product, experience, or policy make life more flourishing?'" (Wang, 2018, p.435).

Both philosophies agree on a top-down approach to design that keeps guiding humanistic values in mind throughout the design process. On structuring the design process, Pohlmeyer and Desmet write that the "higher goal of pleasurable and/or meaningful experiences [guides] the design process from the start" rather than it starting from low-level technical requirements (2017). While artful design does at times encourage the contextual value of bottom-up design (e.g. when exploring a new medium as in Principle 2.2: "Design inside-out" (Wang, 2018)), its focuses on aesthetics and invisible human needs can provide the top-down guiding forces that positive designers rely on during the design process.

Both philosophies agree on the value of direct, active user participation. Artful design's principles on interaction design, inhibition, and the social dimension can help positive designers navigate ambiguity when planning for users to be active creators of their own human flourishing.

Artful design's focus on aesthetic-driven design and articulation of means-to-ends and ends-in-themselves can inform the positive design dimensions of design for pleasure and design for virtue. Especially when the driving aesthetics are interactive, (positively) emotional, and social in nature, aesthetic-driven design can be used as a guiding force when designing for pleasure. Moral-ethical aesthetics, in turn, can inform design for virtue. Meanwhile, artful design's extended treatment of the balance and interplay between means-to-ends and ends-in-themselves can guide designers grappling with how to balance high-level design goals with the pragmatic reality of designing an artifact that must, at the end of the design process, function.

Artful design can also connect with the broader positive design community. Let us consider two theoretical perspectives articulated in the Design for Subjective Wellbeing track of the previous Design Research Society Conference (Cain et al., 2018). The perspective of soma-wearable design suggests that Somaesthetic practice can inform fashion and wearable design to address somatic wellbeing (Jung & Ståhl, 2018). While this perspective already has a strong theoretical underpinning, artful design's principles regarding embodiment may be useful during the practice of the design process itself. Similarly, the Play Blueprint

is a framework that identifies many of the core components of play in order to help design meaningful play experiences (Legaard, 2018). Here too, artful design's principles on supporting and encouraging play, especially through creative self-expression, can be informative to designers in the midst of the design process.

Now, we turn to a few areas in which the careful consideration of artful design's philosophy might be used to extend approaches to the practice and theory of positive design.

On methodology: Desmet and Pohlmeyer identified that the "development of appropriate hands-on methods that equip designers… [in] strategic planning, task clarification, problem framing, and conceptual design" would be necessary, moving forward (2013). Artful design takes a somewhat opposite approach in its firm assertion that "there is no specific playbook for design," that "design is intentionality exceeding methodology" (Wang, 2018, p.39). While we would not suggest that the development of methodology is fruitless, we might suggest an understanding that appropriate methodology is always highly contextual, and that in some situations it is reasonable to proceed in an exploratory fashion, guided by higher-level design goals and principles but not by specific hands-on procedures. Nevertheless, the two philosophies agree that "intentionality and process" are where the most crucial design practice interventions lie (Desmet & Pohlmeyer, 2013).

On design for personal significance: the positive design framework heavily emphasizes design for personal goals, which allow users to strive for growth and self-actualization (Pohlmeyer & Desmet, 2017). As mentioned above, it is possible for people to grow without the scaffolding of setting and meeting personal goals. Artful design presents a broader notion of how to help people grow: by addressing "invisible" needs such as esteem, cognitive, aesthetic, self-actualization, and transcendence needs (Wang, 2018, p.415). This broader framework might guide positive designers in situations where personal goals are not relevant or possible, such as in the context of amateur creativity and self-expression.

Amateur creativity and self-expression itself is treated thoroughly as a humanistic value by artful design (Wang, 2018, pp.89-101). Especially when designers are concerned with building experiences and activities rather than possessions (Pohlmeyer & Desmet, 2017), this practice might become the focus of design processes both when it is held as a personally meaningful value by the intended users, and also as a virtue in its own right.

We have identified possible limitations to the application of artful design to positive design practice. Specifically regarding evaluation: Desmet and Pohlmeyer identify this as a particularly challenging problem due to the fickle nature of user self-reporting on subjective well-being (2013). Quantitative evaluation is an issue that artful design does not address by any means. Instead, it argues that designed work ought to be evaluated qualitatively and critically. Also, some of the more pragmatic advice in *Artful Design* is specialized to the medium of interactive audiovisual software or for the creation of musical instruments. Nevertheless, its principles on philosophy and aesthetics are clearly applicable to broader contexts, as evidenced above.

4.1 Future Direction: "Folk Design" (Flourishing via Amateur Design Practice)

Looking toward the future, the 2018 Design Research Society Editorial on Design for Subjective Wellbeing writes that academic focus is shifting to include experiences "where it is the act of designing which can also contribute to a meaningful experience and improved subjective wellbeing" (Cain et al., 2018). Artful design also has something to say on the subject: Principle 8.17, "We design as an act of play", and Principle 8.21: "Aesthetics as self-emancipation!" come to mind. Nevertheless, in our own ongoing studies of this phenomenon (which are unfortunately outside the scope of this article), we are still searching for a more rigorous formalization.

So far, we have tentatively formalized the term "folk design" to mean "design practiced by amateurs in the context of and for the benefit of their own local social context." The term is a parallel of Rich Gold's term *folk art*, describing the practice of people who "make art for themselves and for their friends; [who] engage in art making not because it will last forever, or because it will please a million people, but because it is fun, enjoyable, and satisfying; because it is a way of interacting with and strengthening the bonds between friends and family" (Gold, 2007). Then, *folk design* would describe the practice of people who do *design* for all the same reasons. The formalization is not ideal, however, due to the severely overloaded nature of the meaning of the term "folk" in contemporary discourse. We are actively seeking perspectives on better ways to discuss this phenomenon and any existing academic scholarship already devoted to it.

5. Conclusion

This article proposes that the design philosophy of artful design is well-aligned to the intentions of design practitioners of positive design. Through the presentation of a case study, a virtual reality music-making experience, we have considered how following a design process informed by the design principles of artful design resulted in an active experience that aligned with all components of the positive design framework. Specifically, we advocate that artful design's top-down focus on humanistic values and aesthetic-driven design can help reinforce positive designers' focuses on design for pleasure and design for virtue, and that artful design can also inform related approaches to design for subjective well-being involving the body and play. We posit that artful design's assertion that there cannot be one pre-ordained process for design suggests that positive designers might benefit from working without a rigid methodology in some exploratory contexts. And, we suggest that artful design's focus on invisible human needs might allow for a broadening of the approach to design for personal significance beyond notions of personal goals.

Moving forward, we look forward to increased consideration of (amateur) creativity and self-expression for subjective well-being, both through processes like music-making as well as through encouraging amateur creators to flourish through practicing design itself. More work should be done toward formalizing the latter process (here termed "folk design"), including an understanding and approach to supporting and evaluating both amateur creativity and

social support.

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Jack Atherton works on design for human flourishing through amateur creativity and folk design. His current work empowers amateurs to create virtual worlds and populate them with creatures using interactive machine learning in virtual reality. See also Doing vs. Being: A Philosophy of Design for Artful VR (2020).

Appendix

Here follows the text of each design principle from *Artful Design* referenced in the text above. Where prudent, an additional quotation is provided to add clarity. The page number is provided for the quotation only where it differs from the page number of the principle.

Table 1 Principles from Artful Design referenced in this article.

#	Theme	Text	P.
1.1	What is Design?	A working definition of design. Design is a shaping of our world, aimed at addressing an intended purpose, carried out with aesthetics and humanity, within a medium. Corollary: Anything worth designing is worth designing beautifully. "Design is an act of alignment. We design to bring the world into *pragmatic* alignment with what we consider to be *useful* and into *aesthetic* alignment with our notion of what's *good* and *beautiful*, or 'the way things ought to be.' Within this creative endeavor are real, rich, expressive opportunities to speak to our human dimension."	30
1.2	What is Design?	Problem-solving is a *problem* in search of a *solution*. Creative design is *technology* in search of a *problem*. Artful design is *technology* in search of *the sublime*!	31
1.3	Aesthetic-driven Design	Aesthetics of Artful Design: material, structural, interactive, emotional / psychological, social, moral-ethical.	32
1.5	Ends-in-Themselves	Design is means vs. ends!	34
1.8	What is Design?	Design is intentionality exceeding methodology. "Design begins when we have an intended outcome without knowing how to achieve it, or if it's even possible as envisioned. This is why there is no specific playbook for design."	39
1.15	Needs and Values	Design not only from needs–but from the values behind them. "While needs indeed give rise to design, the most powerful designs are also grounded in values, deeply-held beliefs, and an understanding of human beings."	48
1.16	Ends-in-Themselves	Design is the radical synthesis of means-to-ends and ends-in-themselves into a third type of thing – both useful and beautiful.	49
2.1	Play	Design for play and delight.	73
2.6	Needs and Values	Technology should create calm.	86
2.7	Interaction and Participation	Design to lower inhibition. "Design is being cognizant of how we as humans tend to think and using that awareness to encourage certain behaviors that, hopefully, are beneficial for us!"	99

#	Theme	Text	P.
4.7	Aesthetic-driven Design	Aesthetics is not a passive thing – but an active agent of design! "Aesthetics is not something you add to a nearly finished product, but an *active* force and *intentionality* that shape design from the start. It takes the form of creative constraints and articulations of preference that push a design forward in a sea of petrifying possibilities."	196
5.2	Aesthetic-driven Design	There is an aesthetic to interaction.	208
5.4	Embodiment	Bodies matter!	210
5.7	Interaction and Participation	Instant music, subtlety later.	228
5.17	Embodiment	Embody! "We humans are embodied creatures; we operate more efficiently, satisfyingly when we 'feel as one' with the interface we are using!"	238
6.1	Play	Play is what we do when we are free; play is what we do to be free.	309
6.5	Aesthetic-driven Design	[The aesthetics of games:] Reflection. Games as mirror of our humanness.	313
6.7	Interaction and Participation	All games require interaction and active participation. "Like a musical instrument, a game does not move forward without your actions and decisions!"	317
6.9	Play	Play is free, voluntary, uncertain, unproductive by choice; it occurs in a separate space, isolated and protected from the rest of life.	330
6.12	Play	A new category: Tekhné (art and expression as play).	331
7.6	Interaction and Participation	Value participation (and design for it).	361
8.6	Aesthetic-driven Design	There has to be an aesthetic dimension that underlies our shaping of technology. "Aesthetics […] provides a human-oriented context and impetus that underlie our advanced logic and reason."	406

#	Theme	Text	P.
8.9	Needs and Values	Technology is about what we can do; morality is about what we *ought* to do. • "Humans are fundamentally playful creatures. The ostensibly mundane can be delightful!" (p. 413) • "Musical expression does a person good. Connect everyday people with musical expression." (p. 413) "There was a time when the word *amateur* connoted something wholly good! … Among other things, amateur musicianship is about personal enrichment." (p. 91) • "Expression doesn't have to come at the expense of gamefulness! There is a unique joy to music-making; bring it back to the masses with technology!" (p. 414)	411
8.10	Needs and Values	Design for invisible needs. • "Esteem (confidence, achievement, respect for and by others)" • "Cognitive (intellectual stimulation and exploration)" • "Aesthetic (need for harmony, order, and beauty)" • "Self-actualization (need to grow and fulfill one's full potential)" • "Transcendence (to become *more* than who we are)"	415
8.17	Why We Design	We design as an act of play. "Design may arise out of a mixture of needs and values, but as a *creative endeavor* it is a bottom-up, inside-out process, closely resembling a prolonged act of play – an isolated, protected space and time where aesthetic impulses, creative curiosities, and a lot of bad ideas can be given freedom to roam, tried in earnest, and followed to their logical or illogical conclusions."	432
8.19	Why We Design	We design to promote eudaimonics. "We design artfully […] to serve people as ends-in-themselves, to proactively support things that make life flourishing and meaningful."	435
8.21	Why We Design	Aesthetics as self-emancipation! "Ultimately, we strive to design useful things that are intrinsically beautiful – that bring the world into alignment with our idea of good, the authentic, and the just – as an end in itself. Design should express our humanity, acknowledging that we value play, find beauty in authenticity, seek to connect with one another, and desire to be free.''	439
8.22	Why We Design	Design is born of life, incorporates it, and is inseparable from it. "Design is all around us, with all the joy and sorrow, dirt, grime, beauty, and imperfections of life."	440

#	Theme	Text	P.
8.25	Why We Design	Transcend… "Design cannot forsake the practical needs of humanity, but it – no less than art – can transcend them, seeking beauty in the authenticity of things, reaching for something more than we are, while speaking to precisely what we are. Sublime design is design that understands us." (p. 453)	451

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Integral Living Research: Synergies in Research, Advocacy, and Healthy Living

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Abstract: The Integral Living Research (ILR) group approach derives from integral theory, appreciative evidence-based design, and social impact practices. This approach consists of a novel and collaborative design research method that melds the disciplines of architecture, interior design, public health, and STEM (Science, Technology, Engineering, and Math) fields into a synergistic whole that improves the capacity for change. Lack of housing equity in America has spurred this group to develop solutions to reduce housing-related stress and support enhanced well-being for urban families. The Integral Living Research (ILR) group deploys generative and empirical design research and has focused all efforts on the development and deployment of five interconnected and interdependent principles for healthy urban housing: access to green space, access to healthy food; privacy; security; and enhanced self-efficacy. This paper will explore several of the projects arising from the proposed principles as a short case study in urban well-being.

Keywords: housing; equity; healthy living; smart vase; insightful design thinking; biophilia

1. Introduction

The Integral Living Research (ILR) group takes an integral theory, evidence-based design, and social impact approach. Working to synergize an innovative process through design research for equitable living over time and with community partners. ILR identifies and develops solutions for families experiencing substandard housing conditions and housing insecurity. The anticipated growth of urban populations and the continued stress on urban families has created a priority for the work done to augment human health through urban spaces (The United Nations, 2017). ILR studies housing, and housing insecurity in the United States, through a novel, inter-professional, and collaborative design research method that brings together the disciplines of architecture, interior design, public health, and STEM (Science, Technology, Engineering, and Math) fields. Integral theory informs this approach,

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one in which sociocultural, individual, and systemic perspectives are applied and examined in the search for an understanding of a problem (Wilber, 1998, pp. 101–103). ILR, as a group, focuses on the U.S. housing crisis as an area of specific expertise, due to the difficulties of the U.S. system. These problematic issues include the market-driven nature of U.S. social services. Housing policy in the United States (U.S.) is fundamentally different from other countries because of the way individual states drive policy for their residents. The ILR group seeks to transform housing stress for urban, underserved families, as currently, these environments fail to promote optimal health and equity. Substandard housing and housing insecurity cause significant pressure in the U.S. urban environment, and this stress has had an enormous effect on the lives and health of those that experience it (Thoits, 2010).

Integral theory is the examination and integration of multiple perspectives into our worldview, and the concurrent ontological and epistemological practices (Wilber, 1998, pp. 101–103). Integral sustainable design leverages the practices of ecological design to apply the integral lenses of culture, system, and individual to the problem of sustainability (DeKay, 2011, pp. 3–4; Fleming & Roberts, 2019, p. 102). Integral theory provides an opportunity for a novel appreciative process with the community, discussed in a further section as driving this inter-professional work. ILR leverages both synergistic inter-professional practices and community-oriented engagement to propose solutions in the U.S. housing crisis for those in need.

Underlying causes of stress in the U.S. urban environment include social inequalities and discrimination. To truly have an impact on the stress levels of those who are marginalized in this way, we must act at the level of the home environment -- seeking to structurally change these conditions within the immediate environment (Thoits, 2010). The urban American mid-century housing renewal that occurred in many major American cities, and suburbs, created a housing shortage and a lack of suitable living spaces that were safe and equitable (Jacobs, 1993, p. 3). The current crises can be seen as the legacy of those policies, and the underlying inequities they have created (Lipsitz, 2011). ILR is primarily focused on the ill effects in urban neighborhoods for families; however, the interconnectedness of these mid-century changes cannot be underestimated. When people live without a stable address, it is challenging to maintain employment. Health is then compromised through a cascade of issues, including the loss of job-linked health insurance (Marcus, 1995). The ILR process and the solutions proposed by this inter-professional group are a synergistic, design-oriented contribution within a much larger landscape of conventional health policy, service providers, and third sector non-profits. The existing ecosystem of organizations in the U.S. is creating solutions for housing insecure families. The work discussed here is aimed at assisting policy directions and supporting capacity creation within the non-profit sector for portable solutions to housing issues. This paper examines the five proposed principles, the broad community process developed by this group, and two case study projects currently under development using the principles and community process.

2. Integral Living Research: Five principles for stress reduction in urban living spaces

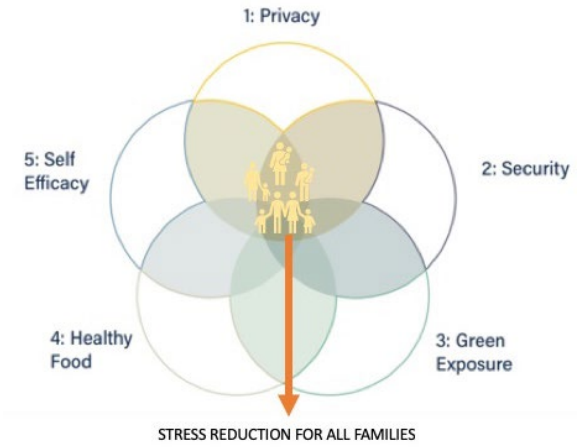

Figure 1 The five design principles for urban family well-being

As previously stated, ILR works to create space and policy-oriented solutions that expand and enhance the following: privacy, security, self-efficacy, and stress reduction in the existing housing pipeline in mid-size U.S. cities. Figure 1 (above) refers to the five areas, and their overlap in the goal of stress reduction for urban families. Unlike the conventional re-design of substandard spaces, this work seeks to see housing and home as a health-oriented service that extends into the various urban environments that influence residents. Thus, the ILR group works on small scale solutions situated within single-family housing, transitional, and emergency housing, as well as eviction and those on the street in America.

The research is framed in terms of a socio-ecological model of health, emphasizing multiple levels of impact, derived from integral theory, and layered with stakeholder perspectives to define problems and identify opportunities for improvement. Here, the health of individuals is shaped by factors at community, organizational, intrapersonal (e.g., family, friends) and interpersonal (e.g., income, access to health care) levels (Krieger, 2012). The work seeks to give individuals solutions, such as a portable privacy screen in their shelter space, that can help them as they cycle through the current housing system in major cities while also addressing the other levels of influence on health mentioned above. For this research, underserved populations are those residing in Medically Underserved Areas (MUA) with “too few primary care providers, high infant mortality, high poverty or a high elderly population (Bureau of Health Workforce, 2018)”.

One aim of the work is to create assets that families can utilize, no matter their current housing situation. The solutions proposed here, in case study 1 and 2 below, address specific conditions in both single-family residences and group housing because these are the best ways to meet the needs that underserved populations in U.S. cities encounter. Unlike the conventional re-design of housing, these portable proposed solutions can be deployed quickly to help those with the most need. To understand the stress-oriented perspective of

the principles and their associated projects and proposed interventions, we must also briefly examine well-being in the urban environment. Well-being is a more encompassing measure of human health and has evolved in the U.S. and around the globe to directly relate to green space, food, stress, and natural exposure. It is the link between environment, psychological well-being, and health; and refers to the combination of mind and body. Well-being in this context is driven by environments that satisfy our needs, creativity, and senses (Kopec, 2017, p. 28). A significant constituent of the mind-body connection is the connection between spaces that set the mind at ease with an improved state of well-being (Sternberg, 2009, Kindle Loc. 112-114). Our environments have the power to support our sense of self-efficacy when they function correctly, this contributes to well-being via mental health and gives us the ability to build healthy lives (Kopec, 2017, p. 28). Well-being relies on minimizing illness through a high level of combined social, environmental, emotional, physical, mental, and spiritual health. (Coles & Millman, 2013, p. 30). Sara Warber, Katherine Irvine, Patrick Devine-Wright, and Kevin Gaston propose an "Interconnected Model of Well-Being" that links the physical environment, the mental state, and the community to an individual's overall well-being. "Through five dimensions of existence: spiritual, mental, emotional, social, and physical, well-being can be operationalized" (2013). This model of well-being directly links mental health to the environment and creates a conversation that is in direct alignment with Integral Theory's holistic approach and the five ILR interrelated principles described in depth in the next section of this article.

3. The five Integral Living Research principles defined

In developing the five proposed principles, the ILR group, a group of core faculty with research students from diverse disciplines including Design, Public Health, and STEM, reviewed historical and current methods of assessing and understanding buildings with the broadest conception of health and well-being. Environmental psychology, or the study of behavior driven by space, also plays a substantial role in understanding how needs can be met through our environment and has influenced the development of these principles (Kopec, 2012). The influence of spatial comfort and configuration, and the stress engendered by a mismatch between users and the environment, is a vibrant area of study (Kopec, 2012). It is well documented that users who suffer from such stress experience health issues (Thoits, 2010). These principles have arisen through intensive work within this environment over 20 years by the faculty involved. The five principles also align with current thought in housing-related to health and stress. ILR has synthesized public health literature, design literature, and processes, to validate these areas as requiring the most attention for those seeking housing solutions. Here, we will discuss each principle briefly, its' capacity to support health, and how ILR's conception of urban housing is touched by it.

3.1 Privacy

The principle of privacy in living spaces is related to several theories of control in environmental psychology including Averill's three areas of control in our spaces: behavioral

control, cognitive control, and decisional control (Kopec, 2012, p. 22). The ability to maintain privacy, including the ability of spaces to accommodate functioning in an overcrowded or unstable situation such as a shelter environment, is an example of a case where a lack of control adds to the perceived helplessness of residents (Kopec, 2012, p. 22). These situations create the following questions in residents' minds: "How do I care for myself and my family; how do I maintain healthy habits?" The better bunk case study project shown in this paper seeks to create privacy for families in emergency housing and directly addresses this issue by giving families a portable shelter storage system that gives them private space in crowded group living situations.

3.2 Security

The security offered by a stable place to live also relates to control, and its effects are well documented on populations experiencing instability. Instability in the living location creates a threat to resident health. Thus, health stability is compromised through the domino effect of losing one's housing (Marcus, 1995). This group has explored how tools that help residents stay in their homes can help to improve the stress of housing insecurity at the source and help build self-efficacy into daily routines. This principle and its associated literature continue to be the basis of the problem definition and project development phase in ILR's community-facing studies discussed later in this paper.

3.3 Green exposure

Biophilia is the need for humans to have exposure to nature. In the urban environment, this exposure is linked to better stress levels and health (Wilson, 1984, p. 1). Within Environmental Psychology, the Attention Restoration Theory is essential. It holds that nature is significant in our ability to recover (Kaplan, 1995). The goal of this principle is to maximize exposure to nature and living plants in the daily lives of underserved urban families to reap the proven benefits of such exposure. Between the work of Ulrich and current epidemiological thought, there is no doubt in the literature that nature exposure is crucial to well-being (Warber et al., 2013). Emerging tools for designers to quantify and qualify biophilia, including patterns for environmental biophilic design, are starting to emerge (Terrapin Bright Green, 2014). The Garden-Fresh Home (GFH) project discussed below draws on biophilia and biophilic theory in its aesthetic development.

3.4 Healthy food access and healthy eating awareness

In America, about 23.5 million people live in food deserts, defined as areas with no food store with more than five employees in a five-mile radius, with nearly half of them also belonging to low-income groups (Southern Poverty Law Center, 2017). Studies have determined that increasing the number of grocery stores in the neighborhoods of under-served populations is not sufficient since many members of this population cannot afford the high cost of produce (Kern et al., 2017). The Garden-Fresh Home project described further in the latter part of this article is aimed at helping residents produce fresh food options within

their homes. Initial testing through community engagement has validated the demand for this unit.

3.5 Self-efficacy

As stated earlier, self-efficacy is negatively affected by the stress and fear of housing insecurity. Self-efficacy is defined as one's ability to be effective and complete tasks, such as self-care. This necessary ability can also be affected by our perception of our abilities in the face of stress (Bandura, 1997; Colman, 2015). Repeated financial stress adds to this equation, and the "Bee Sting Theory" proposes a cascade model for lack of self-care in underserved populations. Research has shown that low-income individuals are unable to prioritize self-care and house repair due to the cascade of other expenses that put them underwater relative to their incomes (D. Bennett, 2008). This inability to care for the self, or the home environment, leaves underserved groups vulnerable to gentrification and other urban ills (VerBruggen, 2007). One opportunity to help, discovered through community and expert deep-dive research, is a service that will assist residents with housing repair stress through access to resources, and creative community processes. Attachment to place is part of our identity and maintaining our ability to live and stay in that place supports strong identity and, thus, healthy people (Coles & Millman, 2013, p. 21).

4. The context for the five principles in current housing

4.1 Understanding housing, health, and stress

Thus far, we have examined health, housing, and well-being through the lens of the ILR Five Principles. In synthesizing the measures and resources that exist in the literature towards understanding how housing drives health, and housing stress contributes to ill health, one measure in particular that the group relies on and is discussed in case study 2 is The Well Building Standard. Developed as a companion to the LEED (Leadership in Environment and Energy Design) Standard, The WELL Building Standard measures occupant health in public buildings. The metric is a series of standards that look at how food, chemical exposure, context, and other elements benefit or compromise occupant health (International Well Building Institute, 2020).

Housing issues have been a public health focus dating to the efforts in the 18th and early 19th centuries to eliminate substandard urban dwellings, or slums (Office of the Surgeon General (US), 2009). In the mid-20th century, the American Public Health Association published a report called the "Basic Principles of Healthful Housing," including a quantitative evaluation tool to assess elements of housing linked to poor health. The tool has since been updated periodically, most recently in 1986 (Committee on the Hygiene of Housing, 1938; American Public Health Association, 1986). As researchers and designers, we know that a safe and stable living space can positively affect our health and well-being. Stable living spaces also give residents a kind of access and independence that is detrimental to

maintaining well-being for all (Centers for Disease Control and Prevention, 2006). Recently, the Center for Disease Control (CDC) developed updated guidelines regarding psychological needs healthy housing must meet that clearly call for privacy, security, family, and community as components of health (Centers for Disease Control and Prevention, 2006).

The current housing policy system in the U.S. is a patchwork effort of city and municipalities that is constantly over-burdened. One aim here is dignity for families within the system both through influencing policy and creating solutions that non-profits can deploy with ease. Given these issues of housing and the need to guide design for those operating in the urban housing space, whether as care providers, designers, residents, or researchers, the ILR group has developed the five principles shown in more detail related to residential spaces in figure 2 (below).



Figure 2 *The five proposed principles of healthy homes related to housing experience and situations*

5. Integral Living Research projects: Case studies in five principles

5.1 Project approaches, processes, and positioning

The work of the ILR group draws on a pragmatic approach and worldview, and it includes an appreciative approach to the community. Here, change is advanced through the choice of questions and study, the anticipation of positive futures, and a correspondingly optimistic method to knowledge and solution production through an honoring of lived experience (Cooperrider, 2020). Table 1 (below) defines five areas of research and knowledge production in which appreciative inquiry plays a part.

Table 1 The five principles of Appreciative Inquiry adapted and paraphrased from David Cooperrider, "The A.I. Commons" 2002

Constructionist Principle	**The subjective state of truth. Truth is a shared construct.**
Simultaneity Principle	Change created by question making or the act of asking a question.
Poetic Principle	Researchers choose the area of study as a way of telling the story that needs to be told.
Anticipatory Principle	Groups practice positive visioning of the future as a path forward for the community.
Positive Principle	Groups practice positive assessment and understanding to create change in communities of need.

The Appreciative Inquiry (A.I.) framework is grafted onto the inter-professional research and design process that this group follows. A.I. is an inspired orientation for the techniques used to integrate perspectives and drive the projects.

The design research processes that the ILR group deploys include iterative deep-dive research and interactions that take the form of card sorts; behavior setting studies; prototype testing; and expert and user interviewing (IDEO, 2011; Luma Institute, 2012; Sanders & Stappers, 2013; Stickdorn, 2019). The analysis and synthesis of these findings are also iterative and drive solution development. The ILR group uses "Insightful Design Thinking" to integrate the health and science framework into the community-driven design research processes. "Insightful Design Thinking" is informed by Appreciative Inquiry, Science lab-based research, and Public Health Research. It requires relying on inter-professional languages and these shared areas of expertise. It includes sustained iterative work between inter-professional experts using design research techniques as shared processes. A road map for the teams discussed below utilizes design research techniques and inculcates designers and non-designers alike into problem definition, community engagement, and proposal of solutions.

The typical project roadmap starts in problem development with groups of students and experts, convened through the inter-professional coursework, events, and research assistantships. Graduate and Undergraduate students at many levels from Public Health, Science, Design, Built Environment Design, and Engineering, all participate in the work of the ILR group at this early phase. The mixed teams work to draw experts, community members, and care providers into their work through interviews and other engagement. In this way, they work to create a validated problem definition followed by analysis, design, and iteration around solutions and ideas. As the projects have developed through these evidence-based practices, individual students take on greater responsibility and work exclusively with lead faculty (the authors of this paper) to continue research and development.

The overall group road map, shown in figure 3 (below), includes an initial phase 1 in which problems and partners are considered and studied—this is done through a case study process and an innovation scan with analyses including concept mapping and stakeholder

mapping to drive the insights. In phase 2, the inter-professional group engages in further problem definition and planning-to-plan with community members and care providers. Community needs and strategic plans to meet these needs are considered and analyzed. This is done using "Insightful Design Thinking" techniques, including expert interviews, user engagements, affinity, and concept mapping. Next, phase 3 includes iterative exploration of research questions and possible theories and intensive human-centered design research with co-design activities. Recommendations, ongoing designs, and research studies arising from the first and second phases are then followed by the 3rd phase of informed implementation and co-design with the community. The two case studies shown here are currently under development with lead students and faculty and are entering phase 4 on the roadmap. In the roadmap in figure 3 (below), phase 4 includes validation through empirical user studies of our proposed solutions, and recommendations. As the projects near placement and the possibility of going to market, we will enter phase 5, which will include informed implementation through user research and continuing co-design.



Figure 3 *Integral Living Research road map: Phases 1-5 of ILR community and design research including "Insightful Design Thinking" and design research techniques deployed in inter-professional teams.*

5.2 Case Studies in the five principles: Health Design Research Innovation Program and Garden-Fresh Home

Two current main project areas of the ILR case studies presented here are the Health Design Research Innovation Program and Garden-Fresh Home. The work shown integrates evidence-based design drawn from primary and secondary empirical research work and fundamental research processes in science into the group process.

These tools and techniques are deployed as a part of the "Insightful Design Thinking" process practiced by the group. The projects discussed here, Health Design Innovation Projects and Garden-Fresh Home, taken together, contribute to a new body of knowledge that is centered around urban living and issues of equity, social justice, and health. The work to date examines the urban house and urban life as a customizable experience that is part of and contributes to our overall health as urban dwellers. Future continued assessment and empirical observational studies of the groups' prototypes are planned for the next year.

Case study 1: Health Design Research Innovation Program

The stress of housing insecurity has an enormous effect on the lives and health of those who suffer from it. To truly have an impact on the stress levels of urban individuals, we must seek

to change these conditions structurally (Thoits, 2010). Approximately 550,000 people are homeless, in a single evening (Gainer, 2013). Low-income households have been hit hardest by current economic trends, contributing to creating a market where rents rise continually for those most impoverished families (National Alliance to End homelessness, 2018). A disproportionate amount of urban families spend a high percentage of their income to stay in substandard housing (Desmond, 2016, p. 5). One perspective that has emerged is that those who may lose housing suffer stress that is akin to physical trauma. These families are easily re-traumatized, and any approach must consider this as part of stress reduction in the environment (Baylor, 2014).

The first case study: The Health Design Research Innovation (HDR) project is a funded year-round project, including an inter-professional course, to develop solutions to improve well-being and address issues related to housing insecurity. These solutions are driven by dignity, health, and design through the lens of human-centered design research. Lead faculty include an epidemiologist and an architect/designer, and this work builds on shared disciplinary strengths and shared terminology to iterate proposed tools related to privacy, security, and self-efficacy, as discussed below.

Working iteratively with community members, including providers of temporary and long-term housing to homeless or vulnerable people, students, and faculty, initiated several phases of inter-professional "Insightful Design Thinking" as defined above. Using these techniques, the Better Bunk Project, A retrofitted bunk design, and portable divider emerged. Developed through repeated on-site empirical observations conducted by students, this project aims to create opportunities and cues within the shelter environment for families to safely and effectively store their belongings and have privacy in the often crowded and unsecured shelter housing. Based on research and analysis of several options on-site with community members, these storage units have evolved into portable bags that can be taken along with each family as their situations change. In the U.S., shelters are driven by an approach that minimizes the resources available for shelter interventions. Named Housing First, this policy has created an environment in which the emergency spaces do not meet the needs of residents, according to many sources (Desmond & Kimbro, 2015). Through expert interviews, on-site observation, community engagement, and prototype testing, the idea that bunks could be retrofitted emerged as the best option to meet residents' needs. The project has developed to create a more humane and hospitable environment while at the same time helping residents keep their belongings in an organized fashion. Currently, the research group is designing and validating specific portable prototypes, with community and user input.

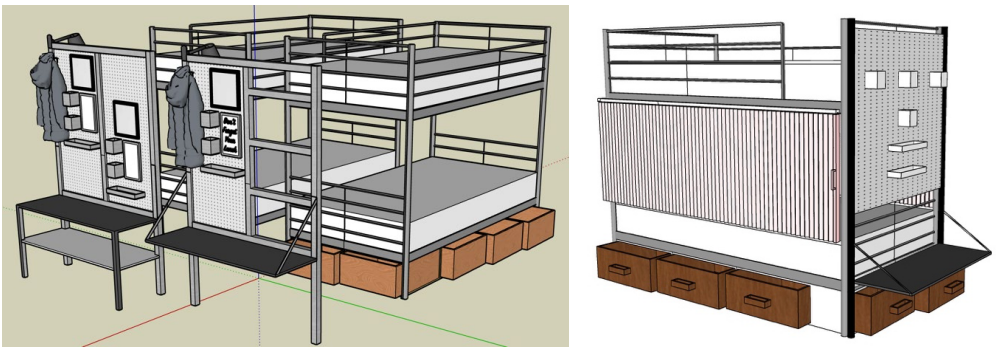

Figure 4 *The Better Bunk storage retrofit for shelter environments by Drexel Design Research student, Nicholas St Angelo*

The Better Bunk, shown here in figure 4 (above) in an earlier prototype, is a modular solution for privacy and security in shelter housing where multiple families are living in one space. Validation of these proposed tools is still underway, and initial findings are positive as the devices meet the streamlined needs of the care providers and the lack of control experienced by the families. Aimed at improving and protecting privacy and security and improving self-efficacy (ILR Principles 1, 2, and 5) for people in vulnerable housing situations, we believe that this project has the potential to enhance well-being significantly.

Case study 2: Garden Fresh Home

It is estimated that by the year 2030, over 50% of the U.S. population will suffer from obesity (DoSomething.org, 2017). Also, obesity is frequently a risk factor for other diseases like cardiovascular disease and type II diabetes (Office of the Surgeon General (US), 2010). Substandard housing conditions and health are linked; for example, obesity is caused by a lack of access to a healthy diet, which is related to the environment in which people live. Studies show that certain racial and socio-economic groups are more affected by obesity than others; among women, and specifically non-Hispanic white women, obesity prevalence increases as income decreases (Ogden et al., 2015). These problems are worse in specific communities because access to affordable and nutritious food is difficult (Kern et al., 2017). Once again, those in low-income communities of color and rural areas with limited access to grocery stores are most affected. For this reason, these areas are often called “food deserts,” and in America, 23.5 million people live in food deserts. Nearly half of these people also belong to low-income groups (Southern Poverty Law Centre, 2017). These data indicate that low-income populations lack easy and convenient access to nutritious foods, particularly vegetables and fruit, and may face barriers to eating a healthy diet.

The second case study: Garden Fresh Home (GFH) is a biophilic and food production project comprised of a proprietary indoor hydroponic plant growth system to grow vegetables and fruits inside the home (Figure 6). Plant hydroponic growth in an indoor space allows the inhabitants of that space to grow food without the need for garden space or soil attached to, or nearby, the home. This strategy increases the availability and easier access to fresh green vegetables for families, which will profoundly and positively impact their diet and

their health. The proposed hydroponic system harnesses the ability of proprietary growth medium to produce fertilizer for plant growth on a scale suitable for the indoor living space. Edible plants are thus grown organically in this system. Herbs, which are generally used to add flavor to food and serve as digestive aids, have been successfully tested in this system. Additionally, by increasing access to fruits and vegetables, Garden Fresh Home also increases the green space within the interior of the home, contributing to stress reduction of the inhabitants.

Driven by a Microbiologist and a Designer/Architect, along with graduate research assistants, and STAR scholars from many disciplines; the group has iteratively researched these issues and the opportunity to increase dietary intake of fruits and vegetables through a biologically driven home growing unit. In the United States, only 1 in 9 adults gets the recommended amount of fruits and vegetables (Lee-Kwan, 2017). The Garden-Fresh Home hydroponic design creates a healthy kitchen counter growing unit in indoor spaces with no architectural alteration to space and utilizing minimal space. The patent-pending unit will provide easier access to produce for families, creating a green habit in the home. This product assimilates design driven by research into urban living spaces that lack such access, including the urban row home, temporary shelters, and community-based spaces.

Urban green space promotes health and well-being for individuals and families (Bertram & Rehdanz, 2015; Feng & Astell-Burt, 2017; Ma, et al., 2018). The main component of the growing unit, as stated above, is a simple organically driven plant hydroponic system, which is low maintenance, requires no soil and little space, and enables plants to grow well in an indoor urban setting. Called a “smart-vase,” the device will serve as another tool in the current toolbox of strategies used to combat obesity and stress in the urban home. Fertilizer for the growing plants is supplied not from an inorganic mineral solution but instead from nitrogen-fixing bio-mix. This microscopic bio-mix is photosynthetic and absorbs nitrogen gas from the air and converts it, using a well-described and documented metabolic process, into nitrate (Golterman, 1975). The excess nitrate produced can be found in the liquid medium of the hydroponic system and is available for use by the growing plants.

Several studies to determine the efficacy of the bio-mix and to iterate forms that encourage both plant and bio-mix life have been undertaken. In an early study, the group was able to lab validate the bio-mix in tap water in the hydroponics system, rather than in the unique nutrient medium customarily used to culture them in the laboratory. These technical advances in the lab improve the system to function as a user-friendly set up for families.

Further empirical study has included the process of designing and developing the “smart vase” hydroponic system. Similar to the Better Bunk project, the initial phase of research has incorporated feedback from the community and tested the aesthetics of the container for the hydroponic system. Consequently, as the group designs and tests the prototypes in the laboratory, the analysis for successful algal growth, container aesthetic, and the ergonomic ease of using the system are converging into a series of bench science studies that are currently underway. Ultimately the system will be validated through in-home placement and

measurement of plant yield.

The current prototypes have been part of community conversations with resident families and an initial market research validation process. Community feedback and potential customers have validated the need for such a device and have lauded the utilization of a 100% organic method for growing plants in the home. Additionally, the ILR group believes that the invention can be part of teaching children healthy behaviors in the family home. With the smart-vase, families can develop a family hobby: growing plants in an indoor hydroponic system. Growing plants in the home also creates the type of indoor green space that helps to mitigate stress, enhancing the health-promoting aspects of this device.

The Well Building Institute has correlated fresh food availability, access, visibility of fresh options, and education around healthy food with points in its health rating system for buildings. While not available for single-family dwellings, WELL currently measures how buildings can optimize nutritional health success through enhanced green space and availability of healthy food for each occupant (International Well Building Institute, 2020). Using the measures of the WELL Nourishment standard, each occupant must have access to a growing space of one square foot per occupant. Occupants must also have access to 4 fresh options per day, and they require access to healthy eating educational materials (International Well Building Institute, 2020). The GFH “smart vase” will meet this standard. When this low-cost vase is deployed in multiples, three units will provide 12-16” square inches of growing area per unit. The modularized design will allow the user to tend to the growth of multiple species per household, and the educational materials will give recipes and activities to undertake with the harvested edibles. The group has been validating their WELL driven approach and continues to deploy prototypes in both the lab and the community. GFH, as part of a constellation of urban food strategies, and education, has the potential to induce dietary changes in populations that do not have easy access to healthy food and to assist with the stress associated with health habits in this environment. The unit builds on ILR principal three: exposure to green space, and ILR principal four: access to healthy food as the primary drivers.



Figure 5 *Garden Fresh Home smaller tabletop units in development rendered by authors and student Thelmalis Abreu (Garden Fresh Home Unit: Patent Pending)*

6. Conclusion

The Integral Living Research (ILR) group believes that the most sustainable house is one that a person or family can stay in, and hand down to future generations. The five interconnected principles related to relieving housing-related stress and building healthy habits in our living spaces are a vehicle for the continued progress in urban advances in designing healthy living spaces. We are continuing the empirical studies of these proposed solutions to understand their authentic influence in the home and shelter environments. Detailed reporting of lab results will occur in future papers post the award of patents. Validation of this approach is currently occurring through correlation with existing measures such as the WELL Building Standard and the ongoing empirical work undertaken by this group to test their solution in situ. Figure 6 (below) shows group approaches to topics such as stress, obesity, and aesthetic issues through this series of projects.



Figure 6 *The Single-Family Underserved Urban Home and the Fronts of Stress: Synthesis of the Integral Living Research Topic Areas*

ILR integrates and leverages design solutions, stakeholders, context, and feedback to determine placement, suitability, and scope. This work occurs across disciplinary boundaries and in several different modes, including pedagogy, studio-based exploration, field study with partners, and bench science. It emerges from a group method of “Insightful Design Thinking” that draws on the home processes and domains in each of the disciplines of architecture, design, epidemiology, and bench science, to create new shared knowledge.

The Integral Living Research group works through the five principles described in this paper, and the research associated with them, to build equity for those who suffer from the ill-health effects of substandard or inaccessible housing. The objective of this work is to influence, through community partners and advocacy, how the housing pipeline in the U.S. is “designed’ by policymakers and community care providers moving forward. The definition of this area and the five principles arise from the gaps in the current network of interlaced non-profit and government entities, as observed and studied by this group. The dissemination, deployment, and discussion of the proposed solutions and the process are part of creating change in the American patchwork housing system as it currently exists. The ILR group will continue to use these five principles as an evolving lens for the design-oriented

solutions they generate. The Integral Living Research group believes that the focus on the five principles proposed here, coupled with engagement across disciplinary boundaries, existing measures and qualitative empirical validation, creates a synergistic path forward to a new kind of advocacy and improvement in the American urban housing sphere that will build healthy urban living from the inside out.

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Human-centered AI: Different Human-Centered Design practices in the design and research of ethical AI

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Abstract: Artificial Intelligence has the tremendous potential to produce progress and innovation in society. Designing AI for people has been expressed as essential for societal well-being and the common good. However, human-centered is often used generically without any commitment to a philosophy or overarching approach. This paper outlines different philosophical perspectives and several Human-centered Design approaches and discusses their contribution to the development of Artificial Intelligence. The paper argues that humanistic design research should play a vital role in the pan-disciplinary collaboration with technologists and policymakers to mitigate the impact of AI. Ultimately, Human-centered Artificial Intelligence incorporates involving people and designing Artificial Intelligence systems for people through a genuine human-centered philosophy and approach.

Keywords: human-centered; artificial intelligence; design research; ethics

1. Introduction

Artificial Intelligence (AI) has the potential to transform industries and societies. This transformative potential requires to consider implications for people such as ethics and well-being. For this reason, the European Commission (EC), Massachusetts Institute of Technology, Stanford University, and others committed to the design, development, and application of AI for the good of people (Jobin, Ienca, & Vayena, 2019; Xu, 2019). For example, a high-level Expert Group of the EC presented ethics guidelines for trustworthy AI (EC, 2019). The Massachusetts Institute of Technology announced a US$1 billion commitment to AI to address the global opportunities and the need for ethical application ("MIT reshapes itself to shape the future," 2018). Similarly, Stanford University established an Institute for Human-centered AI. This commitment illustrates both the potential as well as the need for designing AI systems human-centered, including the ethically and trustworthy development

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of AI. The EC Expert Group stated that AI is not an end in itself, but rather a promising means of enhancing individual and societal well-being and bringing progress and innovation (EC, 2019). These commitments indicate that human-centered approaches have a pivotal role in the development and use of AI technology for the well-being of people. However, Bannon (2011) pointed out that researchers often use the term human-centered in a generic way to encompass a range of distinct research themes without any commitment to a philosophy and overarching conceptual framework.

This article discusses two different philosophical perspectives in AI, the rationalistic and design perspective (Winograd, 1996). This discussion is followed by examining these different perspectives and their implications in guiding the development and application of human-centered AI. The article elaborates in more detail the humanistic design perspective and discusses several Human-centered Design (HCD) approaches and their role in the development of AI. HCD research is the overarching term encompassing various research approaches that center people in the design process. The article focuses on the humanistic design perspective because of the over-valuing of the rationalistic approach that grew up around the advances in pure science and technology of the mid 20th century (Winograd, 1996). The article concludes that a comprehensive or pan-disciplinary design approach is needed to design, develop, and advance human-centered AI.

2. Background

Artificial Intelligence systems and technologies such as machine learning, natural language processing, expert systems, and robotics have evolved over the last 80 years since Alan Turing (1950) proposed the Turing-Test (Crevier, 1993; Grudin, 2009). In this evolution, two distinct philosophical perspectives have emerged in how humans and computers should interact (Grudin, 2009; Lieberman, 2009; Winograd, 2006). These are the “rationalistic” and “design” perspectives (Winograd, 1996). The discourse about these two philosophical perspectives or cultures of science and humanities is ongoing over decades beyond the development of AI (Snow, 1993). This philosophical divide between the two perspectives was present in the early developments of AI, represented by John McCarthy (“rationalistic”) and Douglas Engelbart (“design”) (Markoff, 2005; Winograd, 2006).

From the rationalistic perspective, the term AI encompasses the theory and development of computer systems that mimic human abilities and perform tasks that require human intelligence. AI research focuses on mathematical and technological advancement. People are seen as “cognitive machines” (Winograd, 2006; Winograd & Flores, 1986). The role of this perspective in the research of AI is the advancement of the understanding of statistical language, neural networks, and machine learning that form the adaptive mechanisms of AI (Winograd, 1996).

The design perspective views AI as a problem-solving tool to advance people’s capabilities and improve human conditions. The design perspective focuses on the interaction or involvement of the human with the computer (Winograd, 1996; Winograd & Flores, 1986).

This perspective sees human thought and human physical embodiment as inseparable (Dreyfus, 1992; McKim, 1972). The benefit of the design perspective is that it allows coping with the real-world complexity and messiness of the human situation (e.g., Rittel & Webber, 1973). The design perspective has its strength in the interactions of people with the AI system. Figure 1 shows the two perspectives in relation to two main areas of design research.

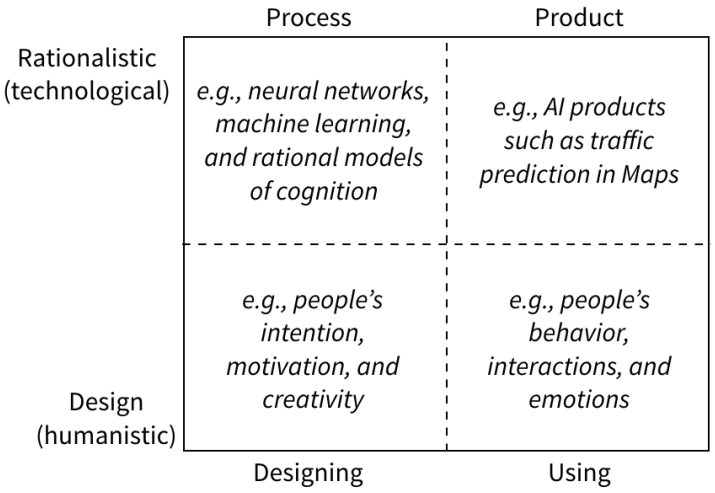

Figure 1 *Illustrates the spectrum of the rationalistic view and design perspectives. The rationalistic perspective focuses on thought and people as a formal symbolic representation and focuses on process and product knowledge. The design perspective focuses on knowledge creation about the interactions between people and the enveloping environment, including technologies when designing and using artifacts.*

2.1 Philosophical perspectives in guiding the principled development of AI

The rationalists and humanistic designers are approaching the question of ethics and the human impact of AI differently. The rationalistic perspective focuses on developing aggregated or normative models and principles. The design perspective focuses on examining the messiness of the human situation through "enlightened trial and error" (Winograd, 1996).

Based on the rationalistic perspective, government, non-profit, industry, and research organizations have outlined general principles and guidelines of ethical AI (e.g., Jobin et al., 2019). These guidelines provide advice on the development (process) and application (product) of trustworthy AI. The EC Expert group expressed guidelines such as lawful, ethical, and robust (EC, 2019). Firstly, lawful includes that all AI applications need to respect laws and regulations. Secondly, trustworthy AI applications need to fulfill ethical principles. Lastly, AI applications require to be robust. Robustness requires the safe, secure, and reliable performance of the AI, and safeguards should be foreseen to prevent any unintended adverse impacts (EC, 2019).

However, such general guidelines do not represent real-world complexity. Firstly, laws and

policies often evolve slower than technological development. As stated in the EC (2019) report, laws are not always up to speed with technological developments, be out of date with ethical norms, or not well-suited addressing context-specific issues. Secondly, ethical principles and moral choices are not universal as surveyed and identified in the Moral Machine study (Awad et al., 2018). Different cultures have different ethical perspectives. General principles and guidelines may not provide the answer in guiding ethical questions in context-specific cases such as autonomous driving. Lastly, robustness does not represent real-world complexity as the social impact of AI is hard to predict or foresee. Katz (2017) expressed that the human species has been excellent in anticipating the consequences of failure, but not so good at preparing for the consequences of success. Similarly, Muehlhauser & Helm (2012) expressed the potential of unintended consequences in AI. As laws may not be up-to-date, universal principles cannot answer context-specific ethical questions, and robustness does not prevent unintended consequences, the humanistic design perspective may provide a more suitable approach to examine the societal impact of AI.

In contrast to the rationalistic perspective, the design perspective utilizes interventions through methods such as prototyping to examine the emerging ethical dilemmas in the interactions between people and AI systems. Methodologies such as Wizard of Oz prototyping are ideal for examining experiences of machine learning (Browne, 2019). Such prototyping methodologies allow examining human needs, behavior, interactions, experience, and cognition in situ (e.g., Martelaro & Ju, 2017a; Norman & Draper, 1986). Examining the emerging interaction, behavior, and needs allows assessing the impact on people. However, experiments require designers and design researchers to decide which ethics perspective is included and how each perspective is assessed and integrated. These decisions pose ethical dilemmas with consequences for AI behavior and its societal implication (Baum, 2020). The implication of these choices indicates that design researchers need to consider various aspects of human implication in the design experiment beyond merely paying close attention to human and social factors (Bannon, 2011). As a remedy, different HCD approaches provide specific viewpoints in researching human concerns in AI.

3. Human-centered Design Research in Artificial Intelligence

HCD is the design approach that centers people and their needs, motivations, emotions, behavior, and perspective in the development of a design. However, involving people in the design does not necessarily mean that they are “centered.” Language often reveals how people are viewed in different approaches. In engineering, people are often perceived as “human factors,” an influencing factor in the performance of the technology. In management, people are often considered as “human resources” or “human capital.” HCD requires viewing humans as people. People with different prior experiences, needs, desires, ambitions, interests, irrational decision making, and lifestyles embedded within specific cultural contexts. HCD is a shift of viewing humans not as a part of the system but central in every aspect of the design.

Several scholars developed design approaches that center human values in the design (e.g., Arnold, 1959; Dreyfuss, 1955; McKim, 1959; Papanek, 1973, 1983). Each of the different HCD approaches provides a valuable perspective when designing for people. The outlined approaches were selected to provide different perspectives such as societal, diversity, interaction, and human needs in the design of computer systems such as AI. Each HCD approach provides an opportunity to research and examine the impact of AI on people from a specific lens. The next sections discuss in detail the implication and value of several HCD approaches in researching the implications for people of AI systems.

3.1 Human-centered Systems and Artificial Intelligence research

The first HCD approach is *Human-centered Systems*. This HCD approach allows investigating the changes in large-scale social structures resulting from the design, implementation, and use of computer systems such as AI (Sawyer, 2005). This human-centered perspective views technology as interdependent of political, ideological, and cultural assumptions of a society that give rise to it (Cooley, 1980; Kling, 1977; Kling & Scacchi, 1980, 1982; Kling & Star, 1998). Figure 2 illustrates this interrelation.

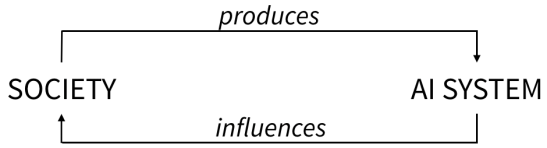

Figure 2 *Illustrates the relationship between society, including political, cultural, and ideological assumptions and AI technology. Examining technology within the social context allows identifying socio-economical processes that gave rise to the AI systems as well as the influences on society by AI systems.*

This HCD research approach allows examining the impact of AI systems on social organization (e.g., Lisetti, Brown, Alvarez, & Marpaung, 2004; Serenko, Ruhi, & Cocosila, 2007). For example, Pee, Pan, & Cui (2019) investigated the collaborative knowledge work of the AI robotic system and people in the workplace of a hospital. They identified distinct forms of knowledge embodiment, as well as the effects of embodiment on social connections between people and AI robotic systems. Such studies allow identifying effects produced by the design and use of the AI system such as multiple and sometimes paradoxical effects, benefit of some groups more than others, moral and ethical consequences, and reciprocal relationships with the broader social context (Sawyer, 2005). Another critical aspect of Human-centered Systems is the designers' ideologies and cultural context in the design of the work system. Cooley (1980) expressed that ideologies such as Taylor's (1907) scientific management will determine how people are treated within the designed system. The next HCD approach addresses this concern.

3.2 Social Design and Artificial Intelligence research

Social Design addresses the designers' ideological issue, as expressed by Cooley (1980). It is an HCD design approach that focuses on the designer's role in society. This approach includes the designer's responsibilities in the design choices made that impact society, as emphasized by Papanek (1973). The designer is the translator of societal needs into an AI systems design, as illustrated in Figure 3. Examining the socio-economical system as well as the role and intent of designers allows identifying underlying values and motivation of specific AI solutions..



Figure 3 Illustrates the intent and role of designers in the translation of societal needs to an AI system. Examining the socio-economical system as well as the role and intent of designers allows identifying underlying values and motivation of specific AI solutions.

Researching AI through this HCD approach allows investigating the intention, decision making, and responsibilities of designers in the development and implementation of the AI system. This investigation includes the socio-economical processes underpin designers' choices. For example, Facebook's business model of targeted advertisement drives the design and implementation of the AI that generates user engagement by filtering content, which impacted democratic elections (Eisenstat, 2019). Such AI systems employed on social media platforms have ethical consequences that need to be considered and resolved (Kane, 2019). Examining if the AI system and business models aim to replace or enhance people provide insights about the values and role of the designer in society (Norman, 2017). Examining the socio-economic and political processes in which the designer is embedded, as well as the intention choices made, can make underlying motivation and values explicit. Designers need to recognize their role, ideology, and socio-economical processes in which they are embedded for the design of AI systems beneficial for society. An HCD approach that can overcome the isolated viewpoint of the designer is Participatory Design.

3.3 Participatory Design and Artificial Intelligence research

Participatory Design focuses on the democratization of participation in systems design (Bodker, 1996; Ehn & Kyng, 1987). This HCD approach engages in questions of human impact such as democracy, power, and control (Ehn, 2017). It enables co-creating with different stakeholders (e.g., users, employees, and customers), as illustrated in Figure 4 Illustrates the participatory design approach in which the user and other stakeholders are involved in the design process. People co-create the design solution..

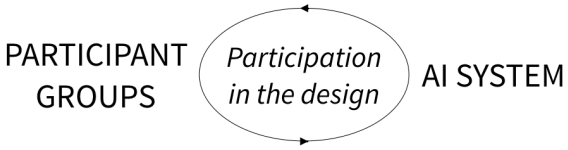

Figure 4 Illustrates the participatory design approach in which the user and other stakeholders are involved in the design process. People co-create the design solution.

Participatory Design is essential in the design of AI systems (Neuhauser et al., 2013). This HCD research approach contributes by informing AI developers and cyberneticians about subtle distinctions among sub-groups in society who could benefit from better functional access to computing systems and their adoption (Neuhauser & Kreps, 2011). Participatory Design can help create ideas for the AI System through diverse methods. However, it only represents the design space for the period of the project, and users need to have a basic understanding of what AI can do and not do (Bratteteig & Verne, 2018). Participatory Design is often limited in real-life participation as participants are often only involved while the project is running, power issues are not addressed as management makes final decisions, and participation is resource-intensive and often never compensated (Bodker, 1996). Participatory Design addresses the perspectives of people involved in the project. Another HCD approach that takes a similar view is Inclusive Design.

3.4 Inclusive Design and Artificial Intelligence research

Inclusive Design is an approach that includes and considers the needs and behavior of diverse groups in the design to make mainstream products, services, and systems accessible, usable, and useful for as many people as possible (e.g., Waller, Bradley, Hosking, & Clarkson, 2015). Figure 5 illustrates the inclusion of diverse groups in the design of AI systems.

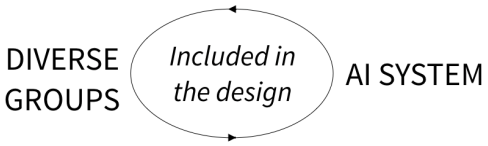

Figure 5 Illustrates the interrelation of including and considering diverse groups in the design and development of AI systems.

This HCD research approach examines the usability, accessibility, and usefulness for specific groups of people in the AI design. Inclusive computer system designs enable accessibility and usability and have a positive impact on ethical issues (Abascal & Nicolle, 2005). An important aspect is the categorization of individual differences such as physiological, psychological, and sociological aspects to accommodate differences in the design (Benyon, Crerer, & Wilkinson, 2000). The choices of whom to include has ethical implications in AI systems. For example, excluding specific groups of people when training AI systems result in race and gender bias (Garcia, 2016; Leavy, 2018). Developing diverse design teams can prevent machine biases in the design of AI systems. Building AI systems that overcome biases is not only a matter of

having more diverse, and diversity-minded design teams as AI systems themselves can help identify gender and racial biases (Daugherty, Wilson, & Chowdhury, 2019). HCD experiments that include and consider diverse groups enable identifying and making biases explicit early in the design process. Such experiments can include interactions between people and AI systems.

3.5 Interaction Design and Artificial Intelligence research

Interaction design was first proposed by Bill Moggridge and Bill Verplank (Moggridge, 2007). It focuses on understanding and designing human-machine interactions by examining people's behavior, actions, and cognitive processes within the interactions (Norman, 1986, 2013; Norman & Draper, 1986). Figure 6 visualizes the human-AI system interaction.

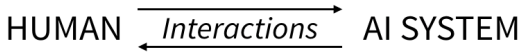

Figure 6 *Ilustrates the human-design interaction in which AI system designs are altered to create a more useful, usable, and meaningful interaction and experience for people.*

This HCD research allows examining human-AI systems interactions through prototyping (Browne, 2019; Houde & Hill, 1997). In particular, a reverse Turing Test like prototype termed Wizard of Oz is a common research tool in Human-AI interaction research. Such prototyping was used in AI interaction research such as autonomous driving interactions (e.g., Fu et al., 2019; Rothenbücher, Li, Sirkin, Mok, & Ju, 2015) or human-robot interaction (e.g., Martelaro, Nneji, Ju, & Hinds, 2016; Shibata, Tashima, & Tanie, 1999). Human behavior, activities, and emotions are directly observed in the interaction with the AI system. These observations allow examining the immediate influence of an AI system on people. Similarly, Xu (2019) argues that HCI researchers can contribute to ethical AI design and technological enhancement. This HCD approach enables identifying potentially harmful interactions and creating valuable experiences for people. It can nudge people into an economically healthier behavior, as outlined by Thaler & Sunstein (2009). The same approach is utilized to persuade people into intended behavior through technology such as AI.

3.6 Persuasive Technology and Artificial Intelligence research

Persuasive Technology is the approach that attempts to intentionally change human attitudes, behavior, or both through technology (Fogg, 2003). Figure 7 illustrates the underlying persuasive ability within human-computer interactions.

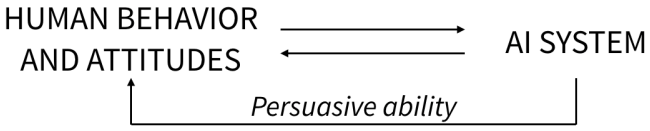

Figure 7 *Illustrates the relationship between the persuasive ability of technology to change*

human behavior and attitudes within the interactions of technology.

This HCD research approach has two directions in the development of AI systems. Companies utilize the persuasive ability of AI systems to "hook" users to make highly profitable products (Eyal & Hoover, 2014). The other is that this HCD research provides increased knowledge about persuasive computers allowing people to adopt such technologies to enhance their own lives and recognize when technologies are using tactics to persuade them (Fogg, 1998). Researchers investigated AI systems such as robotic agents and ambient intelligence for the persuasive ability (e.g., Midden & Ham, 2008; Verbeek, 2009). Berdichevsky & Neuenschwander (1999) outlined a framework to consider and minimize ethical abuse of persuasive technologies. However, to be able to identify actual motivational strategies employed in AI technology, studying how the strategies work is required (Orji & Moffatt, 2016). Researching AI systems through this HCD research approach incorporates the examination of the AI system design and people's behavioral changes within everyday life.

3.7 Human-Centered Computing and Artificial Intelligence research

A move away from human-machine interactions to the design of "interspaces," as described by Winograd (1997), is *Human-Centered Computing*. Interspaces incorporate people's lifestyles and the system design as present in everyday life of people (Hallnäs & Redström, 2002). In this approach, intelligence is viewed as an attribute of the combination of human-machine-context (Ford, Hayes, Glymour, & Allen, 2015; Hoffman, Hayes, & Ford, 2001). Figure 8 illustrates this combination.

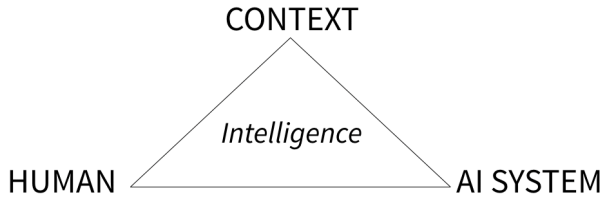

Figure 8 *Illustrates the interrelation of human-computer-context. Artificial intelligence exists only within this relationship and not only in the computer or the interactions.*

This HCD research approach requires integrating diverse views including computer science, psychology, and design to understand the context and situated cognition and action of people using AI systems (Brezillon, 2003; Ford et al., 2015; Hoffman, Roesler, & Moon, 2004; Jaimes, Sebe, & Gatica-Perez, 2006). This approach produces better social outcomes than traditional conceptions of AI as it complements rather than substitutes human intelligence in systems (Hoffman, Hayes, Ford, & Bradshaw, 2012). Research through a Human-centered Computing lens contributes by understanding the influences of an AI system in people's everyday life, including their replacement and constraint of their capabilities and freedoms.

3.8 Need-Design Response and Artificial Intelligence research

The final HCD approach is the *Need-Design Response*, which is based on the work of McKim (1959, 1980). McKim (1959) expressed that every design is a response to a human need, which is often caused by the natural and cultural environment or context. From this perspective, every meaningful AI system design needs to fulfill a need within a specific context. This relationship between needs and an AI system in context is illustrated in Figure 9.

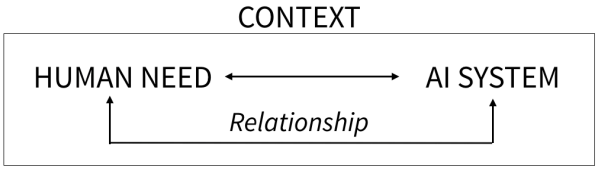

Figure 9 *Illustrates the "human need design"-relationship. Examining this relationship allows understanding the underlying need the AI system addresses.*

This HCD research approach allows finding needs and responding through a meaningful design (Faste, 1987; McKim, 1959). The approach allows identifying the underlying drivers of people's motivation as described by Maslow (1987) in the use of designed systems such as AI. Martelaro & Ju (2017a, 2017b) used a Wizard of Oz prototype to find needs when interacting with the AI system in real-world contexts. The need-design relationship reveals moral implications in AI. This relationship is assessed as follows: Is the "AI solution," which fulfills the "human need" in the "context" potentially helpful or harmful? For example, should a financial *AI system* fulfill the *need for entertainment* by providing a game-based bank account? Such an AI system can easily persuade unhealthy economic behavior. In particular, addressing emotional needs can be highly profitable and requires high morality, as not all human needs are good needs (McKim, 1959). This HCD research approach enables making underlying needs explicit that the AI system design addresses. This approach becomes of particular relevance when AI systems are able to model socio-cultural specific expectations and behavior of people to predict human needs (Riedl, 2019).

4. HCD research for human-centered Artificial Intelligence

Each of the outlined HCD research approaches provides a specific perspective and contribution to the examination of ethical AI, as outlined in Table 1.

Human-centered Systems and *Social Design* provide a societal level of analysis. The first examines the changes in the social organization resulting from the AI implementation and use. Social Design examines the processes that give rise to AI systems, including the role of the designer. Both approaches provide an understanding of the political, socio-economical, and ideological dynamics in the design, development, and use of specific AI systems. Moral considerations include changes in social organization that disadvantage people and business models that drive the use of AI out of self-interest. Making these concerns and implications

explicit and transparent is one aspect of Human-centered AI.

Participatory Design and *Inclusive Design* are approaches that address some of the concerns identified in Human-centered Systems and Social Design. The participation of stakeholders in the design and implementation of the AI system can provide essential perspectives in the re-design of the social organization such as work systems. By including many diverse groups throughout the design and development process allows designing the AI system to be accessible and meaningful for many diverse groups. This approach can overcome the one-sided view or interests of the designer or corporate. However, to examine and understand the direct or unanticipated impact of the AI system requires investigating the human-AI system interactions.

Table 1 Human-centered Design practices.

Approach	HCD research in AI	Ethical contribution	Authors
Human-centered System (HCS)	Implementation and use of AI systems and the impact on social systems such as organizations	Examination of moral and ethical consequences for all participants of the AI system design	(Cooley, 1980; Kling, 1973; Kling & Star, 1998)
Social Design (SD)	Socio-economical systems and designers' ideologies and responsibilities that give rise to specific AI systems	Identification of socio-economical dynamics and ideologies that drive the design of unethical AI systems	(Margolin & Margolin, 2002; Papanek, 1973)
Participatory Design (PD)	The democratization of the design and development of AI systems by including different user groups	Discovery of different ethical perspectives in the participant groups in the design of the AI system	(Bodker, 1996; Ehn & Kyng, 1987; Neuhauser & Kreps, 2011)
Inclusive Design (ID)	Inclusion of typically excluded communities to explore alternatives in the design of AI systems	Identification of, e.g., machine biases that disadvantages or discriminates a specific group of people	(Abascal & Nicolle, 2005; Benyon et al., 2000; Spencer, Poggi, & Gheerawo, 2018)
Interaction Design (IxD)	Interface and interaction design to provide a useful and usable AI system	Examination of usability, accessibility of the AI system and potentially harmful people's behavior and experience in the interaction with the AI system	(Norman, 2013; Norman & Draper, 1986; Winograd, 1996, 2006; Xu, 2019)
Persuasive Technology (PT)	AI systems that persuade people towards an intended behavior	Identification of ethical questionable behavioral triggers of the AI system	(Berdichevsky & Neuenschwander, 1999; Fogg, 1998, 2003)

Human-centered Computing (HCC)	Adaptation and organization of everyday life around AI systems that produces a capability between human and computer system	Examination of interspaces enabled by the AI system that replaces or constrains people's capability and lifestyle	(Brezillon, 2003; Ford et al., 2015; Hoffman et al., 2004; Jaimes et al., 2006)
Need-Design Response (NDR)	Design and development of AI systems for physical, intellectual and emotional needs of people	Identification of unethical AI systems design based on needs such as addiction	(Faste, 1987; Gilmore et al., 1999; McKim, 1959, 1980)

Interaction Design, *Persuasive Technologies*, and *Human-centered Computing* enable the examination of the interaction and behavior of people with the AI system. Examining and iteratively developing the human-AI system interactions allows identifying potential harm and enables creating safe and secure experiences and solutions for people. For example, in the communication between pedestrians and autonomous vehicles, purposefully designed signals can improve the interactions (e.g., Moore, Currano, Strack, & Sirkin, 2019). The Persuasive Technologies perspective allows examining the motivational strategies that are embedded in the system by identifying the resulting attitude and behavior of people when using and interacting with the AI system. By incorporating the Human-centered Computing philosophy in the design of AI systems, the focus of the design challenges moves away from purely technical problems to the enhancement and support of human capabilities through the AI system.

The *Need-Design Response* approach by McKim (1959, 1980) that has been popularized by the term Design Thinking allows identifying human needs in the early phases of the design project through practices such as need-finding. Understanding and having a sensitivity for which human needs the design of the AI system addresses, can overcome ethical implications at the beginning. Need-finding and rapid prototyping techniques allow the identification of, e.g., the potential addiction resulting from meeting unhealthy people's needs through the AI system. For example, AI designs that utilize the need for social acceptance in an unhealthy way to generate constant user engagement can lead to addictive behavior on social media platforms. This HCD research approach allows identifying the relationship between needs and AI designs.

Each of the HCD approaches allows examining specific societal and human implications of an AI system design. The ability to examine these implications allows HCD research to play a vital role in the design and development of AI systems.

5. The role of HCD research for Human-centered AI

The challenge of building AI systems and technologies that are ethical and beneficial for society is two challenges in one, the technical (rationalistic) and beneficial technology (design) challenge (Baum, 2017). Interestingly, scholars identified that there is little discourse

between the fields of user experience (design) and machine learning (rationalistic) (Yang, Banovic, & Zimmerman, 2018). However, as illustrated in Figures 2 to 9, each HCD approach requires the technical side in the design, development, and use of AI systems. For the resolution of this disparity, several scholars have proposed a comprehensive design approach that incorporates psychology, art, business management, and science to bridge the gap between humanism and science (Arnold, 1959; McKim, 1959, 1980; Winograd, 2006). There is a great opportunity for the fields of AI and HCD to collaborate to make progress on growing concerns around fairness, accountability, and transparency of AI systems (Abdul, Vermeulen, Wang, Lim, & Kankanhalli, 2018; Loi, Wolf, Blomberg, Arar, & Brereton, 2019). This pan-disciplinary approach requires to bring the strength of the rationalistic approach for developing new AI technologies and techniques and the advantage of the humanistic design for developing useful, meaningful, and ethical AI systems together. The role of HCD research is to examine the human impact of AI systems through various HCD approaches by collaborating with and informing AI technologists. Figure 10 illustrates the pan-disciplinary approach in comparison to only a rationalistic (technology) and only a design (humanistic) approach.

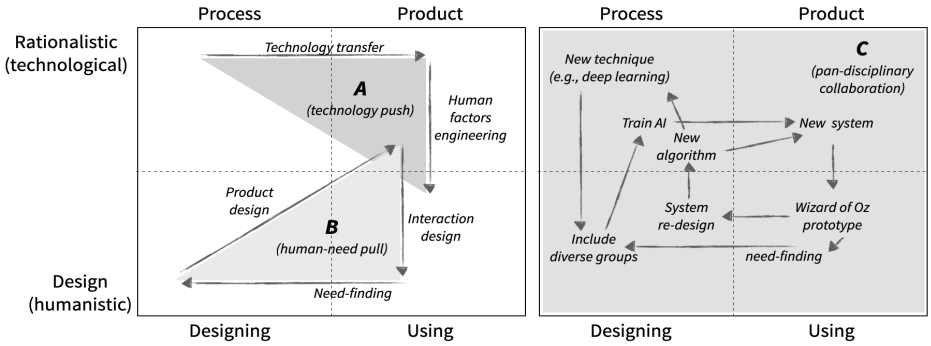

Figure 10 *Exemplifies three different approaches to designing and developing AI systems. A – Develops new technological solutions, translated into a product, and pushed to people. B – Utilizes existing technologies, and re-design them for specific human-needs. C – Exemplifies the pan-disciplinary collaboration of rationalistic and humanistic approaches.*

This comprehensive and pan-disciplinary collaboration design can play the role of mitigating the AI impact on society through collaborating with policymakers and decision-makers. New AI technologies and techniques can be prototyped and experimented through specific designs in a specific context. The pan-disciplinary experiments allow informing decision-makers such as investors and policymakers of the potential human impact of designed AI systems at different stages of the design. This pan-disciplinary collaboration is required to design and develop human-centered AI systems as well as inform and develop policies and guidelines. Figure 11 illustrates this comprehensive design approach.

In this comprehensive approach, the role of Design Research is to examine the potential societal impact of AI technology and systems through “enlightened trial and error.” Design Research can help to overcome the problem of the out-of-date law, allows examining ethical

questions in context-specific cases and can help in identifying unintended consequences by learning faster the impacts on people. To be able to contribute to human-centered AI in this pan-disciplinary collaboration, design researchers are required to develop design experiments and prototypes that can examine various implications of AI systems on the well-being of individuals and society.

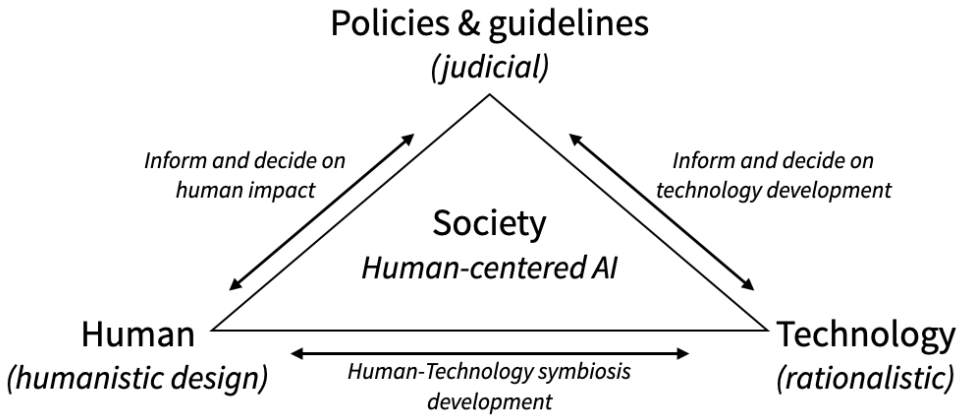

Figure 11 *Illustrates a comprehensive design approach that incorporates rationalistic AI technology development, humanistic AI design, and legal guidelines for new emergent technologies based on the examination of human impact through HCD research.*

6. Conclusion and outlook

This article provided an overview of different *Human-centered Design* approaches and their contribution to the development of Human-centered AI. The discussed HCD approaches illustrate that human-centered AI has essential to do with people, including the designer, user, and other stakeholders and their ideologies, practices, activities, interactions, and needs. Pan-disciplinary research that combines fields such as psychology, cognitive science, computer science, engineering, business management, law, and design is required to develop a genuinely human-centered AI approach.

Educators need to develop pan-disciplinary programs that enable students to understand both the humanistic and rationalistic perspective and are able to collaborate by understanding the technological, societal, and political and policy perspectives and challenges incorporated in the design, development, and use of AI. This educational approach has the promise of designing AI systems and technology that create delightful experiences for people in their everyday life by developing empathetic and creative designers and technologists that combine these viewpoints.

Pan-disciplinary research holds the opportunity to examine the impact of AI on society as well as spark new meaningful innovation for people. For design researchers, an essential task is the development of fruitful experiments for each societal concern in the design, development, and use of AI systems and technology.

Vitruvius Pollio (1914), in approximately 20-30 BC, believed that an architect should focus on three central themes when preparing a design for a building: firmitas (strength), utilitas (functionality), and venustas (beauty). Today, Human-centered AI needs to focus on three integrated perspectives when designing AI systems: rationalistic (technology), humanistic (people), and judicial (policies).

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Global Health SIG

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Editorial: Global Health SIG

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The papers that have been grouped under the sub-theme of Global Health reflect well the DRS Global Health SIG aims of further developing the research area of design for health at a global scale and fostering more research collaborations in design for health between researchers in the Global North and Global South.

A first group of papers highlights the need and value of interdisciplinarity for addressing global health and care challenges. Emphasis is placed on collaboration with disciplines outside design and humanities, involvement of wider stakeholder groups in research and design with as opposed to designing for people.

The first paper by Tsekleves et al. (paper 145) takes a global perspective to present the challenges and opportunities for design researchers who wish to conduct and apply design research methods within a Global South context. They present several challenges grouped under 13 themes, which would help in the development of mitigation strategies that will enable more design researchers to engage further in international research in the Global South. The second paper (paper 118) by Vaughan et al. reflect on the dimensions of an interdisciplinary design evaluation of a psychiatric care facility from across different disciplinary perspectives. They posit that a new paradigm with more interdisciplinary contributions are required for design applications in care to flourish. Lastly, in the third paper (paper 127), Landa-Avila et al. present a holistic outcome-based approach to healthcare systems co-creation. They call for a more holistic approach for strengthening systems thinking methods for healthcare design.

A second set of papers focuses on design interventions for older people with cognitive-related health conditions, in the USA, Indonesia and Australia. The papers emphasise the importance of co-designing appropriate interventions with users and the last two papers present co-created digital health applications. The need for co-creation and adaptation of design interventions, methods and interactions forms a common thread between all three papers. More precisely, the first paper (paper 142) by Aflatoony et al. introduces a photo

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narrative co-design method that engages older people with Mild Cognitive Impairment and their caregivers in designing therapeutic intervention. They present the lessons learnt from applying the method in the field and how it can be adapted and scaled up to address other chronic diseases such as dementia. The second paper by Wianto et al. (paper 292) presents a study from Indonesia care homes that evaluates assistive technology-based design for physical exercise. Their findings from 37 participants provide useful insights for the design of future guidelines for the design of interactive muscle-strengthening devices for older people. Lastly, in the third paper (paper 370), Murphy et al. present the design and evaluation of a collection of touch screen tablet mini-games developed for people living with dementia and their visitors in Australia, aimed at creating enjoyable shared experiences that spark social interaction between them. They conclude that a careful balance between stimulation and familiarity needs to be maintained to create successful and supportive technologies for dementia in social settings.

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For more information on the Global Health SIG, please visit the SIG's webpage at https://www.designresearchsociety.org/cpages/sig-global-health. To find out whether the SIG is organising a satellite event to the DRS2020 conference, or just to get in touch with members and see news on the SIG, please visit the SIG webpage.

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Challenges and Opportunities in Conducting and Applying Design Research beyond Global North to the Global South

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Abstract: With an increase in international projects, comes increased opportunities for design researchers to contribute to research that tackles Sustainable Development Goals in the Global South. Nevertheless, the role of design within this context is disparate and detached, with very limited design literature on the subject. As such, this paper has identified the key challenges and barriers that design researchers face in conducting and applying design research in a Global South Context. Based on a workshop with design research experts doing research in Global South, the literature and lessons learnt from running a design-led project in Ghana, we are presenting and discussing 45 challenges grouped under 13 themes. We envisage that these will form the first step towards developing strategies for mitigating these challenges and help current and future design researchers to engage further in international research in the Global South.

Keywords: global south; design research; sustainable development goals; global health

1. Introduction

The design community, along with other research communities, are called upon to tackle the complex global challenges framed in the United Nation's 17 Sustainable Development Goals. However, these require design research to be conducted in Global South contexts, in low-middle income countries (LMICs), where to date design research has been very limited or non-existent.

This is reflected in the funding opportunities available for international research, particularly those focused on the Global South (Bhutta, 2002), which employ the SDGs as a Framework for research (Hák et al., 2016), for example, the Global Research Challenge Fund in the UK,

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the Newton and British Academy Funds.

Conducting design research in the Global South, therefore, introduces a new context where cultural, social, religious as well as administrative practices often pose challenges but can create new opportunities for researchers from across the globe. As such this paper relates to the ***Processes*** and ***Situations*** conference themes. In terms of the former, applying design research that addresses SDGs in Global South contexts requires cross-disciplinary collaboration, navigating cultures, diversity, ethics, and the habits of different design communities. This in turn requires new processes or their adaptation to deal with challenges related to multiple voices, participation and power distribution, the role of communities and public organisations, and the building of international Global North-Global South partnerships in and for design research.

In this paper we present the challenges and lessons learned from a) previous international design-led/design-related research projects/studies from the literature; b) an international workshop on the subject, which took place at IASDR 2019 in September 2019 in Manchester, UK; and c) a Global Challenge Research Fund Design-led research project. We then offer a discussion of these challenges and the opportunities for design researchers.

2. Context and Related Work

Scientists and researchers today, are turning their focus to address the global challenges facing the developed, and more crucially, the developing world. Design research is starting to contribute to this field and there is a need for more design research to be directed towards addressing the challenges set by the UN.

The Sustainable Development Goals (SDGs) comprise 17 goals and 169 targets. They are intended to be global in embodying a universally shared common vision of progress towards a safe, just and sustainable space for all human beings to thrive on the planet. They reflect the moral principles that no-one and no country should be left behind, and that everyone and every country should be regarded as having a common responsibility for playing their part in delivering that vision (Osborn et al., 2015). The goals are broad based and interdependent. They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests.

Design's ability to engage real people and communities, understand everyday problems and implement the 'right' solution, not just the 'newest technology', enables it to act as a bridge between disciplines. It is an important and growing voice in this field, that helps to bridge the gap between the rapid advancements in science, technology and engineering with people and contexts on an everyday level. Thus, design can take a leading role in research that addresses the SDGs. Despite this, research into the role of design in tackling the Sustainable Development Goals is disparate and unclear. As such, there is a need to identify the key challenges and barriers design researchers face within the Global South context in order to

develop strategies for mitigating these.

The literature has articulated a set of funding, organisational and paradigmatic constraints on research partnerships with potential negative consequences at institutional and individual levels (Godoy-Ruiz et al., 2016). The issues covered include the selection and training of local personnel, the recruitment of participants, sampling challenges, participants' compensation, survey methods and implementation, elicitation methods, the literacy rate of the population, and security/ safety issues in developing countries (Durand-Morat et al., 2015). The most frequently mentioned challenges in conducting research in Global South contexts relate to access to data, data collection issues, diversity of the region, language barriers, and lack of research support infrastructure (Lages et al., 2015).

The majority of past and current research activity in the Global South has traditionally focused on the health research sector (Berndtson et al., 2007; Casale et al., 2011; Atkins et al., 2016; Franzen et al., 2017). As such, most of the research challenges presented in the literature have originated and have been framed for researchers engaging in health research activity. Lessons learnt from these may still be useful for design researchers, who are in the process of engaging with research in Global South contexts, but there is a clear and unmet need for further input from the design research community. Moreover, many professionals involved in North-South development research projects lament the lack of studies on such research partnerships to support critical reflection and the refining of approaches to collaboration.

This paper addresses the lacuna in the literature (Bradley, 2007; Teye, 2012), and collates a design research perspective on the challenges of designing, applying and conducting design research in the Global South.

3. Methodology

3.1 Design Research Workshop

Through a series of interactive workshop activities, the authors explored the challenges of applying design research in the Global South and invited workshop participants to share their own experiences.

The workshop objective was to form an initial map of emerging challenges and opportunities in the application of design research in LMICs. It addressed the following research question: 'How is design research changed in the transitions between the Global North and the Global South?'.

Workshop participants were engaged in a series of hands-on activities, over 120 minutes, that culminated in the preparation of a challenges map. Following a brief presentation of challenges and lessons learned from applying design research in Africa in the multi-disciplinary Dust Bunny research project (funded by UKRI AHRC) and from the literature; Participants working in pairs or small groups were assigned to three tables (working stations),

each one corresponding to a specific design phase (pre-design, design and post-design) – See Figure 1.

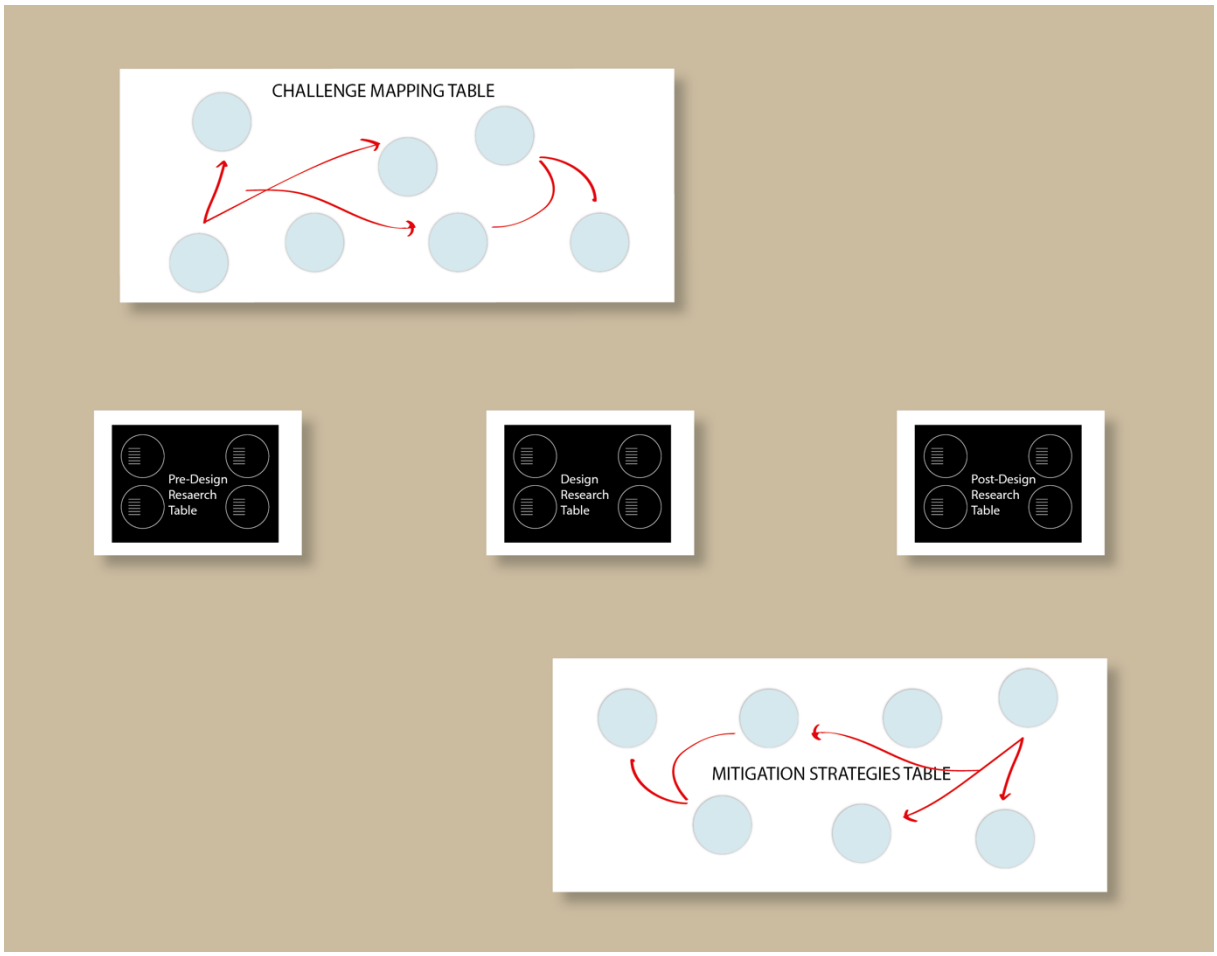

Figure 1 Workshop Set-up for mapping Challenges and Mitigation Strategies

Each group alternated along the workstations to ensure that they contributed to each workstation. Responding to the questions presented by the prompts on the working stations, each group added their own experiences and knowledge on the challenges of conducting design research in the Global South. This led to a collective map of challenges, which participants used as a basis for a reflection on mitigation strategies. Everyone was involved in moments of discussions, during which we reflected on the findings of the day and the next steps.

The workshop took place at the Manchester Metropolitan University, where the IASDR 2019 Conference was hosted and it involved 8 participants with expertise in conducting design research in the Global South.



Figure 2 Mapping of challenges and clustering into themes during the workshop

3.2 The Dust Bunny project

The Dust Bunny project's specific aim was to develop an understanding of the home as a source of infection from antimicrobial resistant (AMR) bacteria carried by dust by exploring hygiene practices across different home environments in Ghana. The project had the ultimate goal of reducing potential bacterial infection in the home environment in order to reduce AMR. In adopting these aims, the Dust Bunny project's aspirations were aligned to Sustainable Development Goal 3, target 3d (United Nations, 2016), and its desire to strengthen the capacity of a developing country in making risk reduction interventions in response to global health issues.

The Dust Bunny project combined design and microbiological and molecular ecology methods in an innovative mixed-method approach. A traditional survey design, a design ethnography, a cultural probe and a microbiological analysis were planned to provide insights for codesign workshops in which new cleaning practices might be developed to minimise any potentially harmful bacteria and particularly AMR bacteria present in the home environments in the Greater Accra Region of Ghana (Tsekleves et al., 2019).

The procession of methods; from survey instrument to design ethnography and cultural

probe, made in parallel with a microbiological analysis, was designed to provide a range of insights into contemporary cleaning practices in Accra. These insights were then to be used by participants to codesign, in a one-day workshop, 'new' cleaning practices for a thirty-day intervention, which would be followed by another round of microbiological analysis. Plans, however, rarely survive an encounter with reality, and though the structure of the research design survived mostly intact, the deployments of some of the individual methods were subject to extensive change.

3.3 Workshop Findings

A total of 45 individual challenges were identified during the workshop. Following discussion and a mapping exercise, these were then clustered into 13 themes, as presented in Table 1 below. These have been further analysed and grouped, following the workshop, into 4 groups of inter-related themes.

More precisely, challenges related to power, trust, consent and resistance to data capture technologies were discussed. These included specific issues, such as participant resistance to use video/audio-based methods, gaining access to community gatekeepers, getting participant consent, power hierarchy between researchers and research participants, as well as several others. Research methods were also extensively discussed with themes focusing on qualitative research literary amongst the North-South research partnership and local knowledge construction. Among others concerns, these related to challenges around how knowledge is framed in local societies, differences in abstract thinking and data collection robustness.

Challenges around the formation and maintenance of the research partnership also emerged. The main themes revolved around collaboration, communication and gender, with discussion touching upon issues of power dynamics and hierarchy, limited Internet access for communication and having an 'all male' research team. In the Dust Bunny project, this was compensated for by recruiting all female Research assistants/data collectors. The impact and legacy of the research was also widely debated, focusing on issues of relatability of the research and its outcomes for different beneficiary groups. Challenges under these themes included communicating findings to stakeholders and beneficiaries, creating legacy after the project end, and the relevance of research to local challenges and communities, as well as several other.

Table 1 Challenges and themes in conducting design research in the Global South as identified during the workshop

	Themes	Challenges
Research Participants and Fieldwork	Resistance to data capture technologies & methods	Lack of exposure to video tech related to trust issues
		Research participant resistance to recording technologies
		Resistance to use video/audio-based methods
	Power	Implied power of the researchers
		Identity, possessions, the body
	Trust	Access to community gatekeepers
		Partnership as point in gatekeeping
		Gatekeepers — relationship building over time -> trust
		Intrusion
		Participant overexposure to research
		Cultural social sensitivity
	Consent	Consent is slow process
		Data collection difficult if people won't sign paper records
		Consent leveraged and continual negotiation
		Ethics: where do we apply for?
		Literacy level, impacting consent ...
Research Methods	Truth	Local research methods knowledge
		How knowledge is framed in local societies
		Gaining local context for adjusting research methods
		Individual vs group behaviour norms
	Knowledge construction, Otherness	Cultural differences in defining 'truth'
		Abstract thinking — lack of education
		Abstract thinking is different (culturally)
	Qualitative research literacy	Research methods robustness
		Robust data collection
		Qualitative data analysis: priorities, patterns
		Where you process the data affects how you process the data

	Themes	Challenges
Partnership	Collaboration	Collaboration agreement setup
		Power dynamics and hierarchy
		Permission to change design research methods
		How do you adapt methods for comparative purposes
	Communication	Infrastructure: (communication technology) lack thereof is a limitation
		Limited Internet access for communication
	Gender	Gender perspective / Gender bias
		'All male' research team
Impact and Legacy	Outcomes (different for stakeholders)	Communicate findings to stakeholders and beneficiaries
		Recording stories which are important for storytelling and impact
		Record data from the start to demonstrate impact
		How to best measure impact and follow up
	Legacy	One thing to report, another to involve in the insight
		Create legacy after the project end
		Disseminate locally: which methods
	Relatability	Relevance
		Sense of topical boundaries (not believing the Q is relevant)
		Our academic delivery of results may be unusable to participants

4. Discussion

In this section the authors discuss the workshop findings in relation to the literature and our own experiences in applying design research methods in the Global South, under the Dust Bunny project.

4.1 Research Participants and Fieldwork

When it comes to conducting field work involving research participants, such as rapid ethnography, observations, interviews, etc., researchers face challenges related to lack of trust and perceived security. Some of these concerns are related to providing safeguards and peace of mind to teams of enumerators and field personnel (Cheema et al., 2018) or to concerns about local social unrest at the time of the fieldwork (Mathee et al., 2010). This clearly impacts negatively on the data gathering process, as it often leaves researchers with little choice but to change their initial data sampling methods, sometimes on the fly, with implications for data analysis (Mathee et al., 2010). For instance, the Dust Bunny project demonstrated that community participation in design research is complicated by issues of social judgement, safety and security. These combine to create a climate of mistrust

among participants who are cognizant of the moral nature of cleaning (Curtis et al, 2003; Bloomfield et al, 2009) and keenly guard their personal privacy. This impacts methods such as direct observation, which have greater validity than those obtained through questionnaire interviews (Curtis et al, 2011), with participants showing resistance to the use of recording technologies in the home and denying, or minimizing, access.

The biggest challenge though is research participant overexposure to research. The increase in funding of research in Global South countries and especially low-income and informal communities has seen some being invited to provide data in too many studies. This has also attracted elements outside the community posing as researchers in order to gain access to households, often leading to thefts and other illegal activities. Similar concerns have been raised by participants during the Dust Bunny project, as evident from the quote below, as well as in the literature.

> "A neighbour allowed a well-dressed man into her home with the aim of conducting interview but ended up raping a daughter and stole some few items and bolted away. Another place they stole lab tops and phones. Some are also of the fear we might kidnap their children for ransom."

It has been reported that potential participants are sometimes afraid to allow fieldworkers onto premises due to high crime rates in many participating areas (Nel et al., 2017). In other occasions entire communities had previous bad experiences of cold-callers and fake lottery schemes, where outside people came and defrauded people of their money by promising large cash and in-kind rewards (Cheema et al., 2018). These concerns coupled with cultural and social sensitivity affect trustworthiness and pose barriers to design research fieldwork in the Global South.

Resistance to community engagement and participation as well as the use of appropriate observational research methods and technologies therefore form a particular challenge for conducting in-depth studies in some developing countries.

In the case of the Dust Bunny project, such local experiences and fears meant that the only documentation of the ethnographic sessions were field notes as people's participation became conditional on our agreement not to use audio or video recording or photography during the sessions. High levels of resistance to the use of recording technologies in the home, were informed by the larger social issues of safety and security, and acted as strong cultural barriers to recruitment and participation in Ghana. Salvador et al. (1999) note, that with limited time to access the field design ethnography draws "on a wider toolkit of ethnographic methods" that include many approaches that make use of technology. Resistance to such technologies therefore is a particular challenge for the use of design ethnography studies in a Global South context.

Gaining permission in a developing country with different social structures presents additional challenges. Gaining trust and permission to communities for participating in research, depends significantly on gaining access to community gatekeepers. Permission from chiefs, community leaders, elders or street committees is often required, and one

is expected to present one's case to them, as well as to provide small gifts. Workshop participant experiences along with ours, from the Dust Bunny project and that of the literature indicate that this poses a hinderance to timely project completion, as it often leads to delays during data collection (Roberts et al., 2019). Once a contact is established, the negotiation to get access to participants is prohibitively long requiring local knowledge of the community needs and diplomacy to gain approval and support for research (Lages et al., 2015; Mathee et al., 2010).

Once gatekeeper permission is granted, then the recruitment of research participants can start. This also includes gaining their consent in participating in the research, following established research ethics procedures. Workshop findings align with the literature with regard to the range of ethical concerns found in the Global South contexts.

Questions arise as to where one should apply for ethics. Should it be in the Global South country where most of the research is taking place or in the Global North institution, which usually leads the research? The literature highlights that many ethics committees in Global South countries lack the authority and/or the capacity to monitor research in the field (Regmi et al., 2017). A lack of clear guidance in most Global South countries on the consent taking procedure poses further challenges to being able to adhere to ethics principles (Amerson & Strang, 2015; Regmi et al., 2017). This is further affected by low education levels, affecting participant's full understanding of what research entails, and also patriarchal or matriarchal social structures, which may require non-research participants to give consent for others to participate (Amerson & Strang, 2015).

Moreover, the choice of the type and the amount of incentives has ethical implications and is not an easy dilemma to resolve (Casale et al., 2011). It is important to recognise and thank people for their participation in the research. Given the low economic background of several of the Global South participants involved in research, not well-thought out incentives can have a negative impact on the participants; especially if the research focuses on low-income and informal settlement communities. Researchers may put participants at risk within their own community if they are seen as suddenly having been given monetary or other incentives of high economic value that differentiates them from others in their community.

4.2 Research Methods

The theme of Truth, in relation to how knowledge is framed within local Global South contexts was widely discussed during the workshop. The way knowledge (truths) are framed within this context often relates to the way the research methods are also framed and executed. For instance, in the Dust Bunny project, we observed a need to better understand the potential application of 'researcher' and 'guest' identities within field work in the home. As such gaining local context for adjusting research methods is important but more importantly research priorities should be determined in or rather by the South (Bradley, 2007).

Cultural differences also exist between North-South contexts regarding gender perspectives

that can lead to gender bias (Berndtson et al., 2007). Added to these are cultural and social conditionings that include an emphasis on seniority and social hierarchies. Especially in forming research teams in the Global South it may be challenging to avoid an 'all male' research team, as research training may be made available primarily to males, with limited opportunities for females.

Local research methods knowledge, is therefore, a requirement when designing a research project. Even more so when running one, where relying on local personnel is crucial to ensuring that different aspects of the research are tailored to the idiosyncrasy of the population being surveyed (Durand-Morat et al., 2015). However, this is not always possible, as from discussions in the workshop and the literature, it is clear that in most partnerships in Global South countries the research protocols were written by researchers from the North with little input from southern partners (Olivier et al., 2016). This is often due to South partners having limited time to devote to the design of research studies, and often have less methodological knowledge concerning research design (Lages et al., 2015).

Language poses another barrier in conducting research in a Global South context. This is the case even when English is the official language, spoken at a national level. Experiences shared by workshop participants matched our own in the Dust Bunny project; where although English was the official language our version of English (British English) was different from the local English (Ghanaian English). For example, in presentations, workshops and other interactions with research participants UK-based researchers had do slow down their speech speed to match that of the local one and often they would have a local colleague repeating what was said (i.e. workshop instructions, etc.) with the local accent in order for it to be fully understood.

Also, in collaborative research where different languages exist amongst the partners, English language (or any other former colonial language) is commonly used between research implementing partners and funding agencies (Regmi et al., 2017). As such, it is a common practice for researchers from Global South countries to draft research protocols, tools used such as questionnaires and consent forms in English. However, transporting a questionnaire across national and linguistic borders means more than translating items accurately from one language to another (Rubinstein-Ávila, 2009; Cheema et al., 2018). Translation does not always ensure that the research method will convey the same pragmatic meaning, requiring further adaptation as well. In Global South contexts, where several local languages exist, research teams require multilingual skills in order to make regular adjustments to the strategy to make best use of opportunities and build long-term relations with the communities (Cheema et al., 2018).

Another challenge, which emerged during discussions in the workshop, was that of knowledge construction relating to cultural differences in defining 'truth'. Differences in the education systems between Global North-South countries coupled with cultural factors result in different perceptions about abstract thinking. In design research, especially in participatory workshops, abstract thinking is often a useful tool employed in looking at the

bigger picture and making sense of different types of information. Our experiences and that of our workshop participants affirmed that many of research participants in Global South contexts lack the experience and confidence to engage in creative lateral thinking, and even to think critically about matters unfamiliar to them. Even in situations with small number of workshop participants, there was still a level of unease when it came to thinking differently, which created conditions of cautious interactions.

This challenge extends beyond workshops to other design research methods, such as questionnaires, as most enumerators find it difficult to fully understand and contextualise open-ended questions (Cheema et al., 2018). This coupled with language barriers and cultural hegemony results in lack of salience of concepts, the non-equivalence of concepts, and the use of levels of language not easily comprehensible to people with limited education (Casale et al., 2011).

The latter also has implications for multi-disciplinary and inter-disciplinary research. The literature suggests that creating multi-disciplinary North-South partnerships and promoting inter-disciplinary dialogue remains a struggle (Bradley, 2007). The lessons learnt from our Dust Bunny project also suggest that a disciplinary resistance may have been at play. As an action-orientated discipline design acknowledges gaps in data and addresses them to move forward, where some disciplines are constrained by data leading to perceived inaction from a design perspective. The challenge for non-design researchers working within a design-led project is in accepting an action-orientated approach, while not diminishing the methodological foundations of their own disciplines. The challenge for design researchers is to recognise these disciplinary clashes, acknowledge the differences in the disciplinary approach, and to guide the project toward action.

The disciplinary and educational background differences discussed above affect the robustness of the research methods, in relation to how they are perceived and employed in the Global North context. During the workshop challenges of qualitative research literacy in relation to data collection and data analysis were reported. Similar challenges are also found in the literature, where poor research production, in terms of both quantity and quality and a critical lack of support for research development activities (including infrastructure and incentives) affect research (Atkins et al., 2016).

Moreover, the variability of research skills (due to diverse research literacy) amongst research assistants and enumerators hired in Global South projects further undermine research method robustness (Durand-Morat et al., 2015) For instance, in the Dust Bunny project, we observed an inconsistency in the data descriptions (length and quality) received from our group of research assistants in the ethnographic study. This matches other reports from the literature, where the quality of focus group facilitation was also inconsistent, which in some cases lead to them having to hire additional staff (Casale et al., 2011).

Challenges have also been reported with regards to the implementation of research methods in the field. In particular, privacy is often a problem in research methods implemented in a low-income setting or informal settlements (Nel et al., 2017). Due to a lack of space and

seating, individual data collection often becomes challenging. Privacy and confidentiality are hard to guarantee and oversee as participants' responses are shared beyond the research team, with whomever happens to be within earshot from the space (communal household or informal settlement) and due to frequent interference of family/community members (Rubinstein-Ávila, 2009; Regmi et al., 2017). As keeping non-participants away can be culturally and physically difficult to accomplish (Regmi et al., 2017), this has implications for the data collection process (as some personal insights may be chosen not to be shared) and/or for the research method itself, as in effect an interview method may have to be changed to a focus group in reaction to the environment/context.

4.3 Partnership

One of the main challenges researchers with experience in the Global North face, when working with researchers in the Global South, is to assume that the same conditions will prevail when expanding their activities into developing countries (Durand-Morat et al., 2015). The conditions are in fact very different. A lot of it relates to power dynamics in the North–South collaboration and partnership.

The literature suggests that asymmetry between partners remains the principal obstacle to productive research collaboration. The '90/10' gap, refers to the *phenomenon* where 90% of the health research is done in countries with 10% of the world's health problems and in a mismatch between the disease burden and the technical and human capacity for research in developing countries (Edejer, 1999; Atkins et al., 2016). This also applies to design research. In the context of North–South global research partnerships, asymmetries in power have been linked to perceptions of unequal knowledge, competence, and resources that confer advantages to Global North partners (Berndtson et al., 2007; Olivier et al., 2016). These include inequitable access to information, training, funding, conferences, publications leading to disproportionate influence of Northern partners in project administration and budget management (Bradley, 2007). This usually results in the research agenda being dominated by the Global North partner researchers and agencies, with funding directed primarily towards international salaries, rather than the salaries of local researchers (Godoy-Ruiz et al., 2016).

Discussion during the workshop also revealed that structural inequalities clearly impact the process of selecting partners and setting the research agenda. Colonialist mentalities in research partnerships formed another concern, with delegates sharing examples of situations where Global South partners felt the need to seek permission to change design research methods. Critiques of the neo-colonialist nature of research relationships between high- and low-income countries have been documented in the literature (Godoy-Ruiz et al., 2016).

Face-to-face time with research partners forms a key enabler to develop further the collaboration and the research, however limited funding for international travel often prevents this. In the absence or limited opportunities for face-to-face communication

(often dictated by the need to reduce travel, due to the climate change as well as to hostile environments and natural disasters in some Global South countries), online/telephone communication becomes paramount. However, collaborations in global research are strained by distance and communication barriers (Godoy-Ruiz et al., 2016). In the case of the Dust Bunny project limited Internet access and poor Global South telephone-conference facilities severely impacted regular and more direct communication.

4.4 Impact and Legacy

The impact and legacy of projects running in the Global South were themes, which were highly discussed during the workshop, especially in light of the different expectations held among stakeholders. How these different expectations are dealt with once the study is finished (Edejer, 1999) poses a challenge that is often unaddressed.

Questions were raised as to how North partners communicate and disseminate findings to stakeholders and beneficiaries in the South as well as how to best measure impact. It was observed that recording data from the start of the project to demonstrate impact was important, as was the recording of stories.

Creating a legacy after the project ends is a challenge for any research project, but it is one that poses a greater challenge for Global North researchers working in the Global South. On one hand, many Global South research institutions still lack capacity to self-sufficiently undertake research to translate findings into impact and policy (Frazen et al., 2017). On the other hand, there have been far too many research projects that use practices of 'mosquito' or 'parachuting' researchers into a Global South countries. These projects perform research work, and fly the data out—with the results being learnt only on publication (Edejer, 1999). In fact, dissemination being oriented towards international journals and conferences rather than local knowledge translation (Godoy-Ruiz et al., 2016), does not only diminish local communities trust towards Global North-led/funded projects, but impedes local dissemination and impact. Regarding the latter, our academic delivery of results is often unusable to research participants. A larger and more difficult challenge is to involve the communities themselves in the research questions and to link the research to their own development (Bhutta, 2002). Design research methods such as storytelling and co-design workshops were recognized by workshop participants as the best medium for sharing knowledge with communities, since they have a great capacity for involving them in the insights gained from the research.

Relevance and relatability of findings with communities is further hindered by cultural factors. Our experience from the Dust Bunny project along with the literature suggest that disseminating findings is not simply an academic or linguistic translation exercise, but also must be adapted to the cultural, social and linguistic norms of each particular context (Rubinstein-Ávila, 2009).

5. Conclusion

In this paper, we have combined experiences from the IASDR workshop we ran in September 2019, our own experiences from running a Global Challenge Research Fund project in Ghana (Dust Bunny project), and the literature to explore and discuss the challenges and opportunities associated with applying design research methods in the Global South. These included challenges in conducting design fieldwork, engaging research participants, and employing design research methods, as well as developing North-South partnerships, and considering the impact and legacy of research.

Regarding building research partnerships, it has become clear that unless the model of North-South collaboration changes, the unintended ill consequences on local research will continue to subvert efforts to apply research effectively, build capacity (Edejer, 1999), which result in genuine impact on the lives of local communities.

Many of the design research methods used in the Global North were developed, and honed in, and for, the Global North. Given the cultural difference between different countries in the Global South and the Global North the design methods common to developed countries are not necessarily appropriate for use in developing countries without significant adaptation.

Global North researchers need sufficient time in-situ with Global South researchers in the pre-design phase of a research study to establish collaborative working practices and in doing so to consider how methods work in, and are adaptable to, Global South contexts. This phase of work needs to be acknowledged as being necessary, at both the funding and the implementation stage, until unique design methods of, and for, the Global South are significantly more commonplace and design research is better established across the Global South.

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The sum is the realisation of the parts: interdisciplinary perspectives on care

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Abstract: Designing through the paradigm of care and for care, is a complex and perhaps precarious activity. It is a domain of design research and practice that is best undertaken through interdisciplinary collaboration. In this paper we reflect on the dimensions of an interdisciplinary design evaluation of a psychiatric care facility from four disciplinary perspectives. Through this discussion we propose that it is the disciplinary and methodological diversity of the research team in conjunction with the research participants, that enables us to develop a comprehensive view of the care facility, and the nature of designing for care more broadly. In short the robustness of our discoveries is the result of the sum of our parts.

Keywords: design anthropology; design ethnography; care; interdisciplinary collaboration

1. Introduction

The provision of care in a psychiatric facility is inevitably complex. It encompasses the breadth of material, social and service dimensions that need to be considered for patients and carers as well as for family and other community members. Understanding how to design the infrastructure and environmental needs of the various stakeholders in such facilities is best achieved through the lens of different expertise frameworks including design.

This has resulted in a shift in design research and practice from the material production of ‘things’ for consumption, to a greater awareness and desire to design a world that sustains, respects and benefits all. Subsequently, a range of design methods and approaches have evolved. Most notably, the shift to human-centered design, has had many positive benefits in enabling this transition, and has expanded the basis for many contexts of design research, not least in the healthcare sector. Researchers are also identifying opportunities for human-centred design to be used in collaboration with other fields of practice, in order to both realise the ambitions of care, and note its limitations (Hammington 2018)

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In exploring design as a practice of care, Vaughan (2018) asks that we challenge some of our assumptions or limiting beliefs about both fields - design and care. Bernard Weicht (2015) argues that we need to consider the intersubjectivity of care - that care is the manifestation of relationships between people, space and things. These relationships may include the intersections between the material world, technologies, the body, our emotions, experiences and sensorial nature of being in place. Typically for institutional contexts of care, these are drawn from a range of people and sources and expertise sets. In order to accommodate a deep appreciation of these relationships we propose an interdisciplinary approach which brings to the fore the expertise associated with different disciplines, but does not seek to submit any approach to the other. Such an approach involves an interweaving of ideas and respectful acknowledgement of disciplinary expertise and how this might contribute to shared goals. In this paper we map out how this was articulated as a mode of interdisciplinary design ethnography. Our approach drew together the theory and practice of design anthropology, human geography and design research in order to attend to the sensorial, atmospheric and creative dimensions of the experience of design, in relation to the processes of design and architectural practice. Thus enabling us to draw new insights into both the ways that our own forms of expertise as researchers intersected, and the ways the experiences and intentions of the different stakeholders in hospital design (patients, visitors, staff, designers) intersected in both the intentional and unanticipated effects of hospital buildings and service design.

Across the field of design research there is a growing community of researchers and practitioners interrogating and proposing new ways for practices of care to be designed in meaningful and timely manners. Peter Jones's 2013 publication, Design for Care, drew particular attention to the relationship between insights from human centred design could inform broader approaches to the design of care particularly in health care contexts. In 2016 Charlotte Bates, Rob Imran, and Kim Kullman published a collection of essays Design and Care, that drew a particular focus on the role of spatial design in realising environments of care. In 2017 Paul Rogers at Lancaster University asked the question Does Design Care? and brought together a global community in his publication of the Lancaster Care Charter (Rogers et al 2017). Like other leading publications and initiatives (networks, conference themes, research labs) Rogers et al, emphasise the need for multidisciplinary or interdisciplinary expertise, if we are to realise ambitions in the design of care.

In our project and in this publication, we have sought to move beyond statements of the need for disciplinary diversity, and to evidence what this means in practice for researchers engaged in research and scholarship. What motivates people to work collaboratively on such projects; how does participation inform and transform their own practices; and what value does this bring to the project and the subsequent insights. As such this paper is structured around four distinct and interconnected anecdotal narratives; it honours the voices of the authors and their respective positions. In doing so, it is consistent with Max van Manen's (1990) proposition, that research on lived experience is best articulated through anecdotal narrative. For such an approach leads us to reflect, it involves us personally, and affords

transformation (p. 121). The tone of the paper is consistent with reflexive writing in design and ethnography, as it endeavours to reveal the perspective of the researchers within the context of a real-world project.

2. Research Context

Between 2016 to 2018 the authors undertook an interdisciplinary design ethnographic study of the design of, and staff and patient transition to, a new psychiatric facility within a greater hospital development project.

The site of the research is the Bendigo Hospital located in regional Victoria, Australia. Through this new development what were originally three discrete psychiatric units were consolidated into one co-located department within the main hospital facilities. It was a complex project for the hospital to realise and involved many stakeholders both internal and external to the hospital. Internally these included nursing staff, doctors, service and administrative staff, patients and other allied care services. Teams of architects, planners, landscape architects and numerous service providers were charged with realising the project. The guiding document for all the stakeholders was the hospital's Model of Care - an extensive document that outlined what the principles of care were for the new facility and how these would be realised. Safety and wellbeing of patients and staff is the central theme throughout it. This model of care was an evolution of the practices undertaken in the previous facilities. It was the guide for both the project development, and the care practices of the hospital staff.

As noted by Wood (2013) and experienced by this research team the design and development of a new psychiatric facility is an extraordinarily complex undertaking. There are layers of material, physical and psychological care that are central to the project achieving its outcomes. These are realised through the service models, spatial and material features of the facilities that people live and work in on a day to day basis.

The project team was commissioned by the hospital developers to undertake a design evaluation of the psychiatric facilities. The form of the evaluation was a design anthropological study that engaged closely with the various stakeholders from architects to nursing staff, cleaners to allied health professionals, and patients, family and other care providers. The complexity of the project demanded for a breadth of expertise in the research team. This expertise would frame the research focus and the data analysis. It was also planned that we would, through this research, expand our understanding of our respective fields through our collaboration, and as such would then disseminate the resultant insights back into our own fields.

In this paper we explore how the expertise of the four researchers involved in the project has informed the design of the study, our meaning making in relation to research discoveries, and its implications for and contributions to our respective disciplinary domains.

3. Methodology

Design Anthropology (Smith & Otto 2016) involves bringing together the theory and practice of design and anthropology. This interdisciplinary combination can take a variety of forms (Gunn & Donovan 2012). Our own rendering of it is in the form of a blended practice (Pink et al 2017, Akama et al 2018) whereby neither discipline takes precedence, and research and practice involve a process of mutual learning between individual researchers and by implication for disciplinary reflection. Blended practice, as developed here, requires conceptual containers through which researchers can confer and mutually engage. As discussed above the concept of care recurred throughout this work, through the notion of design as care, the model of care that informed the hospital design, and our research focus on how care was manifested in everyday practice. Thus making the question of care an interdisciplinary concern as well as a question our research wished to unravel, since the study involved a complex intersection of the material, experiential and service experiences of two distinct locations focussed on the provision of care services and how architecture and design inform people's experiences of care.

To understand the articulations of care that were involved in this we needed to combine the disciplinary approaches which could deliver and interweave the practical and theoretical expertise in skilled fieldwork and ethnographic analysis, an awareness of design and human-centred design approaches and the ways that space and place have a profound impact on lived experience of the world. Therefore, the research team was composed of four domain experts across human-centred design, everyday design, design anthropology and experience of built environments, and human geographies of spatiality.

The structure of the study interwove this expertise through two stages of research and analysis across a three-year period. In stage one we undertook two tasks: a series of interviews undertaken with the architects and landscape architects who designed the facility; and an ethnographic study of the participant experience of the original hospital facilities at the three locations, as well as observational data collection of the spaces, facilities and material and sensorial aspects of the locations. Interviews and observations were undertaken with nursing staff, patients, family members, allied carers, service workers and hospital administrators. Video and photography were used where appropriate and only ever with informed consent from participants. At the end of year one the new hospital was complete, and the patients and hospital staff moved into the new facilities. During this time no fieldwork was undertaken to allow time for people's experiences to 'settle' and become normalised in the daily care practices of the staff, and associated experiences of the patients. In year three fieldwork was undertaken focussing on people's experiences of the new facilities. Again, this field work included observational data of the material experiences and qualities of the spaces.

Bringing these materials together required an interdisciplinary collaboration. A deep understanding of design processes, context and the constraints on these was needed to analyse and interpret our interviews with architects, designers and other stakeholders,

and to set their experiences in dialogue with our ethnographic findings. Our ethnographic findings required us not only to interpret the experiences of staff and patients anthropologically, but to set these in dialogue with an understanding of buildings, interior and service design. Therefore, the task of interpretation could never be one of a single discipline scholar but always part of a blended practice. Our analytical processes were therefore always interdisciplinary, involving the collaboration of at least two members of our team, and our final report writing involved the work of all four researchers, bringing together theoretical expertise in design and anthropology, with depth experience of immersion in the field sites. Thus, for instance meaning that the theoretical, experiential and design practice elements on care which were represented by both the different positioning of researchers in the project structure, and their different expertise could be compared.

3.1 Collaboration does not mean assimilation

There are various ways that we can articulate collaboration between and across disciplines and the value of this. Moran (2002) argues that disciplines are by their scientific focus narrow, and we could argue limited. Working with other disciplines affords us the opportunity to expand our worldview and we may do this with a range of intents and expected outcomes. This typically is framed as being either multidisciplinary (a range of disciplines together), cross disciplinary (working across boundaries), interdisciplinary (finding points of intersection) and transdisciplinary (when new knowledge emerges as a blending of disciplinary expertise). This design ethnography is best articulated as an interdisciplinary or transdisciplinary mode of investigation. This is consistent with Winschiers-Theophilus et al (2019) arguments for different disciplinary engagements in design research. The research design was formulated using the expertise and best practices of the various disciplinary domains. The official project outcome was a design ethnography, a field that is an interdisciplinary blended practice that is particularly aligned to developments in human-centred design, that would have value and contribute to future hospital developments. However, the knowledge and practices of the researchers undertaking the study are also transformed through the process of doing the research. This is an often under recognised value for undertaking research, and for working in particular research teams. In this project the research team had an explicit interest in learning from each other as well as interrogating the subject matter.

Typically publications from research collaborations are presented through a unified voice (we – the research team), where often it is only the research publication disciplinary context that allows for difference or disciplinary focus. Through the following reflections by the four members of the research team, each of whom, in their own voice, articulate their particular focus and ambition in the project- we aim to identify how difference and synergy can co-exist in a complex collaboration. These reflections include what they brought to the project in terms of expertise and specific domains of concern and the methodological contributions that they could make to the research design and the subsequent insights on completion.

3.2 Design Anthropology - Sarah Pink

My initial interest in this project was two-fold. My methodological interest was in developing a new design ethnographic approach to building occupancy that goes beyond standard POEs (post-occupancy evaluations) to attend to the sensory, emotional and often unspoken feelings through which people experience and learn to live and work in new buildings. This I believe is a necessary move if we are to understand care and wellbeing as being emergent from the everyday material, social and sensory circumstances in which people are situated, rather than being the effects of design. Drawing on existing design anthropological practice in contexts of health care (Pink et al 2014), architectural design (Pink et al 2018), the construction industry (Pink et al 2013) and homes (Pink et al 2017) I was also particularly interested in what we could learn from this project that would enable us to better understand the relationship between the design and experience of the built environment, interiors and services that would subsequently inform a position on how architectural design for wellbeing might be developed in dialogue with social research.

The research sought to understand the experiences of staff and patient participants through a sensory ethnography (Pink 2015) methodology. Sensory ethnography pays particular attention not only to what people say and what they can articulate verbally, but to what people show us, perform for us and collaborate to bring to the surface in situ in the places where these activities are normally played out and experienced sensorially through the difficult to articulate experiences of light, sound and temperature. Often these experiences are felt rather than being observable or necessarily easy for participants to verbalise in interviews, yet they are fundamental to how we 'feel' in place and therefore vital to understanding how design and architecture are experienced. Where appropriate sensory ethnography uses video and photographic methods in collaboration with research participants to demonstrate, show and record enactments of and artefacts from everyday life environments and actions. This was adapted in practice during the fieldwork in relation to the environment and particularly in connection with the participant groups of hospital staff and psychiatric patients.

This approach was also tailored to attend to design anthropological questions focused on how participants use, improvise in and make themselves feel 'right' or comfortable as they learn to live and work in the new hospital environment. Therefore, going beyond the usual questions of how people experienced the new building the research was designed to ask how they improvised to reshape such experiences. Thus I was interested for instance in how participants developed techniques to change the temperatures, benefit from sunlight or experience a sense of quiet or peacefulness in ways that had not been accounted for by the architectural design of the hospital. It is by learning from both how participants benefit from and use intended design features as well as by understanding how they improvise to achieve what they need in spite of existing design that we can best provide new insights that will enable us to propose how consultation processes can be refigured as future-user research which can offer insights for design that are based in the sensory, unspoken elements of user experience that so often underpin and are vital for wellbeing. It may be noted that the team

did include two design researchers, similar in their design premise but different in their focus and tenure as design researchers.

3.3 Human Geography - Shanti Sumartojo

I was responsible for conducting the fieldwork in the first part of the study, working from a set of research concerns that asked how people experienced the hospital inpatient units in the facilities that predated the construction of the new hospital. My task was one of understanding how the gardens, corridors, shared spaces, bedrooms, nurse stations and treatment rooms felt to the people that work, dwelt and moved through them.

This meant trying to understand how different elements configured together to comprise affective and sensory experiences, connecting tangible and describable things to feelings that were sometimes difficult to express or communicate in words. My research interest was therefore conceptual in its attention to place and the distinctive atmospheres that were part of what they meant to people. It was also methodological as I sought to translate the framework provided by the research questions into ways of interacting with research participants that best allowed them to express their experiences of the different wards.

In practice this meant feeling my way into the site by attuning to it in various ways with my own body and senses, making notes about the distinctive sounds, smells or the quality of the light, and taking note of the furnishings, equipment, routines, and many other elements. These embodied experiences of my own gave me a way to engage with others in the same environment, sharing my impressions as a route to learning about theirs. I spoke with and moved around the wards with patients, visitors and staff members, asking them to show me their routines or places that were particularly significant to them. I got to know the rhythms of the ward, and began to recognise how care was expressed and responded to in various interactions and by way of materials, objects or substances. Many of these encounters were video or audio recorded, creating materials that the research team could work with later.

Over ten weeks in the wards, we amassed materials that allowed us to begin to generalise some of the terms in which people understood care and wellbeing in this particular environment. While these findings were inextricable from the specific spatial contexts in which the research took place, they pointed towards abstract concepts such as homeliness, safety, movement and connectedness as important and common aspirations for what an ideal environment would enable. Here, the notion of care emerged as entangled with much more complex and expansive ways of relating to each other and to surrounding environments, including those in the past and in the future. These categories then became central to what we would interrogate in the next phase of the study, in the new hospital building.

3.4 Design Researcher - Melisa Duque

As a design researcher, I joined the project in its third year after staff and patients had moved from the previous facilities. My arrival at the Psychiatric Units was informed by the

ethnographic materials from the first-year experiences, which provided me with a helpful degree of familiarity. For instance, the recorded conversations that my colleagues had with the hospital staff, opened a path that I was able to pick up with participants as they remembered the purpose of the research and the open-ended style of our interviews.

I developed a design research practice specific to the site in which I worked. As I became immersed into the hospital context, I could relate to staff accounts about their experiences of working there. At times, I navigated the hospital imagining how it would feel if I were a family member visiting a loved one. Moreover, I learned from the staff, who in their empathetic responses often invited me to think of how the hospital design and services would feel if I were the patient. These personal, situated and imagined experiences were further informed by my industrial design background. This sometimes oriented our conversations to explore how the materiality, spatiality and sensoriality of the design elements of the units played key roles for psychiatric care. In addition to the memories of these encounters, the research methods used to record the fieldwork included a variety of tools (see Figure 1) to gather written notes, photos, audios and videos.



Figure 1 Kangaroo bag with recording tools, with required Duress alarm and swipe card access.

Besides researching the roles that design played in this context of care, I found a community of practitioners who worked creatively to generate environments of care and adapt their practices to the new facilities. This made spaces meaningful to themselves and to the people they cared for. Some of these practices of care included what nurses called TLC (tender loving care), ranging from always having fresh flowers, to giving patients a walk around the Unit at their arrival, as orientation to the new spaces, services and technologies. They also performed sensorial and communication interventions, using some of the surfaces to communicate with each other in allocated notice boards, and by decorating windows. Both the design of the physical environment and the everyday designing practices (Duque, 2018) found at this Psychiatric Hospital, informed my understanding of the broad scope of material

and relational designs for/with care.

3.5 Design Researcher - Laurene Vaughan

I came to the project with an interest to know more about the intersections between the intentional design of physical spaces and services of care and people's individual experiences of 'care' within these. Undertaking research in a psychiatric unit was also particularly interesting, such care contexts are not typically available to designers and often not experienced outside of the popular imaginary. It could be said that a core interest for me within the research was to identify and critique what might be called 'popular' approaches to design research and practice and conventional ways to articulate value and care through design. In current practice and discourse this is presented as being the value of human-centred design (HCD) - it places the focus on the people who are the receivers or co-designers of a design outcome and by default this means that has value and integrity. I have for some time been concerned by the species preferential nature of HCD and its limited time frame of value (a lifetime or the short term quite often). Like design thinking, HCD is often presented as being neat - the messiness of lived realities and the complexity of design projects and problems often seem to be overridden or ignored in the accounts and evaluations. A new architectural build, with the redesign of services and models of care in the sensitive and sometimes emotionally strained environment of a psychiatric unit is a rich context to explore and consider the real challenges of design, even when done with the best of intentions. As we made our way through the study and the fieldwork documentation, design compromise, something that most designers wish to ignore seems to have become a valid and necessary way to understand the complex interplay between the various stakeholders (material and human) in the design of a facility for care.

Being a design researcher on this interdisciplinary team allowed me to bring to the study an awareness and empathy for the intentions of the architects and designers, as well as a peer informed critical eye for decisions and outcomes that were made in the course of the project. As a spatial designer I felt enabled to make material observations of space and the experience of it in a field informed way. I was able to contribute a methodological understanding to the design of the project, in conjunction with research context insider knowledge regarding the nature of the participant's practices and the material outcomes of these.

4. Findings

There have been many findings from this research collaboration in relation to the research focus and questions. These have been reported in a range of publications across representative discipline outlets. This has been possible because of the diversity of the team, our expertise, our openness to learning with and from each other, whilst maintaining integrity to the project intention and the participant contributions. An example of this are the research findings regarding the way staff experience and use space as being integral

to their ability to care. This use includes how they find rest and reprieve from daily work activities in the form of breaks. Our analysis of the participant data, and subsequent inclusion of this in the final research report, was published in a co-authored journal article Designing for Staff Breaks (Pink et. al 2020). The full report can be accessed at (https://www.monash.edu/__data/assets/pdf_file/0019/2090242/Report_080120.pdf). In this article our different perspectives came together to create an interdisciplinary understanding that would not have been impossible otherwise:

- Sarah: design anthropological interest in human creativity and improvisation to find ways of making the spaces they move through work for them
- Shanti: interest in spatiality as a geographer, to understand how people experience space and movement
- Melisa: interest in everyday design as a design research, looking at how people are continually designing the spaces they use daily.
- Laurene: interest in spatial design and how this is articulated through people's experience and construction of place.

These differing perspectives enabled the researchers to understand how people make, experience, and design spaces, in meaningful ways through their habitation of the new facilities and adaptation of them to their needs. Our differing disciplinary expertise frames enabled nuances of understanding to emerge and could challenge any disciplinary based assumptions from driving findings from the project.

5. Conclusion

The intersubjective nature of care demands that design research into the area draw on a range of perspectives, methodologies and knowledge traditions if we are to make meaningful contributions to people's experiences of care. We need to move beyond statements that such projects need to be inter or multidisciplinary, and make evident what this means in practice, what value does it really bring. We argue that this field demands disciplinary contributions if useful insights for future design applications are to emerge. In this project we have undertaken a design anthropology evaluation of a large -scale psychiatric development that was ambitious to challenge existing paradigms of care, through a transition process from one model of care to another. It is hoped that through this presentation of the four perspectives of the researchers involved in the Bendigo project, that we have been able to evidence the synergies and nuances of the various disciplinary domains and the ways that they have informed and framed the research that has been undertaken. The findings from this design anthropology have revealed significant and useful insights for Bendigo Hospital. The richness of the study and its potential for future application is, we would argue, the outcome of the robust methodology and the interdisciplinary team and the insights about the design of such project teams for future projects.

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A holistic outcome-based approach to co-create healthcare systems.

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Abstract: Healthcare needs to be delivered more holistically, in a way that addresses outcomes for different stakeholders at different levels. Systems thinking has conceptually helped the understanding of the increasing complexity of healthcare outcomes. However, little consideration has been given on how to practically apply this concept to holistic outcome understanding to (re)design healthcare systems. Therefore, this paper aims to develop and evaluate a holistic outcome-based approach to healthcare systems co-creation. Participatory mapping workshops and interviews to co-visualise outcomes as an interconnected system were conducted with two groups: twenty-three design practitioners/researchers and twenty-one patients and healthcare service providers. Results emerged from network analysis which identified critical outcomes, disagreements, gaps and opportunities for system (re)design. The results demonstrated the potential role that this approach could have in gathering, communicating and negotiating the complex needs of multiple stakeholders for healthcare system (re)design.

Keywords: systems thinking; participatory design; systems visualisations; healthcare outcomes

1. Introduction

The healthcare system faces enormous pressure to address complex needs with a holistic paradigm (Norris et al., 2019). Attempts to achieve this holistic vision have resulted in the inclusion of strategies beyond the traditional scope of healthcare, which include multiple stakeholders (Herbert & Best, 2011). Personalised care plans and community care are good examples of current areas aiming to deliver holistic care.

This expansion of strategies and stakeholders involved in healthcare has increased the complexity of outcomes that need to be addressed. Outcomes can include biometrics and meaningful aspects of life, such as wellbeing, but also broader parameters of integrated

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working and safety (de Silva, 2014). These outcomes bring new challenges for healthcare, which needs to account for all these aspects as a whole interrelated system.

Systems thinking is a suitable paradigm to tackle complex challenges in healthcare (Braithwaite et al., 2018; Wilkinson et al., 2018). Applying systems thinking in healthcare can increase the holistic understanding of the systems, challenge assumptions, embrace flexibility and adaptation, and promote leadership models to redistribute shared decision-making (Khan et al., 2018; Paina & Peters, 2012; Peters, 2014; The Health Foundation, 2011). Nevertheless, more is needed to embed the complex understanding of systems into practical applications in healthcare (Rusoja et al., 2018). Furthermore, there have been few empirical pieces of research which consider how an understanding of multiple outcomes can play a role in enhancing healthcare systems.

Some systems thinking frameworks have created synergies with design to mitigate those gaps (Holden et al., 2013; Jones, 2014; Read, Salmon, Goode, & Lenné, 2018). Design has contributed to more practical strategies for deeper engagement and collaboration with multiple stakeholders to co-produce interventions (Tsekleves & Cooper, 2017), and has refined visual strategies to manage and communicate complex messages (Sevaldson, 2018). Of note, the most effective systems thinking actionable strategies have been determined by iterative design processes of co-creation (Jones, 2014). Therefore, it seems appropriate to explore how a holistic understanding of outcomes can be translated into more actionable strategies for co-designing healthcare systems.

This paper aims to develop and evaluate a holistic outcome-based approach to healthcare system co-creation. The term “holistic outcome-based” refers to including a variety of meaningful outcomes for different stakeholders, mixing objective/subjective, self-reported, anecdotal, and quantitative/qualitative elements. Due to the still exploratory scope of this study, the “healthcare system” boundaries to apply this approach remain flexible. Chronic care services have been selected in this study because they demand the integration of different organisations and societal structures, expanding the range of outcomes and stakeholders involved. Finally, “co-creation” refers to the participation of different stakeholders in (re)designing the systems.

To achieve these aims, this paper presents a review of the concept and role of outcomes in healthcare, and how other approaches have supported their understanding and application. Then, the development process of the holistic outcome-based approach is presented; this development has followed the five steps of the Design Research Methodology (DRM) (Blessing & Chakrabarti, 2009). Next, the findings from using the new approach in two cases are presented. Finally, this paper discusses how the holistic outcome-based approach is a promising system thinking framework, which can be used to gather, communicate, and negotiate the complex/multiple needs of different stakeholders for healthcare system (re) design.

2. The role of outcomes in healthcare systems design

The concept of 'outcome' demands a reconceptualisation in order to integrate considerations from contemporary approaches and systems thinking perspectives (Paterson et al., 2009). Conventionally, an outcome is described as the result of a visible effect that is seen after some explicit action. In healthcare, an outcome is associated with quality, and it is generally expected to be positive. The actions needed to trigger an outcome are frequently known as interventions. (Davies & Crombie, 1997; Starfield, 2001). Therefore, providers 'prescribe' an intervention for achieving (positive) outcomes. Nevertheless, this concept of outcomes denotes a narrow and linear approach.

Although the inclusion of psychosocial dimensions and patient-reported outcomes (PRO) such as quality of life had generated a more robust approach in later years, outcomes emerge mostly from the provider's perspective. For example, PRO tend to be employed infrequently, even if they are a valid method for evaluating healthcare quality interventions and provide better information for policy decision-making (Black et al., 2016). Therefore, more qualitative or 'anecdotal' data is required to expand the type of evidence in healthcare. This evidence should consider a broader range of human attributes that can be translated into outcomes (Black et al., 2016; McConachie et al., 2018; Reuben & Tinetti, 2012). Healthcare studies have recognised that a broader range of outcomes that reflect meaningful human aspects beyond health settings and trial studies are needed (Lewis & Killaspy, 2014). Therefore, this holistic outcome-based approach champions for the integration of a rich mix of outcomes.

2.1 Outcomes in systems frameworks

A Although outcomes are common elements in healthcare and systems thinking approaches, they have received only minor attention in design literature. Existing research has highlighted the need to understand outcomes for developing better systems (Flemming, Booth, Garside, Tunçalp, & Noyes, 2019; Petticrew et al., 2019).

Cognitive Work Analysis (CWA) has provided a more protagonist role of outcomes. CWA proposes a means-ends structure to understand systems. The five-level structure is formed by purpose, outcomes, functions, processes, and objects (Naikar, 2017; Rasmussen et al., 1994); this structure helps to identify why and how something occurs. Also, CWA has created traceability from outcomes to the purpose and functions of the systems. However, the application of CWA to directly inform design requirements is scarce. A CWA design-oriented toolkit has been used satisfactorily in transport contexts (Read et al., 2018), but there is not yet the evidence in the healthcare context. Authors acknowledge that the toolkit still needs exploration to "generate designs for first-of-a-kind systems" (Read et al., 2018). Additionally, there is an opportunity to expand this toolkit with a specific tool to tackle the outcome level in-depth.

Outcomes are also part of well-known healthcare frameworks. The Systems Engineering Initiative for Patient Safety (SEIPS) configures healthcare into three major components: work system, processes, and outcomes (Holden et al., 2013). In SEIPS, outcomes are indicators

of performance that represent stakeholders' goals. Outcomes play the role of moderating the adaptation of the system through feedback loops. Identifying unanticipated, reactive and intermittent outcomes helps to adapt and reconfigure the system (Holden et al., 2013). SEIPS have refined the categorisation of outcomes through its three different versions. The latest SEIPS 3.0 (Carayon et al., 2020) employs patients, caregivers, clinicians, and health organisations as categories. Despite its benefits, the authors of SEIPS have pointed out that its descriptive scope does not provide critical elements for action, nor does it deliver multiple views of outcomes to provide a holistic perspective of adaptation. Consequently, they appeal for the development of supportive toolkits to implement the model in healthcare (Carayon et al., 2006; Holden et al., 2013). Another relevant framework in healthcare is the Quadruple Aim (Sikka et al., 2015) which emerged from the Triple Aim (Berwick et al., 2008). The aims of this approach are better health, better care, lower cost, and better staff experience. The Quadruple Aim strengthens the concept of goals as interdependent elements, and the function of integrated care. The Patient Priorities Care (PPC) framework helps patients to identify their priorities based on their outcome goals and their trade-offs (Feder et al., 2019). PPC defines a four-step process to help patients define their most desired outcomes based on their values (Naik et al., 2018). PPC has helped patients to understand outcomes, goals and objectives differently, resulting in better-integrated care.

Finally, Systemic Design has identified principles such as 'purpose finding' and 'idealisation' that are related to the role of outcomes. First, the purpose finding principle is an abstract function that defines the whole system (Jones, 2014). A well-defined purpose will help to guide and align actions. The purpose often gives rise to a series of ideals, goals and outcomes. The idealisation is the principle of identifying actions and conditions to achieve a desirable outcome (Jones, 2014). This principle turns Systemic Design processes into a more future-finding approach. Furthermore, Systemic Design has highlighted how stakeholders act based on individuals' concerns and their own values to achieve outcomes, rather than a shared understanding of collective discrepancies (Jones, 2014). Outcomes have not been explicitly revised by Systemic Design. Still, some systemic-oriented authors such as Dorst (2019) consider outcomes to be the result of a reasoning process (how) that connects elements of the world (what). Other authors suggest that outcomes are "a product"; hence, outcomes can be desired and sought (in purposeful systems). However, outcomes can be emergent and unintended. Jones (2014) also advised that "the four orders of design (communication, artefacts, services and complex systems) represent possible outcomes for designed functions".

In summary, these approaches have recognised how outcomes directly inform the purpose of the system and how outcomes foster adaptive system behaviour. However, those abstract functions have remained distant from more practical applications. An outcome-based approach could support early discussions/encounters with a variety of stakeholders. Those discussions will integrate an initial vision of the system that aligns the (re)designing and supports a holistic decision-making process.

3. Methodology

This research aims to develop and evaluate an approach to co-creating healthcare systems. The systematic Design Research Methodology (DRM) by Blessing and Chakrabarti (2009) was selected to address this aim. DRM is a suitable and rigorous framework with which to undertake empirical research. DRM has been widely adopted to develop, validate and introduce design supports (approaches, tools and methods, among others) (Eckert et al., 2003; Marxen & Albers, 2012). DRM has been proven to provide rigour to Design research; it is compatible with a Research through Design (RtD) approach (Godin & Zahedi, 2014) and has been adapted to embrace broader applied research agendas (Eckert et al., 2003) in complex systems (Hassannezhad et al., 2019).

DRM defines four stages for the research process in which a 'design support' is developed. A design support can have a tool, method or approach, among others. Depending upon the existing knowledge and how much is known of the phenomena, fewer stages could be required. DRM is flexible enough to incorporate different methods and facilitate iterative cycles of research. This paper presents the findings related to stages 2 and 3 of DRM (Figure 1). The following sections are focused on the five steps (task clarification, conceptualisation, elaboration, realisation, and evaluation) for developing the design support.

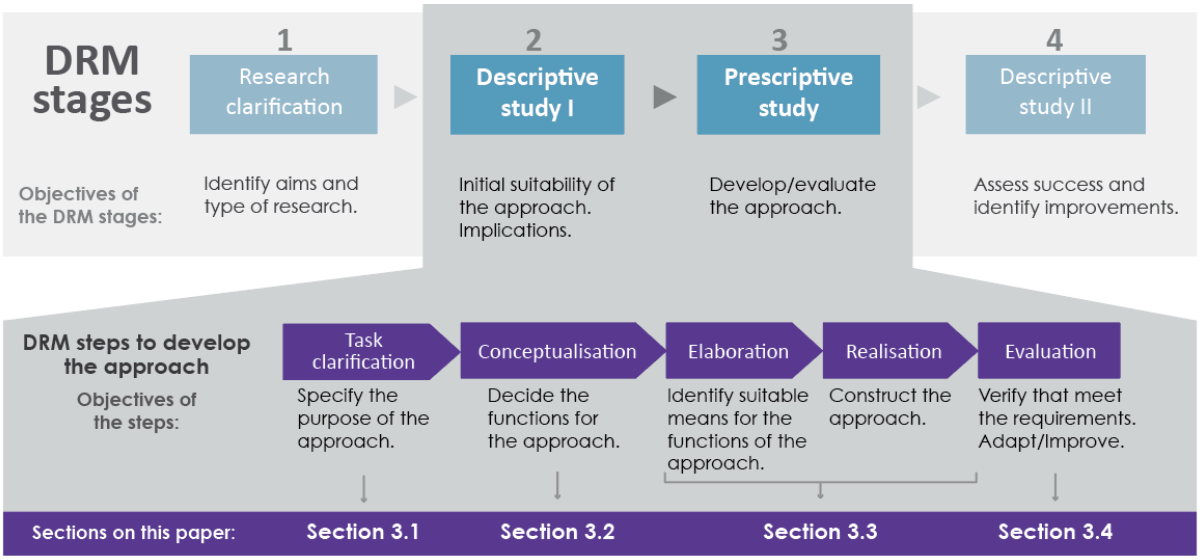

Figure 1 Overview of the DRM conducted to develop the holistic outcome-based approach.

3.1 Step one: task clarification

The design support of this study has the purpose of assisting healthcare stakeholders to co-create complex systems based on a holistic understanding of multiple healthcare outcomes. For this purpose, the holistic outcomes should include a variety of meaningful outcomes for different stakeholders at different levels; a mix of objective/subjective, self-reported, anecdotal and quantitative/qualitative is ideal.

During the research clarification stage (outside the scope of this paper), an initial list of outcomes (Table 1) was defined following a comprehensive literature review process (Arksey & O'Malley, 2005). The literature review was conducted by consulting three databases (Scopus, PubMed, and Science Direct) and three design journals (Design journal, Design Studies and International Journal of Design). Four original keywords and synonyms/variables were employed. Keyword 1: Healthcare (Healthcare, "health-care", "health care", health, {health management}, "good condition", healthiness, wellness, wellbeing, "well-being", wellbeing); keyword 2: Outcome (Outcome, "health metric*", "health effect", "health measure*"); keyword 3: long-term ("long-term", "chronic care", lifelong, "long future"; and keyword 4: chronic care ("Chronic condition" "chronic illness"). Based on the title and abstract, papers were selected for complete review. The inclusion criteria were met when studies explicitly listed outcomes, offered a conceptualisation/operationalisation of the outcomes, and were written in English. Grey literature was included as per recommendation. Outcomes were extracted from the selected studies until saturation was achieved (Saunders et al., 2018)on the basis of the data that have been collected or analysed hitherto, further data collection and/or analysis are unnecessary. However, there appears to be uncertainty as to how saturation should be conceptualized, and inconsistencies in its use. In this paper, we look to clarify the nature, purposes and uses of saturation, and in doing so add to theoretical debate on the role of saturation across different methodologies. We identify four distinct approaches to saturation, which differ in terms of the extent to which an inductive or a deductive logic is adopted, and the relative emphasis on data collection, data analysis, and theorizing. We explore the purposes saturation might serve in relation to these different approaches, and the implications for how and when saturation will be sought. In examining these issues, we highlight the uncertain logic underlying saturation—as essentially a predictive statement about the unobserved based on the observed, a judgement that, we argue, results in equivocation, and may in part explain the confusion surrounding its use. We conclude that saturation should be operationalized in a way that is consistent with the research question(s. Then, the list of outcomes was revised and clustered by the first author following a summative content analysis process (Hsieh & Shannon, 2005). Finally, the list was verified and refined by the rest of the authors.

Table 1 *List of outcomes.*

Category	*	The initial list of outcomes (Use 1- participatory)	Additions (Use 2-part.)	Current list (Use 3 one-to-one)
Psychosocial		Wellbeing, perceive-sickness, quality of life, satisfaction, crisis burden, social functioning, symptom fears, condition distress, happiness.	Dignity, Anxiety	Wellbeing, quality of life, fear of crisis, social functioning, fear of complications, condition distress, perceived health status, the economic burden of treatment, happiness, dignity and anxiety.
Behavioural		Self-efficacy, physical functioning, healthy diet, health literacy, physical activity, medical adherence, self-care activities, healthy lifestyle.	Personal resilience, independence, home care, independence	Self-care, physical functioning, health literacy, physical activity, medical adherence to treatment, healthy lifestyle, personal resilience, independence, home care and self-monitoring.
Comorbidities		Functional status, fatigue, depression, anxiety, fear of complications, cognitive functioning, survival.	Mental health, heart disease	Functional status, fatigue, depression, cognitive functioning, survival, sickness, mental health, long-term complications, memory problems.
Biometrics		Weight, blood pressure, cholesterol and others depending on the specific clinical condition, such as sugar levels, temperature, heart rate, among others.	Pain, work productivity, fatigue	Weight, blood pressure, cholesterol, pain, work productivity, and others depending on the specific clinical condition.
Quality of care (known as quality and cost in use 1)		Quality of care, health benefits, trust in the physician, satisfaction with treatment, physician cultural competency, time of discharge, safety attitudes (safety climate, teamwork, perception of facilities)	Integrated services, length of stay, personalised care plans	Quality of care, trust in the physician, patient satisfaction, length of stay, safety culture, adherence to clinical guidelines, personalised care plans and integrated working.
Institutional (known as quality and cost in use 1)		Cost, mortality, patients increase, emergency admissions, medical resource use, survival. Adherence to long-term therapies, refill adherence, hospitalisation.	Risks, admissions, attend appointment, money by patient, use of community services.	Healthcare cost, hospitalisation, access to care, attend appointments, money by patient, readmissions, crisis, use of community services, financial barriers.

*Colour code assigned to the category

Outcomes were considered equally important. However, their relevance was granted after the group discussion and researcher reflexivity of the results. Table 1 shows the evolution of the outcomesw during the development of this approach.

3.2 Step two: conceptualisation

This step aims to define the functions of the design support. Four main functions were defined: providing a shared language; identifying disagreement; developing a balanced understanding; and making holistic decisions.

- Providing a shared language: the design support should help to build a shared language among the stakeholders. This means explicitly establishing what the outcomes mean in different contexts.
- Identifying disagreement: the design support helps stakeholders to advocate for their outcomes and concerns despite disagreements with other participants. A deep understanding of different perspectives is the goal of this function.
- Developing a balanced understanding: the design support acknowledges the diversity of critical outcomes and how a common path for action may emerge from the result of interrelated outcomes. This approach does not look for a consensus; instead, it aims to build a shared and balanced understanding of outcomes.
- Making holistic decisions: the design support helps to make decisions based on a whole-system judgement. This function recognises that outcomes are the result of complex interactions. Therefore, all the possibilities, interdependencies and unintended consequences of outcomes need to be explicitly communicated to inform decisions (Paina & Peters, 2012)efforts to scale up health services in developing countries are falling short of the expectations of the Millennium Development Goals. Arguing that the dominant assumptions for scaling up are inadequate, we propose that interpreting change in health systems through the lens of complex adaptive systems (CAS.

It is expected that the design support will take the role of a dialectical device, to assist participants when discussing the meaning of outcomes and negotiating trade-offs. These functions should cultivate ongoing sense-making about outcome interrelationships and support the collaborative system development.

3.3 Steps three and four: elaboration and realisation

The elaboration step aims to identify the means to develop the functions. The realisation step seeks to build those means. Therefore, these steps are presented together to communicate the means better.

A participatory open mapping strategy was selected to gather a complex understanding of outcomes from multiple stakeholders. Mapping strategies refer to a graphical way of modelling how systems are perceived. A designerly approach to mapping aims to create an

open space to generate visions towards design action and intervention (Sevaldson, 2013). Mapping strategies provide flexibility for the participants to construct their configuration of the outcome interrelationships. However, outcome representations assist participants to focus their mapping on the same systems attribute. This bespoke mapping process is called outcome-based mapping.

In this approach, the output of the mapping process is called outcome-based system visualisations. These visualisations act as the primary device for documenting discussions and data collection. System visualisations have been recognised in the literature as a suitable strategy to help participants understand complex systems. Systems visualisations have been a common strategy in systems thinking methods to address the discussion of complex topics (Comi et al., 2014; Crilly et al., 2006). Also, systems visualisations have facilitated sensemaking from interdisciplinary perspectives (Holden et al., 2013; Peter & Bowes, 2016; Read et al., 2015).

Different representations of outcomes support the functions of the approach. Outcome cards (Figure 2) were created to increase the health literacy of the participants, to facilitate the group discussions, and to test strategies like “outcomes champions”. The cards consisted of two-sided 105x148 mm rectangles. On the front: the name of the outcome; on the back: a neutral description of the outcome, monitoring tools and the frequency of the monitoring. A feedback space was included to gather contributions from the participants.

Also, the representations of outcomes took the form of tokens and stickers (Figure 3). These elements encourage participants to interact, move and integrate the outcomes on different surfaces, such as magnetic boards and paper.

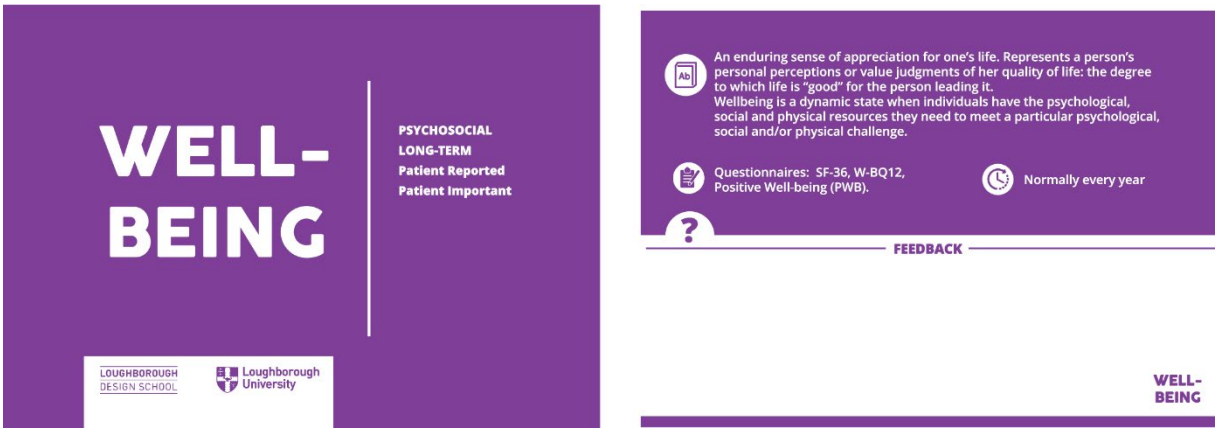

Figure 2 Example of an outcome card (front and back).

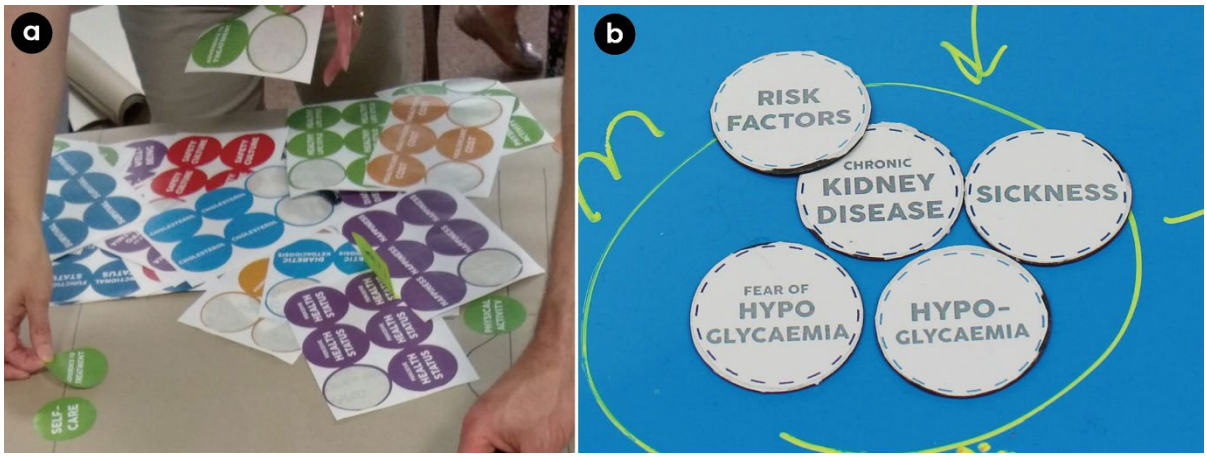

Figure 3 Example of means and materials: A) outcome stickers and B) outcome tokens.

3.4 Step five: evaluation

This step aims to evaluate the completeness and consistency of the approach (Blessing & Chakrabarti, 2009, p 80). This is an iterative step that takes place throughout the prescriptive study stage that helps to improve the approach. This step is part of the development of the support, and it should not be considered its final assessment.

Two cases were conducted for the evaluation step. The first case describes the use of the design support in participatory sessions and has already been published (Landa-Avila et al., 2018). The second case is a one-to-one implementation with patients and healthcare providers. A summary of both cases is presented in Table 2.

A non-probabilistic convenience sample was implemented to recruit participants to the participatory sessions. Twenty-five spaces for the participatory session were advertised at an international Design conference (DRS2018). Information about the session was published on the conference website to gain the interest of the target participants. Twenty-three design practitioners/researchers attended the session. Teams were created randomly, allocating four or five participants to each. For the second participatory session, human factor students of a master's degree programme in the UK were reached to participate in the session.

Table 2 Cases performed as part of the evaluation step.

	Participatory sessions		**One-to-one sessions**	
Participants	23 design practitioners and researchers.	10 human factor postgraduate students	10 patients with chronic conditions.	11 healthcare providers.
Sampling	Non-probabilistic sample.			
	Convenience International Design Conference	Convenience	Purposive	Purposive/ Snowball
Process	Figure 4a		Figure 4b	

Materials	Outcome cards Outcome stickers A0 blank paper Feedback forms	Outcome cards Stakeholder cards Outcome stickers A0 blank paper Means-ends template Feedback forms	Outcome tokens Blank tokens 40x40cm magnetic board Visualisation examples
Outputs	23 individual outcome-based visualisations 5 team outcome-based visualisations (Figure 5a) 5 narratives of the visualisations	2 outcome-based system visualisations 2 means-ends structures 2 narratives of the visualisations	21 individual outcome-based visualisations (Figure 5b) 21 transcripts of the whole session.
	Researcher observations Reflectional memos		
Data analysis for system visualisations	Frequencies of outcomes included. Identification of dominant visual structure. Frequencies of group labels. Visual frequencies of graphic patterns. (Table 3)		Network analysis using Gephi software (Figure 6). Criteria for the network analysis: Each outcome is a node. Each link is an undirected edge with a weight of 2. Each arrow is a directed edge with a weight of 2. Outcomes within a group are undirected edge with a weight of 1.
Data analysis for transcripts	Open thematic analysis following an inductive and critical realist perspective. nVivo software for thematic analysis.		Deductive content analysis. Unconstrained matrix with categories such as purpose, goal, outcome definition, outcomes (from the network), values, system awareness, system tools, follow-up process and usability.
Communication of results (visualisations)	Table with graphic structures Percentage of outcomes used.		2 outcome-based network visualisations, one for patients and one for providers. 1 visualisation that compares key outcomes between patients and providers.
Communication of results (transcripts)	Themes and comments from participants.		Themes with comments from participants.

Participants of the individual sessions were recruited using a purposive sample to ensure representativity. The patient group was invited through social media and posters in community centres and schools. After contact, the inclusion criteria assessment helped to decide the inclusion of the participants. The providers' group was invited to participate via email. Public profiles of healthcare websites (leicestercityccg.nhs.uk/, nottinghamcity.nhs.uk/, bettercareleicester.nhs.uk/) were scanned to create a list of potential participants. Criteria included having experience in coordinating an integrated healthcare project and being involved in the engagement process. Previous participants referred some participants to this group. The patient group included ten people living with conditions such as: (n=2) diabetes, and (n=1 for each of the following) fibromyalgia, postural orthostatic tachycardia syndrome, leukaemia, psoriasis, sarcoidosis, polycystic kidney disease, rosacea, and myotonic dystrophy. Age range was from 24 to 89 (average of 51.6). The providers' group included (n=6) senior managers, (n=2) commissioners and (n=3) local authorities.

The mapping processes were adapted to facilitate an open mapping strategy (Figure 4). Outcomes were presented during the introduction of the approach. Individual visualisations were implemented in participatory sessions to ensure that all participants' voices were included and to foster confidence in the mapping. Narratives of the visualisations were essential to clarify the visualisations and support their analysis.

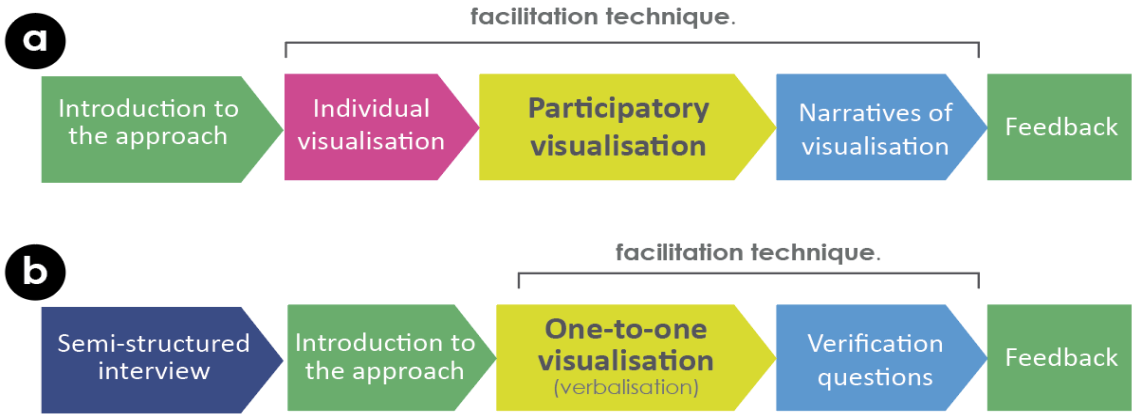

Figure 4 Processes followed during a) participatory sessions and b) one-to-one sessions.

4. Results and findings from the evaluation step

Results and findings from the evaluation step are presented in three sections. The first section is about the outcome-based mapping; then, communication outcomes interrelationships are presented; and finally, the analysis of the narratives.

4.1 Outcome-based mapping

The output from the mapping sessions consisted of outcome-based system visualisations (Figure 5). These system visualisations demonstrate how outcome-based mapping can be a consistent mean to discuss and collect outcome interrelationships.

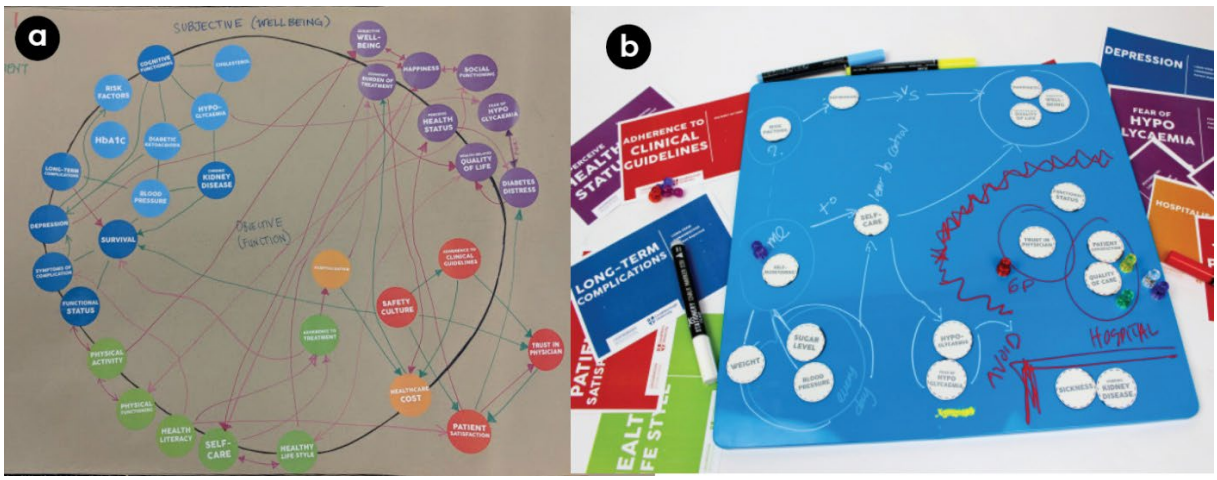

Figure 5 Output from a) participatory sessions and b) one-to-one sessions.

The outcome-based visualisations also documented how participants built and adapted their outcome priorities. When participants created different arrangements and allocations of outcomes, they were shaping and negotiating their decisions.

Participants expressed that outcome-based mapping offered enough flexibility to express complex needs. Patients and providers engaged and performed well with the activity, even if they did not receive/have graphic training. Surprisingly, designers demonstrated confusion when the activity was explained. Designers commented that clearer and narrower instructions were needed. Some designers proposed to frame the activity inside a problem-solving exercise.

4.2 Communication of outcome interrelationships

Table 3 shows what percentage of outcome cards was used by each group during the participatory sessions with designers. This table illustrates the first analysis proposal for the outcome-based visualisations and is aimed to identified the most integrated outcomes into the system visualisations. Also, the outcome categories analysis aimed to reflect how participants made sense of outcomes and assigned their labels to the groups.

Table 3 Analysis of team visualisations from participatory sessions with designers.

Group	Outcomes categories	1. Quality and cost	2. Comorbidities	3. Clinical	4. Behavioural	5. Psychosocial
A	Patient and non-patient Objective and subjective	100%	100%	100%	100%	100%
B	Disease, patient and healthcare system	100%	100%	100%	100%	100%
C	No categories created	66%	14%	50%	83%	75%
D	Pre-diabetes, diagnosis and treatment	50%	100%	83%	100%	100%
E	Out of control, in control and monitored	83%	86%	100%	100%	100%
Overall percentages		80%	80%	87%	97%	95%

Due to the descriptive scope of the analysis presented in Table 3, a different analysis was conducted for the one-to-one sessions. The network analysis allowed the synthesis of the individual visualisations into two main visualisations (Figure 6). Network analysis is the process by which to model systems using two essential elements such as nodes and links (Havlin et al., 2012). Studies have used network analysis in healthcare systems for different and new purposes (Benhiba et al., 2017)social networks and the internet of things permeated our daily life; a new perspective for understanding the complexity of our interconnectedness has become necessary. One approach that has predominantly proven useful in discovering hidden relationships, connections and trends of complex systems through mathematical and graphical techniques is Social Network Analysis (SNA, such as the analysis of pathways (Kohler & Ercole, 2020). These new studies have assigned to different system elements the role of nodes and links. This research considered each outcome as a node, and the links were created based on participant structures (see Table 2 for details). Gephi software (Bastian et al., 2009) was used to perform the network analysis.

In this study, network analysis synthesises outcome-based system visualisations without oversimplifying the richness of the data collection. The two outcome-based network visualisations enable the communication of outcomes as interrelated elements. Also, network analysis supports the recognition of critical outcomes by identifying measures such as degree (outcomes with direct influence on others), closeness (outcome closest to all outcomes), and betweenness centrality (outcomes that act as a bridge and connect distant outcomes).

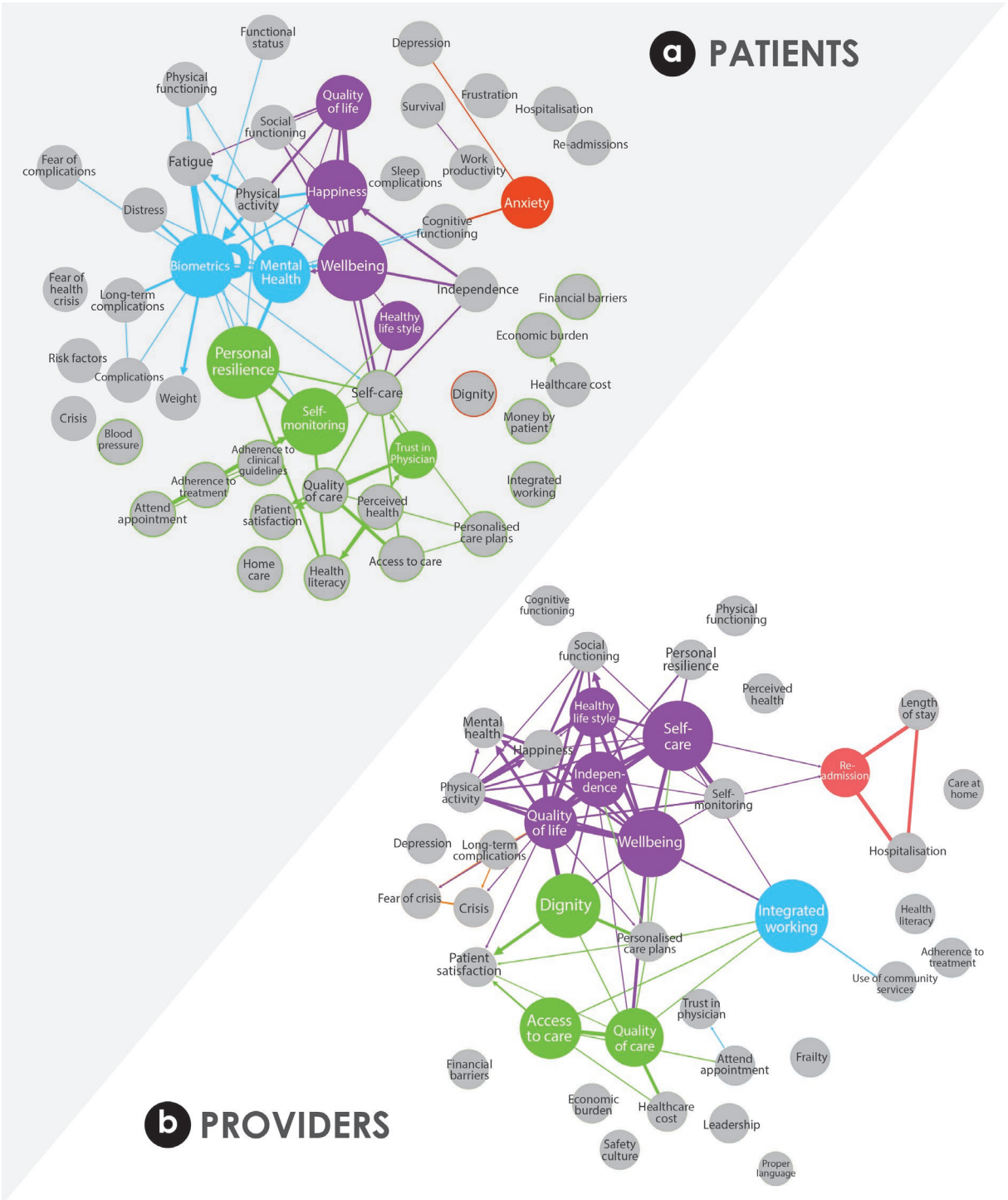

Figure 6 The two outcome-based system visualisations from the one-to-one sessions.

In this case, patients prioritised outcomes such as resilience, self-monitoring and anxiety; whilst providers prioritised integrated working, self-care and dignity. Both groups agreed about the importance of wellbeing and quality of life. Nevertheless, the network analysis provided new categories of outcomes (communities). The colour code in Figure 6 shows

how outcomes grouped differently from Table 1. Therefore, network analysis is envisioned as a suitable analysis of the holistic outcome-based visualisation approach. Network analysis helps to maintain a powerful graphic representation that communicates the complex interrelations among outcomes. Also, the final system visualisations guided the content analysis of the interviews.

4.3 Analysis of narratives

Three main themes emerged from the narratives of the participatory sessions (Table 4).

Table 4 Thematic analysis from participatory sessions.

Theme	**Comments from participants**
How should the outcomes be used?	Outcomes should be continuously monitored rather than discussed once upfront.
	Psychosocial outcomes should be considered as long-term.
	Health status, happiness, cost and efficiencies were the most mentioned outcomes.
What did graphics represent?	A circle was used to represent a continuous and organic process.
	Lines were used to segregate outcomes.
Timelines were considered easy to use, but unhelpful in communicating complexity.	
	Graphics should look messy to represent complexity.
How can visualisations be used in practice?	Visualisations are a great and simple tool (for designers) to identify correlations and improvement areas.
	Visualisations can help to solve conflicts between patients and providers.

A content analysis was conducted following a deductive approach for the one-to-one sessions (Elo & Kyngäs, 2008). Four main categories emerged (Table 5).

Table 5 Categories which emerged from one-to-one sessions

Category	**Insights from participants**
Outcomes to reconfigure systems comprehensively.	Useful to monitor what is shifting or constant.
	Useful to assess that our (providers') outcomes meet the patient's needs.
Challenge assumptions and trigger *conflict*-based conversations.	Useful to identify discrepancies in outcome priorities and reflect about what (and why) it means that.
	Useful to bring conflicting/hard-to-address outcomes and mitigate the vandalisation of data.

Systems thinking literacy.	We need to identify connections and look at the whole process, rather than pieces of service.
	To see how things connect and can cause others is useful to evaluate my decisions.
Usability – Prioritisation.	Potential misinterpretation if the people did not draw the diagram.
	It is harder to choose a priority once we visualise the connections.

5. Discussion of findings

This paper describes the development process of a holistic outcome-based approach to understanding multiple outcomes for co-designing healthcare systems. Findings from this development process show how outcome-based mapping can build mutual understanding and assist discussion amongst different stakeholders. The network analysis is a promising structured graphic analysis that helps to identify critical outcomes and spot agreements and disagreements amongst different stakeholders. This understanding can support negation of conflict priorities to facilitate the (re)design of healthcare systems.

5.1 Strengths and considerations for the holistic outcome-based approach

The role of outcomes

Outcomes are the key element of this approach; nonetheless, outcomes are not considered the most critical element of healthcare systems. Outcomes need to be understood as key drivers in creating a shared understanding of other people's meaningful needs. Patients and providers understood this role for outcomes more clearly during the sessions. Both sets of participants were confident in selecting their own needs and in using outcome interactions to represent their vision of the system. Also, participants recognised that other stakeholders might prioritise outcomes differently and, therefore, that certain key priorities within healthcare systems require a deeper understanding of how multiple outcomes interact.

This practical approach towards outcomes can help to expand system thinking models such as SEIPS and CWA. SEIPS 2.0 categorises outcomes as un/anticipated, short/long term, and intermittent or constant (Holden et al., 2013). Although this categorisation seems a sensible proposal, participants of the above cases created different categories to work with outcomes. Thus, open outcome-based strategies could be more beneficial to '(re)develop' systems. CWA has exposed how outcomes keep a relationship with other elements of the system, but it is more prescriptive about how to collect those relationships. During the mapping sessions above, participants organically created relationships among outcomes and diversity of system elements. The outcome-based approach provides a more naturalistic/logical way in which information can be collated. Nevertheless, the CWA structure could be useful for researchers to conduct further outcome analysis.

Surprisingly, designers were more cautious and struggled to use outcomes for creating a complex representation of systems. Outcomes are less represented in design theory; therefore, less 'practical experience' was expected from the design community. Thus, an

outcome-based approach should be explicit in conceptualising the role of outcomes for design practitioners. A primary concern is that outcome-based system visualisations may be understood as the 'expected result' from a design intervention. This approach does not attempt to be a foresight method, but rather a dialogical device for sense-making and reflection towards a systems thinking oriented process of change. Then, the understanding of multiple outcomes can be embedded in the design development process as a dynamic element supporting new/desired skills of designers to interpret a complex system situation (Dorst, 2019)complex and increasingly networked, many have turned to design thinking as a way to obtain solutions and achieve innovation. In this article, I will focus on the question of whether the current design paradigm is capable of delivering on these expectations, or whether design is overextended when dealing with areas of great complexity, such as in the social realm. The fact that at its core, design reasoning or design abduction requires the consideration of two unknowns more or less simultaneously (the "what" and the "how".

Nevertheless, these findings are not conclusive in defining whether this approach can be relevant to all levels of healthcare systems. These cases were contextualised within chronic care services (Meso level) in an attempt to include a variety of stakeholders and societal structures. Senior managers and patients coped well using this approach in this level of the system. Participants mentioned potential uses in one-to-one counselling, as well as in the development of pathways. However, further research could explore different scenarios of use to define whether this can be used in micro as well as macro contexts.

Lastly, the outcome list provided (Table 1) should not be considered as fixed. Although the list was a product of reviews and practical applications, different contexts, times and situations could require adaptations. During the one-to-one sessions, patients and providers added 'new outcomes' (e.g. mobility, civility) that probably fall outside of a traditional/ narrower definition of outcome. This agrees with literature urging the differentiation of related concepts such as outcomes, needs, goals and values; although, it might be the case that all applications are correct (Naikar et al., 2005, p 25). Due to the exploratory scope of this study, all 'new outcomes' were included in the study analysis; however, this approach should define/justify the degree of flexibility regarding the definition of outcomes. Also, this outcome-based approach can benefit from integrating values, as has been done in PPC (Naik et al., 2018).

Pedagogy of systems thinking

There is a small, but growing, literature base regarding how we teach/introduce systems thinking approaches. The findings presented agree with the valuable use of visual strategies to understand/work in complex systems (Jones & Bowes, 2017; Jun, Kim, & Lee, 2011). All participants increased their systems thinking jargon and awareness. It will be an ethical responsibility of the outcome-based approach to offer a formal introduction to systems thinking, in order to facilitate engagement with the approach in the long-term. Also, this formal introduction could diminish the risk of misapplying the complex system paradigm. Concepts such as (new) systems, problem, intervention and process of change can conflict

with some design conventions.

The role of stakeholders as co-creators of systems demands more study. Whilst designers showed confidence in performing a 'visual' strategy, patients and providers could recall experiences and build richer maps even without graphic training. This posed questions about the concept of a designer of complex systems. Systemic design literature has provided knowledge about designers as systems thinkers/facilitators and how stakeholders become the system designers (Jones, 2018). Still, these new roles need to be enforced/positioned by new system thinking approaches.

Negotiation

This approach triggered 'conflict-based' discussions that can be a powerful strategy to build meaningful relationships between stakeholders. Conflicts do not necessarily imply negative results or power fights. Conflict-based discussions could challenge assumptions and increase the understanding of what others perceive as important. Participants manifested that outcome-based visualisations can be a suitable way to visualise discrepancies and think critically about priorities. Then, participants can make a shared decision based on a 'more comprehensive vision' of the system. This agrees with Paina and Peters (2012)efforts to scale up health services in developing countries are falling short of the expectations of the Millennium Development Goals. Arguing that the dominant assumptions for scaling up are inadequate, we propose that interpreting change in health systems through the lens of complex adaptive systems (CAS, who identified that a comprehensive visualisation of interdependencies and unintended consequences lead to making better decisions.

Despite the benefits, healthcare providers were the least keen to recommended mixing stakeholders from different groups to build the system visualisations. Instead, providers proposed to gather visualisations from different groups and compare them later. Although such an isolated application of the method would not provoke as a rich a discussion, it is not entirely discarded as a strategy to cope with resistance to the use of this approach in participatory settings.

5.2 Interdisciplinarity, challenges for design, healthcare and systems thinking

There are challenges to expanding the synergy between systems thinking and design into developing healthcare systems. Healthcare providers manifested that more practical resources are needed to hold meaningful encounters with different stakeholders before starting an intervention. This 'starting point' goes beyond initial steps in well-known design models such as the double diamond (Design Council, 2019) or the fuzzy front-end (Sanders & Stappers, 2008). This 'starting point' is an ongoing need to comprehend healthcare systems. Systems thinking has put more emphasis on 'grasping systems' as a constant learning action, rather than just a practical acute application (Swanson et al., 2012). Hence, design has the challenge and opportunity to reconfigure its process as a cyclical learning intervention.

The experiences of using the outcome-based approach with designers highlighted the

prevalent paradigm of problem-solving. Design should address ill-defined circumstances in healthcare that are not typically understood as problems. Healthcare systems face dynamic states over time looking for improvements/changes (Braithwaite et al., 2018). A whole picture of the system situation is needed if designers aim to intervene in the system (Ulrich, 1988) and tackle the problem situation (Checkland, 2000). Then, designers should be consciously aware that defining a problem should be translated into defining/understanding complex situations and wicked problems when working in systems. As pointed out by Jones (2014), systems thinking and design need to renegotiate how they formulate 'problems', otherwise their collaboration will be superficial. Therefore, designers should have the ability to repeatedly frame complex problems instead of solving problems (Dorst, 2019). Also, designers need to be aware that complex systems are continuously/dynamically redesigned. Hence, any attempt to design a completely new system is 'not possible'.

These results support the need for systems thinking to clarify its meaning and concepts within the healthcare sector (Plack et al., 2018; Rusoja et al., 2018). By the end of the sessions, participants were more aware of complex systems attributes, such as interconnection and feedback loops. However, training participants in systems thinking was beyond the scope of the approach. A robust bespoke approach for healthcare could offer support to introduce system thinking to participants; nevertheless, the recognised lack of consistency of the "system thinking" concept makes this task more challenging.

Finally, healthcare evaluation/monitoring needs to expand its sources of data/evidence. Patients demand more comprehensive monitoring; similarly, providers want to increase the diversity of evidence which inform decisions. In the cases described in this paper, it was encouraging to see how positively the healthcare providers reacted to how the data was collected and presented. Therefore, designerly ways of constructing evidence with outcome-based visualisations should be explored further.

5.3 Limitations and future work

First, the findings presented correspond only to stages 2 and 3 of the DRM. Stage 4 will expand the knowledge about the practical implications of this approach in design practice, and to what extent it can inform other well-known design methods. Furthermore, it is recognised that larger action-based applications are needed to assess the impact of this approach. In addition, this study has been limited by the opportunities to implement the method with heterogeneous groups, as the participatory sessions were conducted with participants of similar backgrounds. The participatory sessions have been conducted with participants of similar backgrounds. Although it is recognised that disagreements can arise in this context, further research with heterogeneous groups could explore negotiation in detail. Finally, the role of the facilitator needs to be mitigated. Participants mentioned that the method was easy to understand. However, it should be further reviewed on how this method is conducted by different facilitators.

6. Conclusions

This paper presents the development and application of an outcome-based approach to co-creating healthcare systems. This approach has been used with design practitioners and researchers, patients with chronic conditions, and different healthcare providers such as senior managers and local authorities. The findings recognise that the outcome-based visualisations create a shared understanding of the interrelated outcomes that support the identification of agreements and disagreements for co-(re)designing healthcare systems.

The findings of this paper contribute to reconceptualising and strengthening the value of healthcare outcomes for different stakeholders. Outcomes are an underappreciated element in the design process, and despite having a more critical role in healthcare, there are few deep reflections about them in either area. However, outcomes can help to identify well-rooted disagreements and (re)define a holistic system purpose. This paper acknowledges that a holistic perspective should include a variety of outcomes, such as: subjective/objective, patient-reported, clinical-experienced, qualitative/quantitative, and anecdotal, from different stakeholders at different levels (from micro to macro). Also, it recognises that related concepts such as values and goals need to be formally integrated/defined in this approach to avoid being misunderstood.

Outcomes can be design drivers, that provide a more holistic vision of the interrelated needs of different stakeholders. Also, this method can support designers in becoming problem framers of ill-defined healthcare situations. Outcomes should be embedded in planning/develop as dynamic/proactive elements. As dynamic elements of the systems, outcomes have complex relationships, interact with other outcomes, and are sometimes unexpected/emergent. Further studies could explore how emergent outcomes can expand how success and failure concepts are employed in healthcare.

These findings can have an impact on the dissemination of complex systems in both design and healthcare. This approach provides new resources for practitioners and providers to engage in complex conversations, build common ground, and contribute to depicting a *whole picture* of healthcare to make shared decisions. Also, this holistic outcome-based approach can expand other well-known systems development frameworks/approaches such as SEIPS and CWA; it also can strengthen systems thinking methods for healthcare design.

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Photo Narrative: Co-Designing a Built Environment with Seniors with Mild Cognitive Impairments

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Abstract: In this paper, we introduce "Photo Narrative," a novel co-design method tailored to actively engage seniors with mild cognitive impairment (MCI) and their care partners in envisioning and creating a future therapeutic program and built environment. The co-design toolkit addresses the complexity of designing for MCI patients by supporting multidimensional forms of expression and facilitates exploration of various literal and emotional aspects of designing for "healthcare" environments, including type of space, level of interaction in, and look and feel of the built environment. We also introduce and describe a comprehensive data analysis technique, which speaks to the need for and value of interpretations of rich co-design workshop data into insightful design requirements and recommendations.

Keywords: co-design; design method; built environment; mild cognitive impairment (mci); empowerment.

1. Introduction

Co-design enables users to make positive contributions in design by engaging in formulating and solving a problem. Sanders used the term co-design to refer to the "creativity of designers and people not trained in design working together in the design development process" (Sanders & Stappers, 2008, p.2). Nevertheless, the process of engaging users in the design process can be challenging due to the different skills and comprehension levels of participants. This can become an even bigger challenge when involving older adults in the design of new environments or technologies (Newell, 2011). Several attempts have been made in the past by researchers who were working with older people (Hees et al., 2019; Lindsay et al., 2012; Leong & Robertson, 2016; Robertson et al., 2014; Vines et al., 2012); however, many traditional co-design toolkits are too demanding for this population, and their unique needs cannot be fully catered to using conventional research methods.

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Older people find it difficult to conduct creative thinking activities (Otjacques et al., 2010) and so feel uncomfortable when they are asked to draw, sketch, or comment on design-related issues (Mitchell & Nørgaard, 2011; Rice & Carmichael, 2011; Uzor, Baillie, & Skelton, 2012). Moreover, seniors may have limited motor functions in the movement and coordination of hands and arms, which restricts their interactions and engagements with tangible artifacts. So, participatory toolkits and activities that require making and interacting with tangible artifacts (Sanders et al., 2008) should be attentively designed or appropriated for this population. These challenges can be even greater and promptness to respond may be lowered when cognitively impaired elders become part of the design team.

Many well-established co-design techniques require certain levels of communication, abstraction, conceptualization, or creative thinking of the participants (Lazar, Feng, & Hochheiser, 2010; Lindsay, et al., 2012; Muller, 2003). As such, there is a need to adjust these methods when working with seniors with cognitive impairments, and researchers need to develop, adapt, and tailor highly individualized co-design approaches and methods to work with this specific user population (Hendriks et al., 2014).

This paper explores the challenges of co-designing with a unique population: older adults living with mild cognitive impairments (MCI). People with MCI are more likely to engage in cognitively demanding activities as compared to elders with dementia; therefore, they may be able to contribute more in co-design practices than is suggested in some previous literature on co-design with people with dementia cited above (Hendriks et al., 2014; Lindsay et al., 2012). There is a literature gap in understanding how people with MCI can be engaged with co-design processes, and to what extent they are able to participate meaningfully. There is also work to be done in understanding which types of techniques, tools, and/or materials can best support their engagement in co-design activities.

To that end, this paper is aimed at introducing and discussing the use of the "Photo Narrative," technique with people with MCI. "Photo Narrative" is a co-design method adapted by this research team to actively engage seniors with MCI and their care partners in envisioning and creating a future therapeutic program and built environment through visually enriched activities. In a series of co-design workshops, we engaged seniors with MCI and their care partners in envisioning and creating a healthcare center for behavioral interventions and education. This program and facility is part of an extensive project that is positioned to explore new models of treatment for MCI and prevention of decline by involving behavioral therapy, technology, and the built environment.

Our main intention is to report and reflect on the application of the method and its associated benefits in designing a complex health-related environment with vulnerable populations (in particular people with MCI) and how such a method facilitates capturing participants opinions, perceptions, and insights, and elaborates on the key factors that led to creating a common ground and shared understanding among the collaborators. Our data analysis method, which we will also discuss herein this paper, enabled us to interpret visual data to generate insightful information and design requirements for the architectural team

to consume; this section speaks to the lack of literature and need for research on the notion of analyzing rich visual-tactile data, one of the major research gaps in the co-design field (Bossen et al., 2016).

2. Related Works

2.1 Co-Designing Public Places and Built Environments

Co-design and its applications have received increased attention in recent architecture literature--in particular, placemaking and community-building (Kuiper, 2007). Design for public interest applies co-design approaches as a means to reshape conventional modern architectural practice: in structuring design around the needs of a community and allowing individuals to have a say in the design of their own built environment (Feldman et al., 2018).

Additionally, there has been increased interest in exploring new ways of designing complex spaces. New strategies have been explored and efforts made to elicit the subjective qualities of people's experiences of and relationships with public place by involving participants in sequentially exploring topics, such as their memories, sensations, sense of place, and stories (Wakkary et al., 2014). The notion of involving "users as partners" (as opposed to subjects) became a preferable approach in co-designing healthcare environments: for example, with nurses involved in co-designing an ideal future patient room or co-creating a concept for ideal workflow on a patient floor (Sanders & Stappers, 2008).

In a more recent attempt, Reay et al. (2017) involved designers, students, patients, and hospital staff in co-designing a hospital space through collaborative prototyping. Another study, Herriott (2018), shed new insight on designing hospitals and made recommendations for changing the design approach to user participation in larger architectural projects. Ludden et al. (2019) proposed technology-enhanced design interventions in built-environments that reduced restlessness behavior and provided meaningful sensory experiences for people with dementia. Jakob & Collier (2017) explored the role of textiles in facilitating multi-sensory enriched environments and meaningful occupation for people living with dementia living in care-homes. While the notion of co-design in built environments and public places is well-studied, people with cognitive impairments were rarely involved in co-design processes.

2.2 Co-Designing with Individuals with Cognitive Impairments

Recent literature on co-design examined approaches and guidelines for designing with users living with cognitive or sensory impairments. While some studies involved only proxies (care givers) as informants, Brereton et al. (2015) highlighted that involving proxies alone is insufficient in co-design because the self-expression of the person with cognitive impairment is crucial, as care partners and family members may provide biased information. To allow actual user participation, researchers attempted to use tailor-made co-design techniques, which include complex tasks such as prototyping. As an example, following "design after

design" by Ehn (2008), a new participatory approach was introduced to inform design choices through simple and functional prototypes. In a similar effort, Wilson et al. (2015) suggested using high-fidelity prototypes (as opposed to the commonly used low-fidelity prototypes) to elicit more insightful feedback from users.

Even though attempts have been made to find universal ways of interacting with patients with cognitive impairments, researchers found it impractical to create generalized co-design methods that work for all and suggested tailored activities to engage participants with varied types of impairments in co-design. Gaudion et al. (2015) advocated a bottom-up phenomenological approach that evolved throughout the study. They started by understanding autistic adults' daily life experiences to inform creating meaningful co-design activities. As a result, the design was not driven by preselected, autism-friendly methods, but built using a progressive approach that enabled researchers to understand users' preferred activities with everyday objects and props. Hendriks et al. (2015) further explored the feasibility of creating generalized and highly personalized co-design approaches for people living with cognitive or sensory impairments (CSI). They suggested a new tradition of sharing experiences in order for researchers and designers to learn from each other in the form of method stories. Following the path of tailoring co-design methods, Branco et al. (2017) introduced a personalized approach that drew upon person-centered dementia care values and contributed to the uniqueness and personhood of people with dementia through exercises that enabled them to select content and co-design artifacts, simultaneously allowing family members to be involved in the group activities.

Winton and Rodgers (2019) adopted "designed with me," a collaborative approach to produce a series of textiles and products, where inputs from people living with dementia were highly valued in the same esteem as other collaborators (their carers and dementia support workers). Rajapakse et al. (2019) suggested using "respectful design," an approach to work with people with cognitive or sensory impairments (CSI) that emphasizes mutual learning, self-expression, and self-determination, which enables participants to express their insights to the design team. Treadaway et al. (2019) introduced "compassionate design," an empathic participatory approach to design a collection of playful objects to support the wellbeing (happiness) of people living with advanced dementia. Rogers (2018) used a number of co-designed interventions with the goal of changing public perceptions of dementia by showing that individuals living with dementia can contribute positively to society. In these studies, the co-design activities and interventions connected people with dementia to their community and helped build their self-esteem, identity, and dignity.

3. Research Context and Methodology

3.1 Cognitive Empowerment Program

This research is part of a therapeutic program entitled the "Cognitive Empowerment Program" (CEP), a collaborative effort between Georgia Institute of Technology and Emory

University Hospital that aims to explore new models of support and treatment methods for people with MCI and their families. The program's vision is to create a "living lab" that empowers seniors with MCI and their care partners using evolving therapies, technologies, and physical environments that will revolutionize how MCI is managed. The program's new space in particular facilitates research efforts to increase understanding of MCI and supports ways to improve cognition, social support, community engagement, independent living, and in general the quality of life of MCI patients and their families.

3.2 Characteristics of the Program's User Group: Seniors with MCI

MCI, often a precursor to Alzheimer's disease, affects up to 20% of adults older than 65. Common cognitive domains affected include memory, language, executive function (e.g., planning), attention, and concentration. While these changes are not severe enough to stop someone from completing day-to-day tasks, they are greater than normal age-related changes and may cause subtle difficulties with complex daily tasks (e.g., taking medication, finances). People with MCI differ from dementia patients since they usually do not present "substantial" functional changes that disrupt instrumental daily activities and require the assistance of others (Brown, 2011). Misplacing items, repeating questions, and trouble keeping track of dates and appointments can be observed in this population. Additionally, those with MCI may not communicate easily due to word-finding difficulties and slow auditory comprehension. Some other issues include, but are not limited to, difficulty with wayfinding, driving, and carrying out everyday activities such as managing money, medications, and cooking (Alzheimer's Association, 2019).

Eleven people with MCI and their care partners participated in the first workshop, and eight participated in the second. All participants were over 65 years old, had different professional backgrounds, and were retired (with the exception for one care partner). The people with MCI and their families were initially approached by clinicians from the Emory University Hospital to act as the Patient Family Advisory Group in the development of the Cognitive Empowerment Program (CEP). They were introduced and invited to participate in the project based on their interest and availability.

3.3 Procedures for Data Collection

We conducted two co-design workshops that each included two activity sessions. We followed each workshop by debriefing the activity and collecting participants' opinions on the workshop activities and their design. During each workshop, in addition to researchers, architects and clinicians provided one-to-one support to people with MCI and their accompanying care partners to ensure the participants were enjoying the process and that their opinions were valued regardless of their ability. The therapeutic team in particular took into consideration the ethical aspects of protecting MCI patients from probable stressful situations, respecting their needs and assisting them closely during the workshop activities. Each workshop took three hours to complete and occurred on a weekday morning.

4. Co-Design Materials and Methods

4.1 Photo Narrative Toolkit Development

In order to facilitate sharing of insights and experiences of people with MCI regarding the future built environment of the CEP, we developed a flexible visual-textual participatory toolkit that includes both images (e.g., indoor/outdoor spaces, interior layouts, green areas) and textual keywords (objects, actions, interactions, and expressions) associated with built environments.

In designing the toolkit, we considered the cognitive symptoms of MCI that may influence interactions with the kit, including managing memory, executive functioning, and communication. For example, people with MCI encounter difficulties in remembering words to communicate effectively which may lead to frustration and difficulties in managing emotions, whereas being provided a set of words to select from may be easier to handle.

Moreover, we applied an empathetic approach to involving people with MCI, including personalized (Branco, 2017) and respectful (Rajapakse, 2019) strategies. Our higher-level intention was to empower participants through self-expression and self-determination. These empathetic strategies were reinforced through the usage of visual cues (images), verbal cues (keywords), and the orientation of participants in doing each activity. This procedure aimed to support MCI patients with memory recap and enable them to explore and reflect on their personal stories, experiences, and feelings associated with visited places in the past. The participants defined and shared preferences for the type (enclosed/intimate vs. social/open) and look and feel of spaces, in addition to capturing feelings associated with spaces through visual- textual activities (Figure 1). Other factors were taken into consideration to support ease of use and interaction with the toolkit. For example, visual design principles for the elderly such as type size, contrast of text/images, and scale of the cards were applied in the design of the toolkit to avoid legibility complications (Farage, 2012).



Figure 1 *MCI patients engaged in the space look and feel activity. The toolkit was comprised of photo-text components and printed on game card-sized paper to facilitate the participants' ease of use, interaction with the toolkit, and decision-making processes.*

4.2 Workshop Introduction

The workshop was initiated by providing detailed information on the project, and institutions/core teams involved in addition to the location, floor plans, dimensions, and other information related to the future building by the architecture team. The participants were approached as equal partners in the design of the space. The introductory session continued by asking questions about "places that participants visited in the past, a place that they like to go once a month outside of their home, and a place that they do not like to go or somewhere they went once and did not want to go back to." The goal of this activity was to invite everyone (including the researchers and architects) to participate in the design discourse and the process of relieving tension by encouraging everyone to express themselves regardless of their role or identity, setting the stage for an open and engaged workshop.

4.3 First Participatory Moment: Type of Space and Level of Interactions

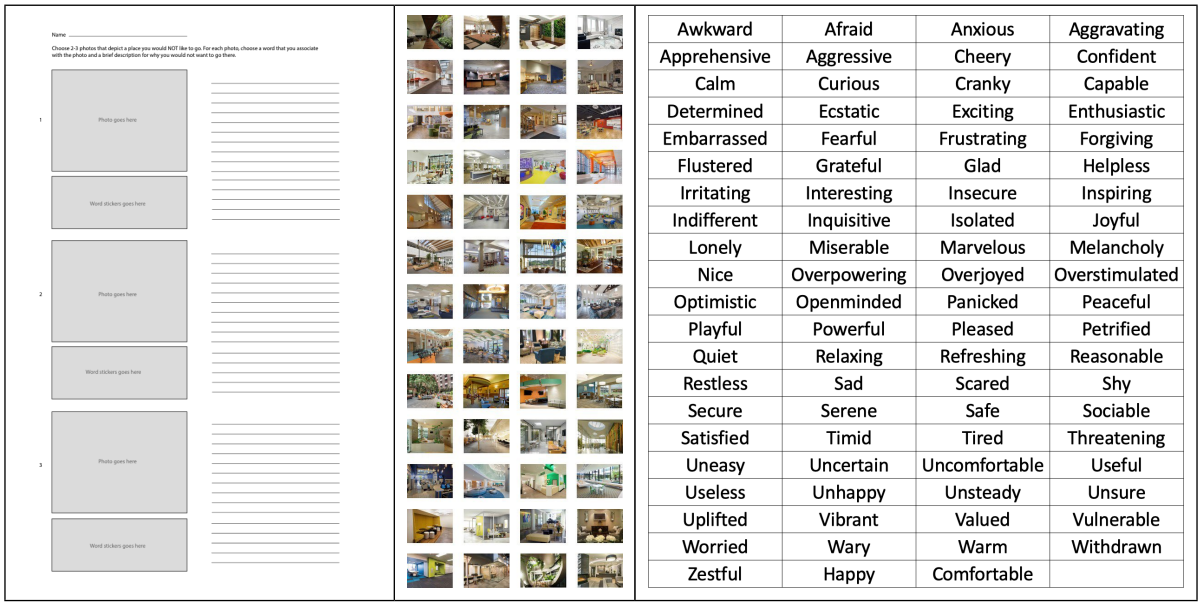
In the first hands-on activity of the built environment workshop, the participants were given an "activity matrix" to identify types of spaces where they would prefer to do various therapeutic activities. The matrix was divided into two axes (X and Y), where the Y-axis represented the continuum of open to closed spaces and the X-axis, intimate- social spaces. Each participant was given a set of twelve types of activities and asked to "use the matrix to identify where would they like to do them." The intention behind the matrix activity was to understand the participants' higher-level preferences in terms of general forms of built spaces and levels of interactions with other participants while doing different activities. The tool consisted of labels with the printed names of activities and a 2x2 matrix sheet. The participants were asked to associate each given activity with a particular matrix area and place it in that area. Because the notion of a matrix is not new and has been used in many fields (e.g., polarity maps in business), we found it provided a common visual tool which could be easily understood by our participants.

4.4 Second Participatory Moment: Space Look and Feel

In this activity, the participants were given a set of fifty-two cards that involved photos of places with different design, interior decoration, furniture and colors as well as eighty keywords (adjectives) to associate with those photos. The research team initially collected ninety photos and cut the sample down to fifty-two to avoid participants' physical and mental exhaustion, as suggested by the therapeutic team.

The people with MCI and their care partners were asked to choose six photos each depicting places they like/do not like to go; choose one associated word for each photo; and give a brief description of why they like/do not like to visit those built environments. The intention behind creating this activity was to learn about the participants' preferences in regard to the quality and type of spaces. We gave each participant a set of fifty-two photo cards, sixty labels with positive and negative adjectives, and a template to combine and place the photos

and adjectives (Figure 2).



Awkward	Afraid	Anxious	Aggravating
Apprehensive	Aggressive	Cheery	Confident
Calm	Curious	Cranky	Capable
Determined	Ecstatic	Exciting	Enthusiastic
Embarrassed	Fearful	Frustrating	Forgiving
Flustered	Grateful	Glad	Helpless
Irritating	Interesting	Insecure	Inspiring
Indifferent	Inquisitive	Isolated	Joyful
Lonely	Miserable	Marvelous	Melancholy
Nice	Overpowering	Overjoyed	Overstimulated
Optimistic	Openminded	Panicked	Peaceful
Playful	Powerful	Pleased	Petrified
Quiet	Relaxing	Refreshing	Reasonable
Restless	Sad	Scared	Shy
Secure	Serene	Safe	Sociable
Satisfied	Timid	Tired	Threatening
Uneasy	Uncertain	Uncomfortable	Useful
Useless	Unhappy	Unsteady	Unsure
Uplifted	Vibrant	Valued	Vulnerable
Worried	Wary	Warm	Withdrawn
Zestful	Happy	Comfortable	

Figure 2 *PD toolkit for the space look and feel activity: set of fifty-two photos cards, eighty positive- negative pairs of adjectives, and a board template with a simple layout. The layout design has image and text placeholders.*

4.5 Third Participatory Moment: Space Experience and Associated Activities

Several weeks after the first workshop the patient and family advisory board was invited back for another workshop. In the third participatory moment, the MCI patients and their families were asked to envision and describe the experience of spending a day at the empowerment center in a photo narrative form. They were given a set of fifty-two cards with photos of tasks and activities that can be accomplished in the space with an

associated template to facilitate writing an imaginative story of spending a day at the center (Figure 3). The co-design tool was created as a "narrative storyboard," a common method in interaction design to explore user experiences with an interactive prototype or environment (Greenberg, 2011). Narrative storyboarding uses sequences of images to tell a complete story about people's interaction with an artifact over time and facilitates creating rich information about the context of use, location where the interaction takes place, and people's action and interaction with the environment. Both the research and therapeutic teams collaborated in selecting the images to be provided to the participants.

The intention behind this activity was to understand the MCI patients and care partners' preferences for the type of therapeutic activities to be performed in the space, as well as their preferred sequential order over a day at the empowerment center. This activity also informed the architects on important design requirements to support different therapeutic activities.

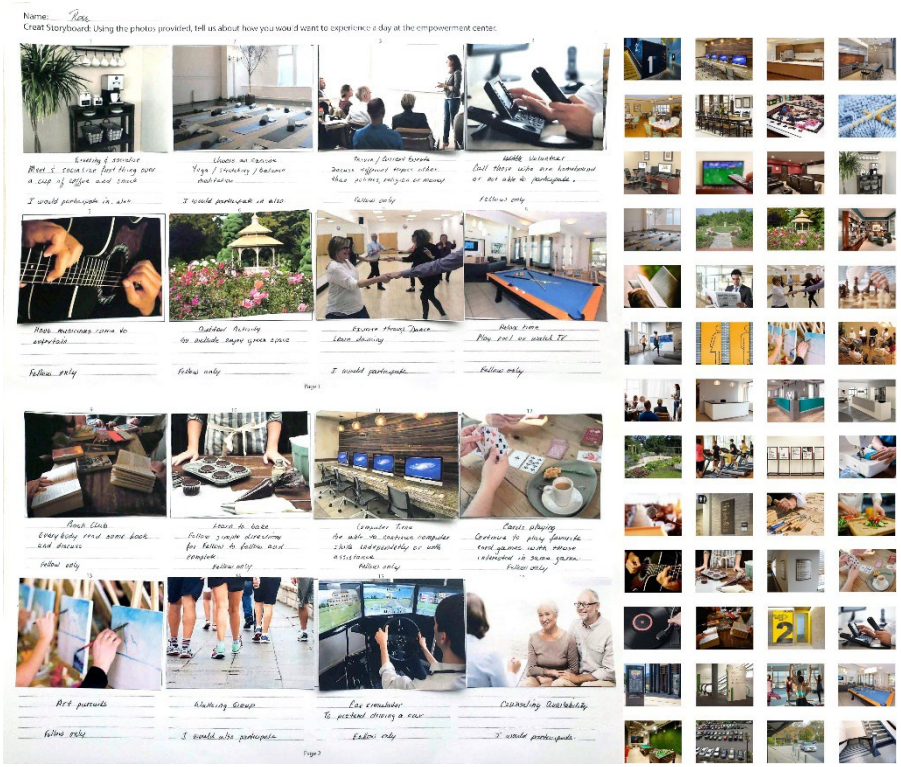


Figure 3 *An example of a storyboard created by a care partner who imagined and described her one-day experience at the empowerment center.*

5. Workshop Analysis and Findings

5.1 Procedures for Data Analysis

After the completion of each workshop, the research team conducted group data analysis sessions, including clinicians, to the visual-textual data. We used document analysis, a form of qualitative data analysis in which documents (texts of various formats, images, audio, or video) are interpreted by the researcher to give voice and meaning around a research topic. The process of analyzing the data was highly iterative and followed a systematic approach. We initiated the process by organizing and transferring the visual-textual data to Excel sheets which were shared with the research team members prior to each analysis session. The data was broken down into both quantitative and qualitative interpretations, providing commentary on the textual-visual data.

Furthermore, each photo was analyzed for the frequency of use and organized in a new table for further synthesis. Extensive focus was placed on group interpretations of visual-textual data to avoid potential biases in the findings. Each analysis session took 2-3 hours to complete.

5.2 MCI Patients' Insights about Ideal Spaces

The analysis of data from the workshop revealed that clear wayfinding and appropriate lighting are important points of consideration in designing built environments for people with MCI, and clean and clutter-free layouts that support social interaction are preferred. This quote from one MCI patient emphasizes the importance of good wayfinding:

> "…A lotta doors, because you don't know which door is where, and trying to get back to where you were is so hard because it will all be new. You would go in one door and come back out, and there are three other doors…you don't know which one you went through, came out of, or know where you need to go."

Furthermore, the participants prefer windows in the building that bring the outside in: "I don't like any windows covered with drapes or blinds so it's definitely like outside." Most participants prefer soft, lower light levels and avoid overhead lights: "I like a little light inside instead of the overhead bright lights"; "I don't always use the overhead lights because I like lamps and kind of lower lighting that just feels comforting and not so stark." Overall, a medium, balanced lighting system is preferred by participants: "I cannot stand going into a restaurant where you cannot see things. I don't like it dark in the room, but I also don't like it too bright, so it has to be that soft light."

The participants prefer open, clean, and clutter-free spaces with "not too many distractions, just simple themes." Another participant described that "I like open spaces. I don't like doors shut or closed-in places". The built environment may also support social activities, as stated by several participants, that enable them to "[sit] around casually and socialize." One participant pointing at the furniture pieces in a picture, said: "I think about spaces where people socialize, and they have round tables instead of having square tables. You can see everybody." A similar viewpoint emphasizes the importance of sensory spaces that support social connectivity:

> "A space should intentionally make people feel something…You walk into an old cathedral, you feel the grandeur… we think of places to have lunch meetings not based on food, not based on location, but based on whether you can have a conversation, which is more important to us than food."

Overall, these findings speak to the participants' needs and limitations in using current built environments due to their cognitive impairment.

5.3 Built Environment and Associated Attributes

All the participants living with MCI were able to understand the scope of the first, second, and third co-design activities, contribute actively and positively to the activities using images and associated words, provide descriptions of their ideas, and share insights on ideal and non-ideal spaces.

The quantitative analysis of the proposed daily activities of MCI patients and their care partners in the matrix activity revealed that people living with MCI prefer to use intimate and enclosed spaces for activities such as watching TV, using the computer, making a phone call,

and working with support groups. Additionally, the analysis revealed the level of interactions with the environment for each type of activity. The participants had a strong intention to do activities such as exercising, dancing, playing games, and crafting in open spaces that facilitate and support social interactions.

The analysis of the second participatory moment, "space look and feel," unfolded the space typologies and the interior design principles (e.g., furniture, color, arrangements) that need to be incorporated or avoided in the design of the empowerment center (Table 1). The findings revealed the importance of including natural elements and greenery in addition to providing comfortable sitting areas with appropriate furniture and arrangements. Shiny elements with dominant vibrant colors were not welcomed by the people with MCI and must be avoided in the design to provide a clean and non-distracting environment.

Table 1 *The most liked and disliked spaces according to MCI patients' opinions and implications for built environment design.*

	Example one	**Example two**
Examples of the most liked spaces		
Associated attributes and keywords	Open minded, Optimistic, Peaceful, Refreshing, Vibrant	Refreshing, Sociable, Uplifted
Design considerations	Create comfortable and sensible accommodation (e.g. coffee tables, options for sitting); incorporate plants and greeneries; modern design is welcome if it incorporates natural elements such as access to daylight, stone, wood, plants; earth/neutral color tones; a variety of seating arrangements to promote socialization.	
Examples of the most disliked spaces		
Associated attributes and keywords	Anxious, Frustrating, Lonely, Overpowering	Awkward, Isolated, Uncomfortable
Design considerations	Should avoid glass rooms, overwhelming colors (bright/ unnatural light), dark and low ceiling, cluttered spaces, long and narrow corridors, shiny surfaces, and ill design sitting arrangements (e.g. uncomfortable, awkward).	

The third co-design workshop leant itself to a quantitative analysis of the textual-visual data. The research team started the analysis by creating "codes" for the workshop's therapeutic activities (Figure 4). All therapeutic activities were organized and divided into three activity types, as follow: 1) structured vs. unstructured, 2) active (or engaged) vs. passive, and 3) social vs. individual. We define structured activities as those that require guiding, supervising, or assisting by therapists or care partners and unstructured activities as those that can be done independently by the MCI patients. Additionally, to further narrow down and detail the codes, we sorted the therapeutic activities into eight identifiable activity categories: relax, make/craft, physical/exercise, game/play/entertainment, learn/reinforce a skill, chores, basic needs, and share/discussion. These categories were identified and refined as we proceeded with the data analysis. The coded data enabled us to create numeric values to define type, order, and the level of interaction for the various activity types relevant for the empowerment center.

An in-depth analysis of the workshop data showed that all individuals with MCI would like to do physical exercise at the center. Also, while the people with MCI are interested in hands-on activities (e.g., craft-making, playing games), their care partners prefer to have discussion sessions to share their experiences and concerns with other care partners and therapeutic staff. All participants would strongly prefer to do "active" activities in the middle of the day (91%), and people with MCI would like to do these activities "socially" (72%). Both parties suggested considering time to gear up and wind down in between activities through laid-back, open-ended, and relaxing activities.

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in the “pre-design phase” of envisioning the future built environment and their experiences within the space through activating their feelings and memories.

Some of the challenges and limitations of this research were: 1) while the involvement of people with MCI in designing the toolkit and analyzing the outcomes can make a positive impact on engagement in co-design, we could not involve them in this step due to time limitations and participant availability; 2) the need for considering dissociated co-design activities—being involved in a continuous chain of activities can be overwhelming for people with MCI, so we broke sessions up into two workshops; and 3) the need for extensive attention and an ongoing recognition of the cognitive load of MCI patients in designing the generative toolkit, which limits the possibility of creating more advanced toolkits to support divergent thinking. In this research we relied heavily on clinicians to make recommendations on the design of activities to limit cognitive burden and frustration of the participants.

Key factors in making the Photo Narrative method distinct were the multilayered forms of expression accessible to participants through verbal, visual, and textual commentary, which enabled all participants to share their valuable insights easily and independently and complete activities without extensive support from care partners, designers, or clinicians. The care partners also had the option to share their opinion independently, which revealed dissimilar or competing goals in regard to the usage of the future built environment by some dyads. Moreover, the unique format introduced in the Photo Narrative method produced rich findings and design requirements that could be directly applied to architectural design. While the level of engagement of people with MCI and their care partners varied throughout the workshop (e.g., people with MCI were reluctant to write), overall, we observed high level of engagement and responsiveness from both groups as an indication of the effectiveness of Photo Narrative when working with this population.

Our secondary contribution in this paper is the analysis method, which speaks directly to the literature gap and need in co-design for interpretations of rich co-design workshop data into insightful design requirements and recommendation (Bossen et al., 2016). The process of analyzing data in this flexible and at times quantitative way led to insights about the needs and preferences of those with MCI and their care partners in the design of the future therapeutic built environment. The data was shared with architects and clinicians as insight on preferred space typologies, levels of interaction, programmatic activities, time organization, look and feel of spaces, and design considerations that support therapeutic activities inside and outside of built environments.

Although we developed and adapted workshop activities to the symptoms of MCI, we still observed some difficulties during the co-deisgn workshops. Some participants were reluctant to write down their stories in the provided template and limited their story lines to the provided labels and photos. In this case, as soon as we became aware of the lack of interest and/or ability to write, an effort was made to make the process as flexible as possible. Thus, we decided to conclude the workshop by debriefing the activity and asking the participants to share their stories verbally with the larger group. Such a process enabled the people with

MCI to describe their stories in depth and add verbal expressions and details to the visual components. The in-the-moment decision to consider verbal recapitulation was in line with our empathetic approach in engaging participants by employing a flexible and respectful (Rajapakse, 2019) strategy. Given this, we suggest that researchers are open to on-site adaptation of the co-design method when working with seniors with MCI.

Future research can be conducted to explore the Photo Narrative method in the co-design of other types of built environments such as patients' homes. It would also be critical to know if this method can be applied to other populations such people with autism, or older adults who have progressed from MCI to early stage dementia or Alzheimer's disease.

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Understanding interactivity for the needs of the elderly's strength training at nursing home in Indonesia

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Abstract: Regular exercise has been shown to be beneficial for the elderly. However, the prevalence of the elderly doing exercise is low, and muscle-strengthening exercise is even lower. Therefore, physical inactivity has been reported as a significant health problem worldwide. Many assistive devices have been developed to overcome the problems of lack of engagement. This study explores opinions from the elderly regarding an acceptable and affordable technology-based design that focuses on the strength training specific to the elderly in two middle-class nursing homes in Indonesia. This paper presents qualitative findings from 37 participants who are part of an ongoing study. The results of this study show that when creating an interactive device for the elderly, easy procedures, a small lightweight-looking device, direct rewards, and instructor companionship should become the main considerations.

Keywords: elderly; interactive device; nursing home; strength training

1. Introduction

The concept of healthy aging emphasizes how people have the opportunity to live a long and healthy life. This concept is supporting the World Health Organization idea about creating opportunities for the people to be and do what they value throughout their lives based on intrinsic capacity and relevant environmental characteristics (www.who.int/ageing/healthy-ageing/en/). Thus, the success of medical research will result in increasing the life expectancy rate, which is best supported by the ability to maintain functional capacity and obtain a longer health span. This present research continues from the earlier study

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(Wianto et al., 2019), focusing on the intrinsic capacity of the elderly, specifically on their physical activities (PA) and lifestyle. The preliminary study showed that the elderly, especially those in a nursing home, are generating a sedentary lifestyle due to their low PA scores when compared to the ones in a community-dwelling. The Physical Activity Scale for the Elderly, an inventory instrument owned by New England Research Institute, was used to measure the PA developed by Washburn (Washburn, Smith, Jette, & Janney, 1993, pp. 153-162). This instrument breaks down the typical activities used by the elderly into leisure time activities, household activities, and work-related activities. Although the elderly self-reportedly practicing regular PA related to walking outside the home, they infrequently or never practiced muscle strengthening to detain mobility limitation (Bohannon, 2019, pp. 1-4; Dodds et al., 2016; Wianto et al., 2019). Then this current condition is not ideal.

Exercise as part of PA, according to National Institute on Aging and the Medline official websites, should be differentiate into endurance, strength, balance, and flexibility (https://go4life.nia.nih.gov/4-types-of-exercise/); each type will provide different benefits (https://medlineplus.gov/exerciseforolderadults.html). Thus, focusing on to one type of exercise is not enough. The increased urgency also takes sarcopenia into consideration, as the 2019's European Working Group on Sarcopenia in Older People review on muscle strength argues that this progressive skeletal muscle disease now can happen earlier in life because of the loss of strength and performance of the muscle (Cruz-Jentoft et al., 2019, p. 16).

However, emerging challenges regarding the development of the Internet of Health Things are predicted to grow relentlessly, as are the issues related to a lack of engagement by the stakeholders and a disregard of culture (Tsekleves, 2018, pp. 2377-2379). Assistive technology should not be a source of frustration that invokes reluctance in the elderly (Shore, 2018, pp. 1919-1937). Thus, the effort to understand the preferred interaction to enhance muscular fitness appears to be feasible and becomes the primary context of this study. As such, the general purpose of this ongoing study is to gain a better understanding of how a technology-based design will be accepted by the elderly, which focuses on the elderly in nursing home with their living arrangement advantages, limitations, and a specific muscle-strengthening exercise using a free-weight device.

2. Sarcopenia, sedentary lifestyle, and a lifelong sport experience

The optimum benefit of doing PA needs to include duration, frequency, intensity, and type. This consideration was also implemented on the PA intended for the elderly. The benefits will improve cardiorespiratory and muscular fitness, bone and functional health, and reduce the risk of non-communicable diseases, such as depression and cognitive decline (WHO, 2010, pp. 8-10; 2011).

Progressive attempts to change the sedentary lifestyle of the elderly, such as giving information on the direct benefit of PA, whether specified (Lavin et al., 2019, pp. 112-122; Schott, Johnen, & Holfelder, 2019, pp. 15-24), or general (Gine-Garriga, Roque-Figuls, Coll-Planas, Sitja-Rabert, & Salva, 2014, p. 754; Nielsen et al., 2019, p. 10), or to the healthy or

frail (de Labra, Guimaraes-Pinheiro, Maseda, Lorenzo, & Millan-Calenti, 2015, p. 14), or with different methods: changing the intensity and time consume (Felipe Garcia-Pinillos, Jose A. Laredo-Aguilera, Munoz-Jimenez, & Latorre-Roman, 2019, p. 1445), or using optional or specific device such as elastic tubes for resistance training (Souza et al., 2019, p. 132), or combining with non-PA related such as naps (Arakaki, Tufik, & Andersen, 2019, pp. 886-887), still resulting in inactive behavior or a sedentary lifestyle (Rezende, Rey-López, Matsudo, & Luiz, 2014, p. 2). This fact proves that the knowledge, benefit, and awareness of PA have not been able to trigger the elderly into doing PA regularly.

The fact is there are difficulties motivating elderly people to do PA, so this current study tried to align with the idea stated by Karahanoğlu (Karahanoğlu, 2018, pp. 2116-2125) suggesting a lifelong sports experience, which emphasizes injury prevention, sustained lifelong training, and recognition of the elderly's capabilities.

3. Study approach

3.1 Methods

This study followed the qualitative method based on the experiences, meanings, and perspectives of the chosen group of elderly people (Hammarberg, Kirkman, & Lacey, 2016, p. 499). The qualitative descriptive design in this study uses semi-structured interviews generated from the interviewing method into textual data (Simon C Kitto, 2008, pp. 243-246) and is supported by exploring the behaviors, willingness, gestures, and figures of speech of the elderly to obtain natural context and meaning. Before the interview process, potential participants performed the following pre-screening tests: Mini-Mental State Examination (MMSE), SARC-F Questionnaire (SARC-F), Hand Grip Strength (HGS) test, and 1-Repetition Maximum (1-RM) to obtain reliable participants.

The MMSE, or Folstein test, was used to detect cognitive impairment and validate a given statement by the elderly (Tombaugh & MA, 1992, pp. 922-932). The SARC-F test was used to rapid screen the presumption of the elderly regarding sarcopenia (Malmstrom, Miller, Simonsick, Ferrucci, & Morley, 2016, pp. 28-36; Malmstrom & Morley, 2013, pp. 531-532). There is no minimum point set for the SARC-F, as the purpose of classification was to find whether any clustered opinions emerged based on health conditions. HGS was tested using the Jamar Dynamometer and Electronic Hand Dynamometer (EHD) according to the American Society of Hand Therapists protocols used to measure grip strength and to classify overall strength as a presumptive value to identify frailty, sarcopenia, and malnutrition (Bohannon, 2019, pp. 1-6; Roberts et al., 2011, pp. 423-429; Sousa-Santos & Amaral, 2017, p. 15). Figure 1 shows participants holding the EHD. 1-RM was measured in this study because of its high reproducibility and safety (Barbalho et al., 2018, p. 171) to define a baseline weight suitable for the elderly (Reynolds, Gordon, & Robergs, 2006, p. 584).



Figure 1 Participants were recorded while doing Hand Grip Strength's test.

3.2 Ethics

The study protocol was approved by the Research Ethics Committee of Universitas Kristen Maranatha (Maranatha Christian University) – Immanuel Hospital, number: 179/KEP/VIII/2019. The submission of the protocol included the pre-screening test, the intervention using the proposed free-weight device, and informed consent form templates for the participants.

3.3 Participants

A convenience sample of individuals living in two selected nursing homes was recruited in this study. Both of the nursing homes are located in Bandung, West Java, Indonesia, as they suit the socio-demographic. All participant considered eligible are a minimum age of 60 years old, are fluent in Bahasa Indonesia and/or Sundanese or Javanese and have lived in the designated nursing home for at least six months. The additional pre-screening test is preferable but not mandatory. The chosen nursing homes consist of around 90 elderly, separated into potential and non-potential categories. All of the participants in this study categorized as potential were able to do at least one basic daily living activity, such as taking a bath, dressing, eating, or managing their mobilization.

Both of the nursing homes selected in this study are ministered by the Christian Church coordinating with the Social Department of the Indonesian Government. This arrangement was established more than thirty years ago and provides not only for shelter and nutrition but also manages activities for the residents. Regular activities held in the nursing home consist of Sunday Service, singing/playing musical instruments called Arumba or Angklung, and stretching as exercise.

3.4 Data Collection

A semi-structured interview using a questionnaire was conducted with all participants after

they received an explanation about the study. Before or after the interview, participants did the pre-screening test. Guideline questions consist of:

1. What is your effort to live independently?
2. What is your opinion about preferred exercise, frequencies, and duration?
3. How you explain the difficulties in training regularly?
4. What is your reason to stop exercising?
5. What are your good habits and motivation to do those habits?
6. What is your preferred condition to motivate you doing exercise?
7. What is your visceral perception regarding the prototype free-weight device offered?
8. What is your ppinion regarding the feasibility of using the prototype free-weight device for future muscle-strength enhancing exercise?

The guideline questions are arranged from a broader opinion regarding life itself, and then to how the participants have managed life until now, how exercise helps them to maintain their desirable life, and finally how they feel about the strength-training type of exercise.

In order to visualize the free-weight device indicated in the guideline questions, a proposed prototype device in 3D modelling and snap shots taken while the participants were holding the dummy are presented in Figure 2 and Figure 3, respectively.

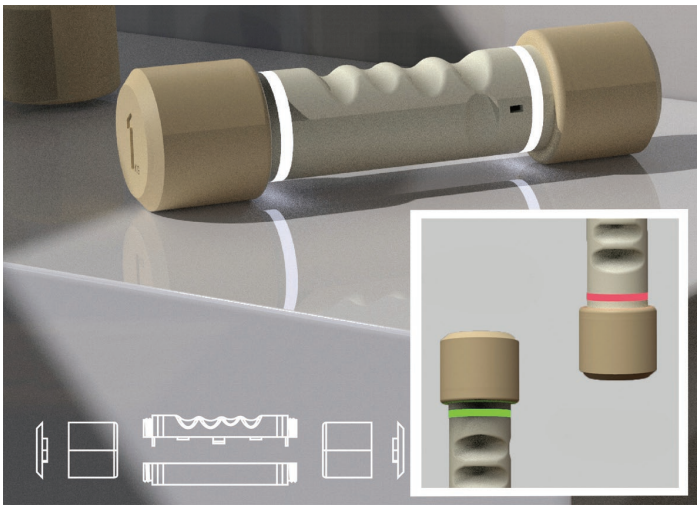

Figure 2 3D modelling of the proposed free-weight training device.



Figure 3 Participants experiencing the proposed free-weight device.

3.5 Data Analysis

Interviews were done in Bahasa Indonesia and transcribed verbatim from audio recordings to text. The transcript was imported into NVivo 12 for data management. In order to have broader information and to cross-check whether the participants' answers contradicts their conditions, cases were separated into age, gender, HGS status, medical history, MMSE, nursing home, and SARC-F. The first coding process refers to the guideline questions without considering the cases to avoid researcher bias on health stereotyping. The second coding was generated manually based on the participants' answers because sometimes their answers were overlapping from one context to another. Following coding, the researcher categorizes the theme and then concludes referring to the aim of the study. As for the data referring to the intercontextual answers, coding can fall into one or more categories and subcategories when necessary.

4. Results

4.1 Characteristics of Participants

This research includes 37 participants, consisting of 35 women and 2 men (age range: 63-94 years). An MMSE screening test was given to the elderly. The results were moderate, mild, and normal for 3, 4 and 26 participants, respectively. Perceived sarcopenia screening using SARC-F was done. The results were suspicion and normal for 7 and 26 participants, respectively. 1-RM was tested using 0.3-, 0.5-, 0.75-, and 1-kilogram weights. Based on the 1-RM test, one, two, six, and four participants were suitable to use the 0.3-, 0.5-, 0.75-, and 1-kilogram weights; the other participants were able to use heavier weights.

The handgrip strength ranges using the analog Jamar Dynamometer and the EHD according

to their guidelines (https://www.performancehealth.com/amfile/file/download/file_id/6971/product_id/27106 and https://www.camryscalestore.com/pages/manuals-catalog-and-downloads) were between 8.67 kg to 33.33 kg and between 8.87 kg to 33.93 kg, respectively. Both dynamometers indicated a similar result: the Jamar Dynamometer showed 20 and 13 statuses below and between the average, while 19 and 14 statuses showed weak to normal using the EHD. The slightly different results might be caused by the hand position of the participants while doing the test. The results of handgrip strength showed a similar result of below average for the participants over 81 years old; only one participant (code: D10, age 90) obtained a better result of between average. Characteristic details of the participants are presented in Table 1.

Table 1 Participant Characteristics.

No	Participants Code	Ethnicity	Age	Sex	Medical Historic
1	D01	Tionghoa	77	F	hypertension, dyslipidemia
2	D02	Tionghoa	84	F	diabetes, hypertension, cholesterol
3	D03	Tionghoa	88	F	wheelchair, dyslipidemia
4	D04	Tionghoa	80	F	hypertension, dyslipidemia
5	D05	Javanese	89	F	hypertension, dyslipidemia
6	D06	Tionghoa	94	F	wheelchair, heart, insomnia
7	D09	Tionghoa	74	F	dyslipidemia
8	D10	Tionghoa	90	F	walker, osteoarthritis
9	D11	Tionghoa	89	F	-
10	D12	Tionghoa	82	F	-
11	D13	Tionghoa	84	F	osteoporosis
12	D14	Javanese	81	F	hypertension
13	D15	Tionghoa	75	F	hypertension
14	D16	Tionghoa	72	F	gastritis
15	D17	Javanese	70	F	-
16	D18	Tionghoa	76	F	cane, diabetes, hypertension, dyslipidemia
17	D19	Tionghoa	75	F	Eye, low back pain, neural,
18	S01	Tionghoa	83	F	Bell's palsy (1989)
19	S02	Ambonese	80	F	heart
20	S03	Javanese	63	F	hypertension
21	S06	Sundanese	77	F	cataract
22	S07	Minahasan	66	F	hypertension, asthma
23	S08	Sundanese	74	F	hypertension, diabetes
24	S09	Batak	86	F	-
25	S10	Tionghoa	89	F	-
26	S12	Ambonese	81	F	hypertension

No	Participants Code	Ethnicity	Age	Sex	Medical Historic
27	S13	Javanese	89	F	-
28	S14	Tionghoa	75	M	-
29	S15	Tionghoa	70	M	diabetes
30	S16	Javanese	70	F	-
31	S17	Tionghoa	81	F	left pelvis fracture
32	S18	Tionghoa	79	F	cataract
33	S19	Javanese	77	F	stroke (2007)

Only 33 participants able to finish all four pre-screening tests, but there are four participants which haven't done the pre-screening tests are willing to share their opinion. Those participants coded with S04, S05, S11, and S20.

As Indonesia has much ethnic diversity, the ethnicity of the participants was also stated in Table 1. We assumed that with the ethnic differences, there would be different levels of fitness in the maximum gripping dimension when they tried to hold the prototype device. The participants came from Ambonese (Moluccans), Batak, Javanese, Minahasan (Manado), Sundanese, and *Tionghoa* (Chinese Indonesian). Of the 33 participants, 2 had an elevated risk of doing muscle-strengthening exercise because of osteoarthritis and osteoporosis, while the others' medical histories mostly stated hypertension, which generally will decrease when using muscle-strengthening exercise. The notions of gender and ethnic group in this study were used to provide background information about whether the participants' ethnicity and gender affected their opinions. However, since the participants live in a nursing home, they have some similar conditions: the majority are female, they do not have children or were never married, or they do not have a family to support their living arrangements in a community-dwelling.

4.2 Findings

The first coding was categorized based on eight guideline questions. This first coding was manually coded by the researcher with the help of Nvivo 12, which generated 1,488 references from 37 participant expressions. Those 1,488 references were then re-categorized based on the answers of the participants into six categories: value, an existing nursing home condition, acceptance of current state, togetherness, exercise as PA, and feasibility of new device. The breakdown of the categories, descriptions, and subcategories are presented in Table 3**.**

Table 2 Categories, Descriptions and Subcategories.

Categories	Description	Subcategories
value	Opinion regarding their way of life	acceptance of something new, collective context, direct benefit oriented, discipline, expertise or pride, independent life, joyful in life, locus of control, related to beliefs, tolerance
existing condition	Opinion indicating daily living in a nursing home	boredom, daily activity (non-physical activities and physical activities related), helped by others, interesting activities, unsatisfied condition
acceptance of current state	Opinion regarding health, including achievements in the past to support current condition	physical limitation, previous activity
togetherness	Opinion regarding preferred way of doing the activities	alone, together with others
exercise as PA	All opinion about exercise or physical activity base	commitment for exercise, concept of exercise as basic needs, duration for exercise, excuse to avoid exercise, preferred exercise, stop exercise, willingness for exercise
feasibility of proposed device	All opinions regarding the proposed free-weight training device	affordance on strength training, familiar concept of strength training, requisite to do strength training

4.3 Categories, Subcategories, and Themes

The six categories were divided into the more specific opinions of the elderly, which were further divided into subcategories that were generated manually by the researcher into 104 codes and 1,818 references. The graphical image is shown in Figure 4.

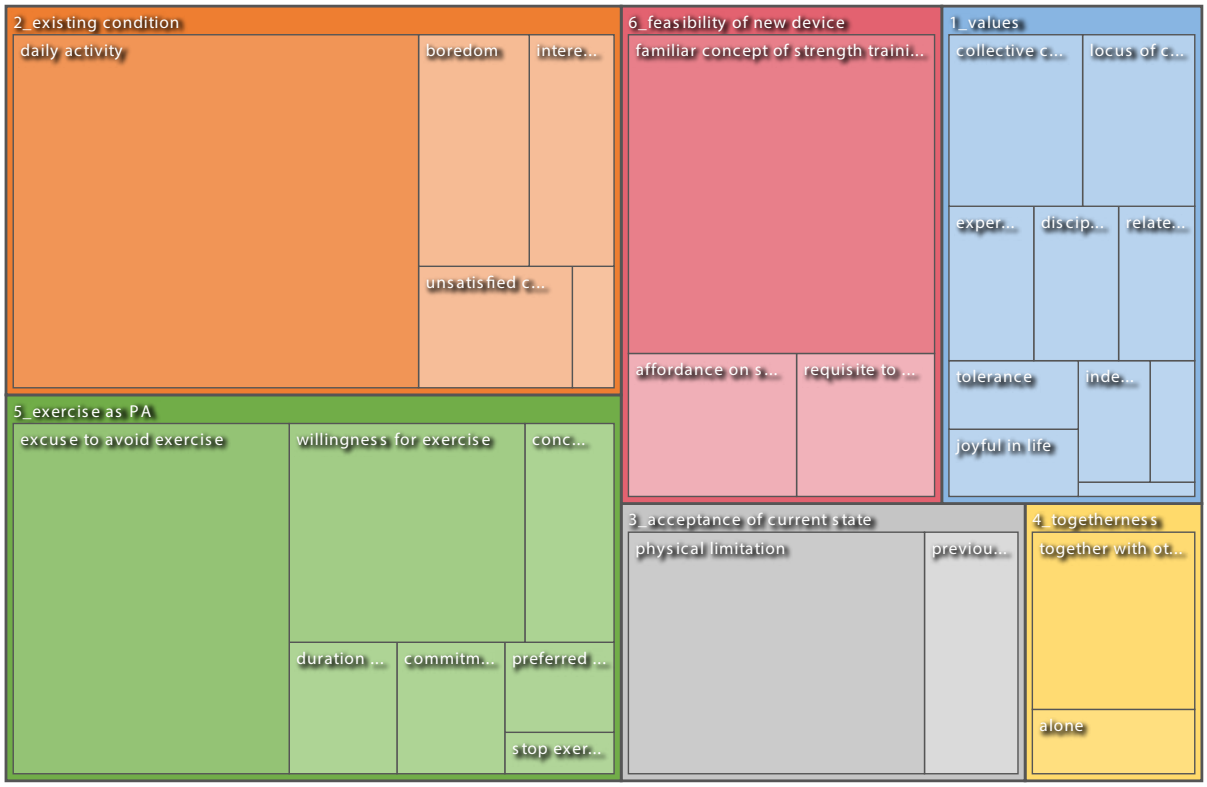

Figure 4 Proportion of Categories and subcategories in tree map style generated from NVIVO

In order to share the data expressed during the conversations, Table 3 to Table 8 show highlighted comments under categories and subcategories.

Table 3 Highlighted Comments Categories: Value.

Sub categories	**English translation from Bahasa Indonesia**	**Participants Code/ Age/ Jamar status**
acceptance of some-thing new	(The design) looks like a traffic light. It must be like a mineral bottle movement. (We) can learn how to do weight training, … but let's try.	S01/ 83/ between average
collective context	…for me, I do not have any difficulties in doing exercise, but for [the name of the elderly], it must be difficult [because using a walker]	D05/ 86/ below average
direct benefit oriented	… lazy because there is no result, exception if it has some effect … or something to achieve or expect. … [reward], get mango (or presents) …	S04/ -/ -
discipline	… obey the rules, life in mens sana in corpore sano. [a healthy mind in a healthy body]	D13/ 84/ below average
expertise or pride	…I was good at basketball… at home, there are many devices for exercise…	D19/ 75/ between average

Sub categories	**English translation from Bahasa Indonesia**	**Participants Code/ Age/ Jamar status**
independent life	… the most important things are (our) heart, think naturally (do not judgemental), and character. My principle is: as long as we can, (we) must do it by ourselves	D14/ 81/ between average
joyful in life	… feel grateful for what it is, do not have to be sorry or grumble about why we end up living here.	D17/ 70/ between average
locus of control	… It depends on how the coach teaches us, whether it is one-on-one or together at once.	S15/ 70/ between average
related to beliefs	… pray for God to (get) strong faith.	D01/ 77/ below average
tolerance	… we can't be egoistic if we have to live together, we came from many different cultures, (so we) have to love and forgive, (so we) will feel peace…	D13/ 84/ below average

Table 4 Highlighted Comments Categories: Existing Condition.

Sub categories	English translation from Bahasa Indonesia	Participants Code/ Age/ Jamar status
boredom	I like to help in the kitchen, so (I) have things to do, but nowadays I am starting to feel lazy, bored... Get bored with the life itself.	D09/ 74/ between average
daily activity: non-PA	Reading the Bible (is our) responsibility and our longing, listening to some preaches on the radio, and have the morning prayer.	S02/ 80/ below average
daily activity: PA related	... Exercise, I cannot stand, so training in my bed after I wake up, done repeated movement 15 times to flex my body… watering flower...	D10/ 90/ between average
helped by others	Now it's better here, mopping and sweeping and getting helped by others.	D07/ -/ -
interesting activities	Together with playing angklung, we recognize the character of each other. The happiest times are singing, chit chatting, and playing angklung.	S10/ 89/ below average
unsatisfied condition	I like sewing, also knitting, but because there is much stock [the result is displayed], I quit and now don't have anything to do (as a hobby).	D05/ 86/ below average
	No routines, I got a stroke, so I feel pain now.	S19/ 77/ below average

Table 5 Highlighted Comments Categories: Acceptance of Current State.

Sub categories	**English translation from Bahasa Indonesia**	**Participants Code/ Age/ Jamar status**
physical limitation	… since last year, I frequently fall, not really often though, because of being tired and I lose my balance. This year I've already fallen more than twice.	D13/ 84/ below average
previous activity	When I was young, I liked to swim. After (I) got old, it is difficult and depends on friends [accompany with] …	S08/ 74/ below average

Table 6 Highlighted Comments Categories: Togetherness.

Sub categories	**English translation from Bahasa Indonesia**	**Participants Code/ Age/ Jamar status**
alone	I prefer to do it alone. When (alone) it will be freer for me; I walk back and forth.	D01/ 77/ below average
together with others	Happy when doing activities together, there is someone to chat with. If someone's sick, (the other) will be able to call out for the nurse.	D02/ 84/ below average

Table 7 Highlighted Comments Categories: Exercise as Physical Activities.

Sub categories	English translation from Bahasa Indonesia	Participants Code/ Age/ Jamar status
commitment for exercise	I will follow once or twice but do not know whether the others decide to (exercise) or not.	D04/ 80/ between average
concept of exercise as basic needs	… doing exercise during school time, but after that, never intended to do it because I don't pay attention to this aspect	D04/ 80/ between average
duration for exercise	Thirty minutes is too long, maybe 15 minutes (is enough), other exercises only took 3 minutes.	S07/ 66/ between average
excuse for exercising	(This) exercise (I am) afraid will make my arms bigger…	D16/ 72/ between average
preferred exercise	As long as there is guidance (I am) willing to do it, feel guaranteed… Happy because there are plenty of friends doing activities together.	S11/ -/ -
stop exercise	When I stopped my education (school), then I also stopped doing exercise.	D01/ 77/ below average
willingness for exercise	… never done it before, so I would like to try it first, just try it first (is okay).	S03/ 66/ between average

Table 8 Highlighted Comments Categories: Feasibility of New Device.

Sub categories	English translation from Bahasa Indonesia	Participants Code/ Age/ Jamar status
affordance on strength training	… it is too heavy for me (0.75 kg), (measurement) of the cylinder is enough; it's easy as long as it is light.	D12/ 82/ below average
familiar concept of strength training	… oh, there was exercise similar to this… The previous (dumbbell) has a more solid grip, so when we hold it (our hand) can fully grab it...	D03/ 88/ below average
requisite to do strength training	… it will be (more) okay if there is coach (to guide) … because the coach can tell jokes and be suitable for feedback.	S05/ -/ -

The above comments were brief insights from the participants. This selection was made from the most explicit comparisons of expressions. From the subcategories, we found that three themes emerged from the participants:

1. Collectivity and Dependency;
2. Boredom;
3. Awareness to Exercise.

Collectivity and Dependency appeared the most within the participants' commentary. Some examples are whether their opinions were similar with the others' or not, whether they were answering on behalf of the others, and whether their request to exercise together with peers or with the instructor was shared. Most participants expressed their acknowledgment of the importance of exercise. Hence, the reluctance to exercise has appeared within many premises under physical and time limitations. Those answers contradicted their explanations regarding idle time and prioritizing. Many participants feel satisfied living in a nursing home even though it is boring. They feel bored because there are not enough suitable occasions to interact with others.

5. Discussion

The findings presented in this paper illustrate the experiences of the participants living in nursing homes with regard to their daily activities and how they perceived exercise in general and muscle strengthening in particular. This study establishes that a sedentary lifestyle has multi-faceted aspects and contributes to a decline in the health-related quality of life of the elderly. Significant themes generated in this study show that the current situation is potentially influenced by a low internal locus of control. The locus of control is defined as the degree of belief in external or internal forces that influencing one way of life (Timmins & Martin, 2019, p. 97). This results of this study also agree with the findings from Zhang et al., which stated that other constructs to support the control of beliefs in the elderly are higher

sleep self-efficacy, positive effects, higher perceived competence, and a higher internal locus of control (Zhang, Gamaldo, Neupert, & Allaire, 2019, p. 1). A low internal locus of control, together with the collectivistic culture commonly found in Asian societies (Riediger & Mosquera, 2015), arguably reduces the willingness of the elderly to participate in individual exercise sessions. Confirming the indication of a low internal locus of control, some of the participants demanded guidance or accompaniment from an instructor or their peers while doing an exercise. Other probable conditions also indicated that there was an ineffective training method in the nursing home since more than 30% of the elderly's grip strength was weak or below average, even though they said they exercised regularly.

The topic of physical activity shared with the participants responded with a limitation of the type of exercise performed, which mainly concentrated on walking and doing chores. Both activities need to improve to ensure that activities help maintain functional ability. Walking as the primary physical activity not only occurs in Indonesia, as another study confirms similar results (Steve Amireault, Baier, & Spencer, 2019, p. 137).

Interestingly, the proposed free-weight training device shown to the participants was not perceived as a peculiar assistive device which separates their daily lives with unfamiliar technologies. Although most of the participants could not express how to make this device more suitable for them, they did not refuse the idea of muscle strengthening.

The term muscle strengthening, which was assumed to be more suitable for men than women, only appears used by one of the female participants (D16), who stated that she did not want to do the muscle-strengthening because she was afraid of having muscular biceps the way a man does. A male participant, (S15), who had experienced muscle-strengthening exercise in his younger years, stated that the proposed device is not substantial enough for him. The rest of the participants did not state the 'gender' of this type of exercise, and they also did not refuse to do the 1-RM measurement, which is a bicep curl movement.

Another interesting finding in this study was the frequent expression of "I like to try it first" over "I cannot" or "I am not able" to exercise with the new device. Those positive indications provided accurate feedback and was acquired by the designer in order to create the device with meticulous consideration of easy procedures, a small lightweight-looking device, direct benefits, and instructor involvement.

5.1 Research limitations

This paper discusses the perspectives of a limited number of participants residing in a nursing home in Bandung as the selected socio-demographic of Indonesian elderly. This was the second time data was gathered here, as the researcher's previous study was also held in the same institution. There is a risk that the general topic of exercise might already have influenced their perceptions regarding PA. However, the familiar face of the researcher possibly increased the participants' comfortability to share their opinion. This study might not be suitable to generalize the behavior the elderly in general, as it is intended for the participation of the elderly with middle to middle-low class economic status. In the future,

more male participants and additional researchers to run the coding should be included in order to explore some hidden aspects and to cross-check whether the results will still show similar expressions to enrich the findings in the study.

The topic of increasing muscle strength in this context is based on physical activity as well as the intention to change behavior, and it is separate from changing nutrient intake.

6. Conclusions and further work

Collectivity traits were shown to be the main expression of the participants, and this will create opportunities for the researcher to focus the free-weight design based on this value along with the described aspects. The direct benefit orientation requires further analysis of the specific cohort so that this construct will correctly interpret the elderly's expectations and needs. Hence, the instructor's involvement signifies the reciprocity expectancy.

A similar result of handgrip strength with an economic status below the average for participants with an age of greater than 81 years old needs to get individualized attention. A suitable cohort of subjects should be limited to a younger generation of the elderly in future experiments. The findings of this study must be tangible to test the prototype free-weight device to measure the effectiveness of the device and the user engagement of the participants. When the experiment is completed, it will be able to be compared within subjects as to whether there is any significant improvement in functional capacity and behavioral modification.

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Designing Novel and Engaging Interactions with and for Residents Living with Dementia and their Visitors

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Abstract: This paper describes the interaction mechanism and content design of the "A Better Visit app" — a collection of touch screen tablet mini-games developed for people living with dementia and their visitors to create enjoyable shared experiences and spark social interaction between them. The published collection, available on the App Store and Google Play for tablet devices, is made up of eight different mini-games. The games were developed and refined over an 18-month co-design and observation process and matured to solutions that support easy to use games leading to meaningful interactions during the visit. Emphasis is placed on different sensory and creative experiences, skill development, and communication between the visitor and resident to live their relationship in the moment of time. The outcome are a specialised set of interaction mechanisms and recommendations developed to aid in the accessibility of the technology experience for people living with advanced dementia.

Keywords: interaction design; dementia; engagement; games

1. Interaction Design for Dementia

Presently, there are nearly 460,000 Australians living with dementia (Dementia Australia, 2020). Dementia is comprised of symptoms linked to exacerbated cognitive deterioration caused by disorders affecting the human brain. Some of these symptoms include memory loss, confusion, changes in behaviours and ability to communicate (WHO, 2017). As time progresses, families and friends may struggle to communicate with people living with dementia as they might not be able to follow conversations, often leading to increased stress levels for everyone involved (Maresova & Klimova, 2015). Engagement is crucial for people living with dementia in order to maintain capabilities and participate in stimulating activities leading to greater quality of life (Craig et al, 2014). Technologies have emerged as capable stimulation and engagement tools in formalised care settings and can be an important component of ageing well (Collier & Jakob, 2017).

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The benefits of tablet computing have been established within the dementia care space for over a decade demonstrating clear benefits to quality of life (Favilla & Pedell, 2014; Upton et al, 2011; Tyack & Camic, 2017). However, the majority of technology currently developed for people living with dementia focuses on creating life stories, entertainment and brain training (Health Direct, 2019). Not many technologies focus on the social aspects such as everyday communication with an emphasis on the here and now. Additionally, existing commercial apps are not always suitable for people living dementia due to their interactions, content or disruptive in-app advertisements. We see a need to design and develop technology that enhances quality of life for people living with dementia through social encounters where the technologies support maintaining and building of relationships. Hence, the developed app presented in this paper aims to facilitate meaningful interactions between family members and friends visiting residents with advanced dementia in aged care homes. We have adopted a point of view towards the development of our apps that respects the older adult and gives them choices instead of assuming what they would like and make decisions for them (Rogers & Marsden, 2013; Light et al, 2016).

Designing digital solutions for people living with dementia also requires taking into consideration impairments linked with age-related decline such as poor vision, hearing loss, limited touch and motor skills (Favilla & Pedell, 2013). Older people with moderate to advanced dementia may not be able to operate a touch screen without frequently resting their palm on the screen. They may also register multiple touches resulting in software crashes or require specialised interaction mechanisms to support feedback (Bree et al, 2017). Furthermore, levels of digital literacy are likely to be lower amongst older demographics as they still face barriers with adoption of new technologies (Anderson & Perrin, 2017).

In order to compensate for the challenges mentioned above, easy interaction mechanisms needed to be found. However, usability is not sufficient for a positive experience between two people. Aspects such as participants' engagement experiences with the technology (O'Brien & Toms, 2008) were considered throughout the co-design process. Non-patronising visual design and content based on the interests of the residents was also strongly emphasised. In addition, there are very limited resources on how to go about creating engaging apps for people with dementia — especially when also seeking to engage a visitor for a shared and meaningful social experience. Here we do not describe the whole co-design process with the older residents and their visitors, as this is detailed in Pedell et al. (2019). Rather, we focus on a selection of novel interaction mechanisms designed to address user experience challenges across a range of interactive touch screen tablet activities that were developed as part of exploring the research question "How can we co-design suitable touch screen interactions in order to maximise the benefits for older adults living with dementia and their visitors?".

2. Method and Design Process

In order to answer the research question, an eighteen month co-design process with

residents, visitors and aged care staff was applied. The process consisted of three phases:

1. Understanding the needs of both residents and visitors during a visit (interest-based design);
2. Systematic co-creative development and investigation of interactions;
3. Iterative evaluations.

The research and development were done by a multidisciplinary team consisting of a developer, psychologist, a musician and sound expert and a digital media designer completing their capabilities in this project. All team members had additional expertise and experience in interaction design.

We applied an iterative co-design process – this means people living with dementia and their care network were not mere participants in the project but co-creators and co-evaluators throughout each project phase (Sanders & Stappers, 2008) for every two weeks. The co-creative process took place in four different living locations of our residential care collaborator. During the regular visits we were applying the interaction studies with the participants. The co-design approach focused on including several stakeholders in the design process to ensure that the results meet the user needs (older adults living with moderate or advanced dementia, aged care staff, and visitors). Effectively, the role of the user transcends that of 'user as subject' and becomes one of partnership with the designer (Sanders & Stappers, 2008, p.1). Co-design is highly beneficial in the development process, as it gives a unique insight into user needs, preferences and ideas, and hence creates products that are more likely to be taken up while these needs were addressed (Taffe, 2015). When it is carefully organised and implemented, co-design can result in a sustainable solution and enhance quality of life of its users (Sanders & Stappers, 2008).

At the commencement of this process we spent time with participants, learning about their interests and trialling touch screen applications to assess the suitability of pre-existing software, and elements therein. Craig (2017) recommends that meaningful activities need to be informed by interests and aspirations to increase quality of life. We also had a strong focus on their emotions during technology use. Demiris et al. (2004) argue that "the challenge as we create new technologies, is to understand the personal effects of the technology in order to make it better serve our human purposes" (p. 93). Hence, emotional aspects of the desired user experience was investigated through the co-design process, too. The technology developed in this project was particularly challenging, as it must fulfil very specific needs and hard-to-define feelings such as "feeling engaged" and "sharing an experience". Previous research has found that adoption rates are particularly low when technologies do not address the emotional and social needs of the older demographic (Pedell et al, 2015). Hence, incorporating emotion-led design as developed by Pedell et al. (2019; 2015) and interest-based methods (Beh et al, 2019,) at the start of the innovation lifecycle of the technology interface is critical to the objective of achieving a high level of adoption of this technology and consequently an experience of the positive effects of its use. During the co-design process we used iterative prototyping as a way of refining requirements

(Beynon-Davies et al, 1999) and as a data collection tool to provide insight into technology supported engagement of adults living with dementia. Participation was leveraged directly from discussion and observation during on-site activity every two weeks. Residents with dementia, staff members and visitors were participating by interacting in real context with the maturing high-level prototypes that were derived through many iterative development cycles. This approach ensured that the team's primary focus remained on the goals and daily activities of the residents. This is important, as they will not merely evaluate the usability of the technology via concrete traditional and measurable tasks but will focus on the impact of the technology supporting adults with dementia through engaging and calming experiences. After every visit, we refined the interactions, and towards the end of the co-design process came up with recommendations for touch screen design for people with advanced dementia. In this paper, these co-design activities with older adults comprised of what we call 'designing interactions'. The co-design process gave all stakeholders a strong voice in the design concept and content and ensured agency was applied. For details on the process please refer to Pedell et al. (2019).

3. Designing for Meaningful Shared Interactions

Eighteen residents living with moderate to advanced dementia and their main visitors (often partners, children and carers) were recruited from four separate residential care homes. Many of the participants had no previous technology experience and a range of conditions including loss of touch and tactile sensitivity, restricted vision, aphasia, and shortened attention spans. Hence, a wide range of interaction solutions needed to be found to accommodate these challenges in order to achieve an enjoyable and sociable experience. Our objective was to develop a range of novel, non-patronising tablet-based interaction mechanisms that engaged people living with moderate or advanced dementia and people from their support network (family, loved ones, carer staff) in a shared social experience.

3.1 Interactions for advanced dementia

Traces (see figure 1) was an interaction designed specifically for people with advanced dementia but was also often used as an activity to introduce participants to touch screen interactions or as warm up. Traces presents an empty screen that transforms touches into colourful traces of light which follow the path of the input multiple times before dissipating. This simple interaction aims to reward all forms of touch, with nothing being a mistake and no specific game objective. Through multi-touch, both players were able to interact at the same time, copying or chasing each other's traces around the screen. It was also easy for visitors to guide the resident's hand to help facilitate interactions. The default trace length and loop count values were set to avoid the scene becoming too cluttered but were also configurable by the users.

During co-design, we found lively music paired well with the activity influencing the participants' input and flow. Uplifting background music was produced based on user

preferences and music memories encouraging engagement in the form of humming, nodding and finger-tapping. The interaction was successful at engaging people with advanced dementia, and in particular, participants with severe speech aphasia.

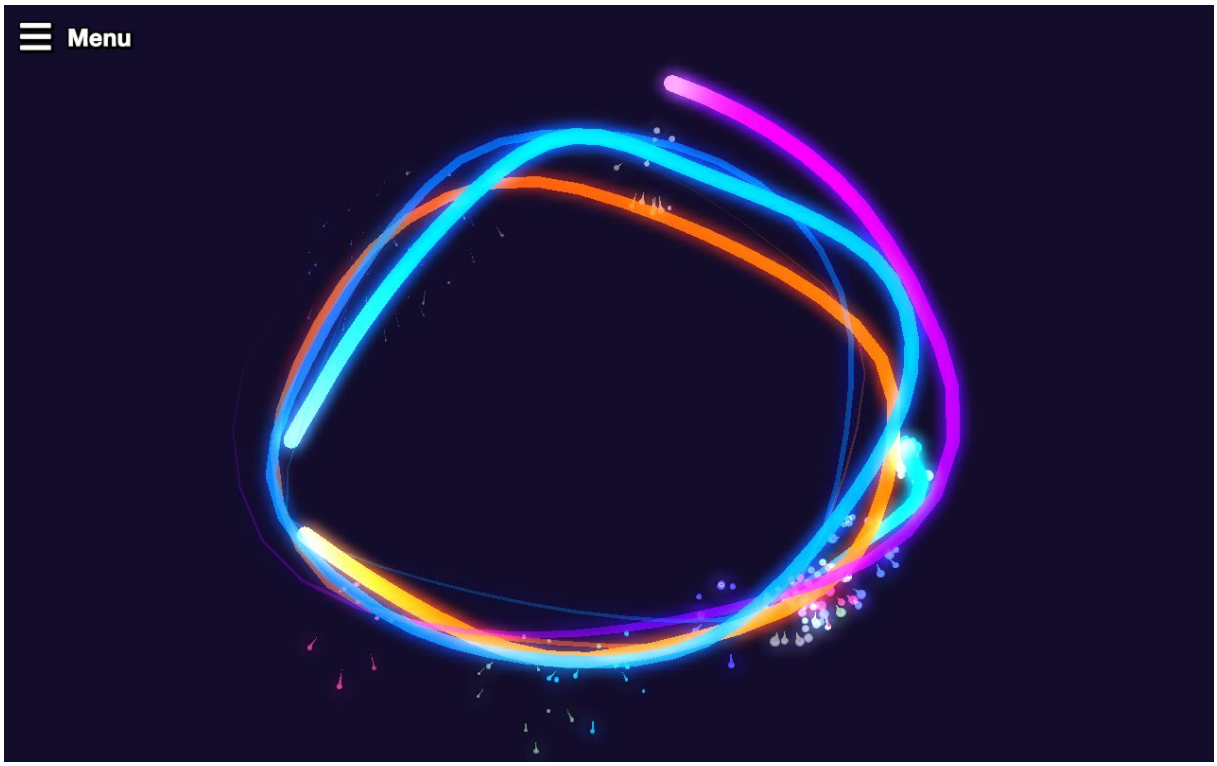

Figure 1 *Traces. The application enables users to experience in free exploration how a touch screen works.*

3.2 Competitive game activities

Tic Tac Tango was based on the traditional game of Tic Tac Toe but with a musical, ballroom dancing twist. This design flair responded to a number of participants' life experiences embracing ballroom dancing culture. Noughts and crosses were replaced by the silhouettes of dancing couples in respective player colours. With each move, music loops selected from familiar dancing styles including Foxtrot and Mambo, sequenced through highlights of the dance track recordings. The integration of music into the activity, played a key role in maintaining concentration and engagement. Participants would play to a driving groove, the carer or loved one amazed when they would genuinely lose a round in a match.

The presentation of the interaction is supported with bold type and strong contrasting colours (see figure 2). Colours were also used to cue game turns indicated by grid lines and the gameboard background.

An accessible tap mechanic was introduced here to aid in the games core interaction of claiming tiles. This was combined with a tile cool-down mechanic: a minimum length of time that users need to wait after claiming a tile before being able to claim another, which

helped reduce accidental interactions and premature selections (see smaller, transparent icon in figure 2). The duration of the cool-down was refined overtime to maintain responsive gameplay, which was important to avoid frustration or confusion, while still fulfilling the intent of the cool-down.

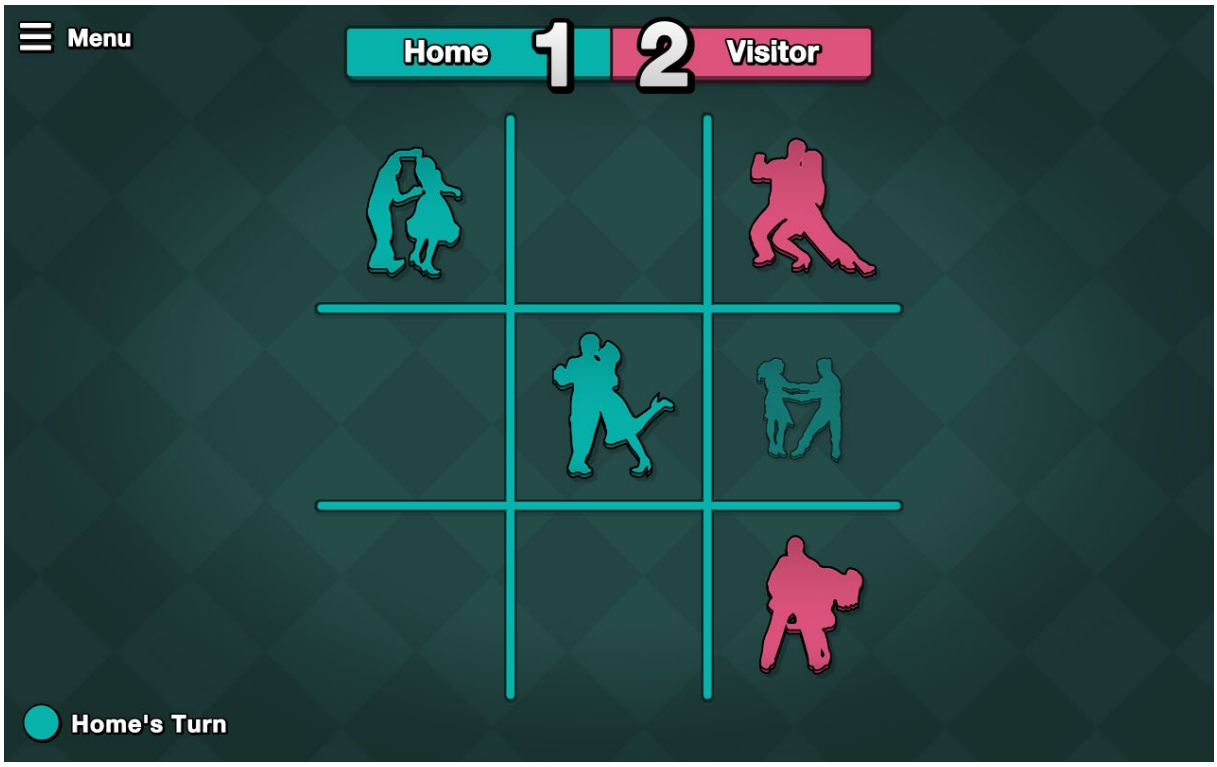

Figure 2 *Tic Tac Tango. Taking turns in a classic game of Tic Tac Toe supported by music to try and be the first player to place three marks in a row (horizontally, vertically or diagonally).*

Bowls, a lawn bowling game (see figure 3), included the most complex interactions of the different games, requiring a degree of mechanical precision from users. Despite the potential complexities of the mechanics, we were intent to pursue with the development due to the popularity of lawn (and carpet) bowls amongst the participants. Furthermore, we felt this may also be a suitable candidate to engage younger co-players who are visiting their relatives.

Early prototypes included an enclosed 8 x 40 metre virtual rink with a ditch at the far end. The game was presented from a bird's eye view using a device in a portrait orientation which naturally catered to the elongated dimensions of the rink.

We explored several interaction methods for launching the bowls including swiping and dragging. The swiping interaction, which interpolated directional input velocity of a swipe into a launch vector, quickly proved to be difficult for users to control. The drag-based interaction was split into two methods:

1. "Forward", dragging the bowl forwards, towards the intended launch direction;
2. "Slingshot", dragging the bowl backwards, inverse to the intended launch

direction.

Both drag methods imposed a limited radius in which to drag the bowl, with the resulting distance between the launcher origin and input position dictating the power of the shot rather than the velocity of a swipe. This allowed users to control the launch without time being a factor, thus making for a more manageable interaction.

Our observations indicated that the “Slingshot” method provided a better experience. This was particularly evident when the person with dementia needed support, it was much easier for the co-players to gently guide a finger backwards than pushing it forward. While the drag-based methods provided more control they still presented some challenges:

- Staggered or interrupted touches—common for older users with dry skin and impaired motor control—would lead to premature launches;
- Unintentional extra touches could also misdirect a shot.

Refinements were made to the launchers to only process a single touch input at a time; however, to more thoroughly resolve the issues, a confirmation mode was introduced.

The confirmation mode allowed users to continually adjust the trajectory and power of a shot over multiple touches and then release it, when ready, by tapping a separate button. This extra step greatly reduced accidental launches whilst also leaving a window for co-operative intervention or guidance. The “Quick Release” mode was retained as an option for those who preferred to bowl in one fluid motion. Nonetheless, the confirmation mode was designated as the default mode due to the benefits it brought for the broader player base.

A dynamic camera system that allowed us to match and highlight the current game state with specific views (Pinelle et al, 2008) was introduced when the game was switched to display in landscape orientation. When taking a shot, the view was from the perspective of the player looking down the rink, placing focus on the launch interface (see figure 3). After a shot was played the camera would look down at the play area to review the resulting lay of the shot and potential strategy at play.

Familiar sounds were introduced to support interactions and increase immersion:

- Swooshing for launching;
- The subtle crinkle of the bowl rolling on the grass;
- Clanks and bounces for collisions with volume based on impact velocity;
- Crowd cheers for celebrating the end of a round.

The collisions between bowls became a satisfaction point for many, regardless of how successful a shot ultimately was in the scope of the game.

A weighted bias was added to the bowls to create curved trajectories, a feature requested by participants to mimic the real-world equivalent. To avoid adding another layer of complexity, the launcher determined the curve direction automatically. If a shot was aimed to the left of the jack it would then curve right and vice versa. A button indicating the direction of the curve was also added to the graphic interface. This button could be toggled by advanced

users to override the automatic curve direction on a shot by shot basis. While the curve sometimes surprised players, most became comfortable with the mechanic over the course of a round.

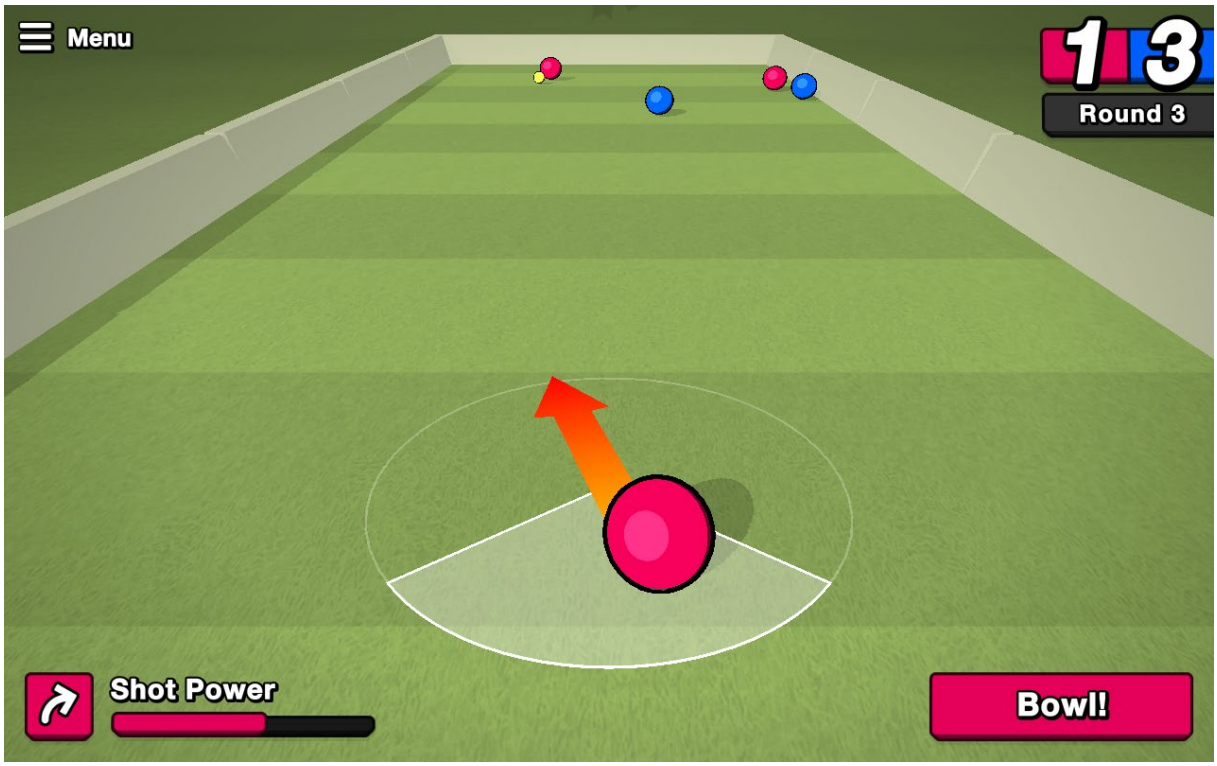

Figure 3 *Bowls. The slingshot mechanism combined with the "Bowl!"-button enables the user to adjust direction and strength of the shot before it is launched.*

Early user testing revealed that a high ratio of shots wound up in the ditch at the end of rink. Therefore, we opted to remove the ditch entirely. This allowed bowls to bounce off the rear barrier, keeping all shots in play and eased the punishment of high-powered shots that missed their mark.

We aspired to make a game that would be considered competitive for both players. This included experimenting with an assistive software shot-making agent, and redirecting shots towards the jack for the person living with dementia. However, no matter the subtlety, the automatic assist was often far too obvious, disrupted shots that might have been intentionally directed elsewhere or simply ineffective. Additionally, residents and co-players would often play as different teams and only for a single round making determining when to use the assistant problematic. Ultimately, curating the launcher's properties to fit the rink by limiting trajectories to a forward arc; clamping power levels along a curve; allowing rebounding off walls; and removing the ditch to keep all shots in play, allowed us to effectively make more shots, and good shots.

3.3 Picture–based games to increase communication

Reveal (see figure 4) presented a grid of tiles which can be tapped to reveal part of an image. While the activity is similar to a jigsaw puzzle the pre-positioned tiles avoid the need to place pieces in a specific position, a task that can be next to impossible for some people with dementia. The tile-based interactions also lend themselves to turn taking while generating natural discussion between players as they tried to decipher who or what the image might be. We also presented a question or talking point alongside the title of the image when it was completed to encourage further discussion and mutual storytelling.

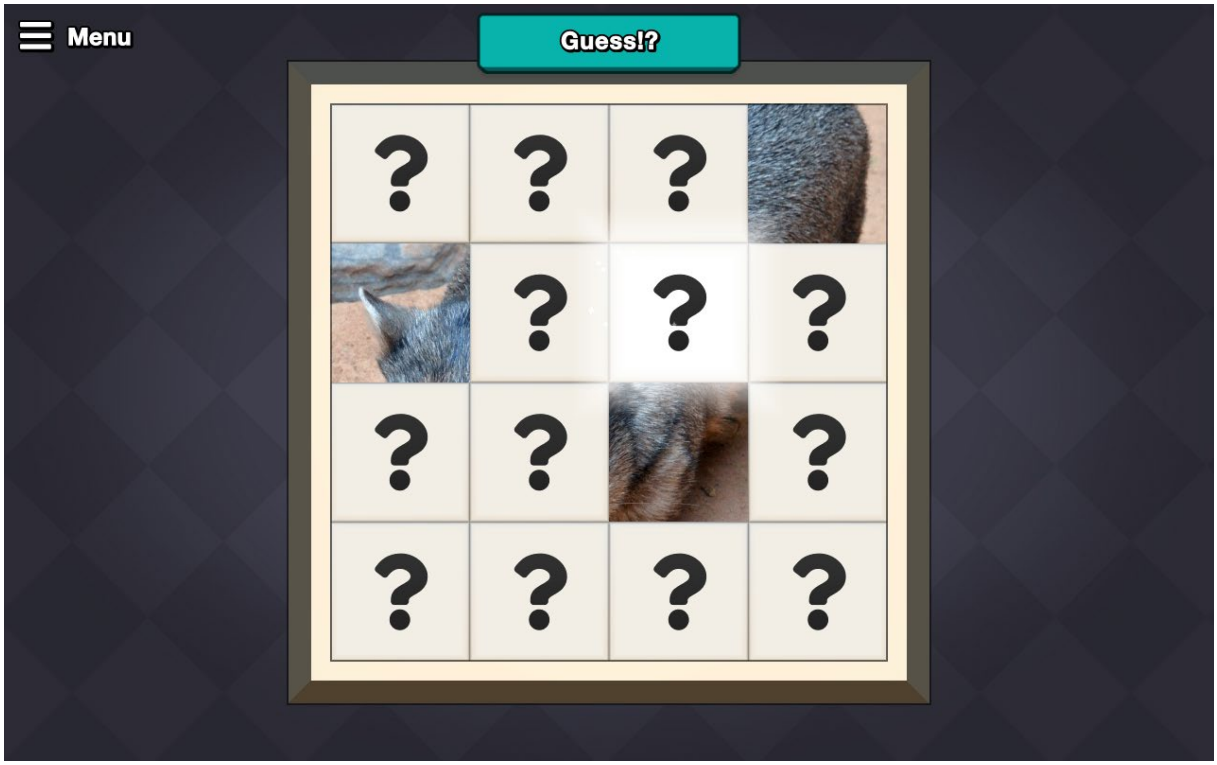

Figure 4 Reveal. Tiles that are turned successively to uncover pictures of popular motives.

Initially, guessing the hidden image was an informality. However, some users were keen to move onto the next image once they believed they had identified it. To address this, we added an optional guess mechanic which was available after each tile turn. The guess dialogue presented a selection of four options, with a correct guess automatically completing the image. Gameplay was also supported by audio queues helping to keep players engaged or spark conversations.

One visitor appreciated the guidance and prompts for the conversation in the activities of the games, feeling it gave her something to share that was easy to relate to for both:

> "Oh yeah the animals. Oh yeah, the sounds! I remember saying to dad: 'what sound would that be?' it gave a question, for me to say something, instead of just bumbling on. More about yeah, trying to have something where we're relating to this thing and speaking about it there and now instead of just waffling about 'oh the tree down the road' or whatever."

Instead of turning tiles to reveal an image, the colouring book inspired Co-Colouring (see figure 5). The activity used free form multi-touch swiping to magically colour-in a series of outlined artworks, which come to life with animation when completed (such as the parrot picking the seed pot). With multi-touch support, users were free to colour-in the images together as carefully or as carefree as they liked. The original artworks were based around familiar Australian themes (e.g. featuring native birds and backyard cricket), with the aim of presenting relatable and meaningful content that had the potential to encourage discussion and storytelling.



Figure 5 *Co-Colouring is easy to use while providing a feeling of accomplishment through an animation element once the picture is filled in.*

Similarly, Washing Windows utilised the same interaction mechanics as Co-Colouring but instead tasked users with wiping clean windows. Each window revealing a highly detailed location photograph. The locations themselves were again designed to encourage discussions and storytelling, often related to travel. Squidgy sound effects accompanied the users' swipes providing interactive feedback. Once completed, the view zoomed into the window for a clearer look at the revealed scene, whilst also displaying the location's name.

4. General Recommendations and Conclusions

The process of routine and tight iterations, co-design and interest-based design led to the development of interactions that were engaging, enjoyable and intuitive. Through the shared engagement, it was possible for care staff to gauge capabilities:

> "It helped me with some of the residents to find out their cognitive abilities which helped me judge what activities I could take them to. We have a lady that we did it with and after doing the app with her you realised that she could remember or that she knew a lot so she wasn't coming to activities that she should be really. That helped us out." The games helped with an experience in the present and without any obligation to deal with the past. One staff member explained: "Because you've been married to someone for so long and… so it was really good I think for couples like that, because it's irrelevant to the past, it's just something that they can do there and then and they're having that memory there and then."

In this section we summarise some interaction mechanisms from our research process as recommendations that helped to create these easy to use and enjoyable interactions.

4.1 Tapping

While the interaction of tapping on touch screens is generally intuitive, to people with moderate as well as advanced dementia it can be challenging. If moving a finger across the screen to an interactive element or continually holding a button would not result in anything happening, frustration or loss of interest would occur. Therefore we advise allowing for held interactions of around 1.5 seconds to trigger tap events. Additionally, tap and trigger events should accommodate touches that begin outside the target element space, meaning users could slide a finger onto a target element and release (or hold) rather than requiring touch events to begin immediately on the target element.

4.2 Layout and Language

The positioning of many interactive elements requires diligence. For instance, we believe menu buttons used for navigating between games and options, should be given a small footprint and positioned in the top left corner. This positioning is less prone to accidental touch input for older people with dementia. Menu screens should also always present a clear route to return to an interaction (or game) in the event they are accidently engaged.

While interaction is generally scaffolded by a co-player there is no guarantee to the level of digital literacy of this individual. Therefore, it is important to present simple, navigable interfaces with accessible language. In addition, moderate and advanced dementia users unfamiliar with touch screens would require quality visual and audio feedback (e.g. audio pings, clicks and visual sparkles) to support their interactions.

4.3 Audio

Music can greatly assist with mood, attention, and engagement. Playing favourite tracks in the background during test sessions can also create positive co-design input through better attention and prompt reminiscence. Music where possible should be selected based on personal or generational preferences of users.

4.4 Default Settings

Many of the games allowed the users to modify a selection of dynamic settings to suit their

preferences. However, the majority of users always played with the default settings. This reinforces the importance of selecting the right base values through rigorous play-testing. Interactions should be iteratively tuned as much as possible throughout the entire co-design cycle.

4.5 Exploration and Instruction

Even when interactions for people with dementia are extremely simple, instructions may still be required. To that end, we recommend including modest tutorials explaining how to play. Tutorials are best displayed at the commencement of each game, just once per session. We also suggest allowing tutorials to be manually disabled in settings panes if preferred by regular users of these activities.

4.6 Consistency and Device Recommendations

We strongly advise for a consistent screen orientation when presenting a collection or range of different activities. A landscape orientation is better suited for dual use settings. Touch screen operating systems often employ special gestures to facilitate system navigation or other functions. Unfortunately, for those unfamiliar with these actions, they can quickly and unintentionally interrupt the use of an app by accidentally send the app to the background (minimising the app). Where possible this should be avoided, for instance, requiring two consecutive edge swipes to trigger the dock on iOS. However, some of these settings are set from a system level, such as multi-tasking gestures, making them difficult to override. Therefore, we advise the inclusion of instructions recommending the disabling of multi-tasking gestures from the application's "How to Play" menu and App Store page.

4.7 Conclusions

This research showed the relevance of carefully designed interaction for social engagement using touch screen tablets. Through a range of activities and suitable interaction mechanisms, older adults living with moderate to advanced dementia were able to engage in a shared social experience. The diverse mini activities were matched to the limited attention span of people living with dementia. Our in-depth understanding of the capabilities and needs through the co-design process allowed us to come up with novel interaction mechanisms specifically for older adults with dementia and formulate some guidelines that we suggest can support designers for development of touch screen applications in the future. Rather than showing off the touch screen capabilities, it was more important to focus on interactions and adaption of the tablet to the residents' needs and interests. The extensive time window in designing the interactions proved to be important to the app's success. Engagement is highly relevant for people living with dementia and promising for future technology extending the activities stepwise towards new use scenarios. In particular, the engagement responses (such as nodding of heads and tapping of fingers) are an important indicator for quality of life as during the progression of the level of dementia often emotions increasingly diminish (Vink et al, 2003). A careful balance between stimulation and familiarity

needs to be maintained to create successful and supportive technologies in social settings. Providing common ground and a familiar setting are crucial for interactions for positive experiences – while we consider the interaction mechanism implemented in the "A Better Visit" app as novel we recommend not to overdo 'novelty' or try to revolutionise the setting itself or the activities, but learn from the older adults' interests.

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DRS2020
BRISBANE, 11–14 AUG
SYNERGY

Editorial: Designing for Responsible Action in Times of Need – the Design for Behaviour Change SIG

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Human behaviour is perhaps the single biggest factor that impacts our lives, our environment and our world as a whole, creating significant challenges from climate change to the Covid-19 pandemic. The last half year has clearly demonstrated this in regards of both. Whether one believes that Covid-19 is an unavoidable evolutionary development or a result of careless human action, differences in how individual nations have handled the pandemic have shown clear differences in results. Where precautions were taken early, the rise and spread of cases was significantly slowed and reduced. Where not, the reverse has been the case, as for example in the USA and Brazil, resulting in large numbers of casualties (WHO, 2020a, 2020b).

The events of the last half year have shown that behaviour change is vital. Not only regarding the immediate effects of the pandemic, but that drastic actions to change behaviour can be taken, and quickly, and that they can affect other areas, such as climate change, in that the lockdown in many countries has led at least to a temporary reduction of CO2 emissions, improvements in air quality, and a recovery of fauna and flora (Arora, Bhaukhandi and Mishra, 2020, Upadhyay Yadav, 2020). This demonstrates that action can be taken, that we can change our behaviour to make our world a better and safer place - if only there is a will!

However, behaviour change is not a mechanistic thing. Rather it is fluid, and to enable behaviour change requires constant assessment of oneself in relation to one's environment to engender and maintain responsible action. We all need to play our part in this, do our bit, whether for sustainable action to halt climate change, or to improve safety, or health. This section track of the Design for Behaviour Change SIG and related papers, investigates and offers philosophical underpinnings, strategic approaches and practical examples of how design can aid and help us implement behaviour change whether on individual or global levels.

In her paper 'Strange bedfellows: Design research and behavioral design' (paper 252), Ruth Schmidt examines the application of behavioural economics principles to real-world

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challenges and its shortcomings. She proposes that the synthetic nature of design research positions it well as a complementary partner to behavioural economics to address complex behavioural challenges. Together, its systems orientation and humanity-centered perspective enable design to address issues of context, evidence, and problem framing and thus to address "wicked problems," (Buchanan, 1990) that otherwise may resist analytical efforts.

The paper by Ferrarello, Hall, Anderson, Cooper and Ross on 'Designing Cross-Disciplinary Relationships for Improving Safety' (paper 129) expands on the idea of design for behaviour change with regard to its strategic implementation. Based on two cross-sector collaborations involving over 200 stakeholders, the authors present the resulting design-led strategy for preventing and mitigating future global risks through a new culture of safety. Its co-production-based development draws on people's capability for resilient through adaptation and creativity.

The last two papers in this session offer examples for practical implementation of design for behaviour change. Investigating how to translate intentions into actions, they present two closely related and complementary examples on health and exercise.

Daphne Menheere, has conducted 'A Diary Study on the Exercise Intention-Behaviour Gap: Implications for the Design of Interactive Products' (paper 329). A small scale, qualitative study, Menheere has investigated the barriers and enablers that affect the discrepancy between people's intentions and final actions, and why any changes to the original actions occurred. Insights include how experiences either enable or inhibit intended actions and are exemplified through three design proposals to promote positive action.

Also concerned with increasing physical activity to facilitate a healthier lifestyle, in her paper 'Meeting Afoot – A Step Towards Transforming Work Practice By Design Of Technical Support' (paper 262), Helena Tobiasson reports on her research into ways of reversing the gradual shift towards a more sedentary lifestyle. Researching how to adapt current work practises to allow people to be more physically active, she presents the case study of 'Meeting afoot', a system, which has been co-designed to support walking-meetings, which allow for physical activity during working meetings.

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For more information on the Behaviour Change SIG, please visit the SIG's webpage at https://www.designresearchsociety.org/cpages/behaviour-change-sig. To find out whether the SIG is organising a satellite event to the DRS2020 conference, or just to get in touch with members and see news on the SIG, please visit the SIG webpage.

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Strange bedfellows: Design research and behavioral design

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Abstract: Behavioral design—the application of behavioral economics principles to real-world challenges—has achieved success across a variety of domains, yet its scale and effectiveness has been limited by its narrow focus on behavioral change to frame problems. While some have suggested that joining forces with the social sciences and other analytical problem-solving methodologies might help overcome its perceived deficits, the more generative and synthetic discipline of design research is particularly well positioned to be a complementary partner due to design's systems orientation and humanity-centered perspective to issues of context, evidence, and problem framing. This disciplinary integration has the potential to be particularly valuable with regard to so-called "wicked problems," which tend to resist analytical efforts. In contributing a more expansive lens with which to surface and develop potential hypotheses, design research shows great promise in its ability to partner with behavioral design to take ground on these complex challenges.

Keywords: design research; behavioral design; interdisciplinarity; framing

1. Introduction

Applied research from behavioral science—frequently referred to as "behavioral design"—has been effectively applied to a variety of domains, from public policy and health care to financial services and sustainability. Grounded in empirical research into human behavioral tendencies rather than the design methodology implied by its name, and applied most regularly to last mile behavioral change problems "for good" (Soman, 2015; Thaler & Sunstein, 2008), behavioral design offers the promise of informing smart-on-paper solutions with insights about how people *actually* behave, rather than what they say they will do. Despite its origin in the interdisciplinary collision of insights from cognitive psychology with economics' assumptions of behavioral rationality, behavioral design itself has been somewhat slow to embrace other fields. More recently, however, it has begun to engage more with a range of social sciences in the interest of seeking complementary analytical

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perspectives, particularly in the realm of public policy.

But is this sufficiently bold? Behavioral design practitioners have increasingly faced a reckoning with regard to its strengths and limitations, in particular its limited ability to scale solutions in the absence of generalizability principles, an over-emphasis on individual behaviors over those of social communities or systems, and the desire to move earlier in the design process to better address upstream root causes and "wicked" problems (Sanders, Snijders, & Hallsworth, 2018). Extending an invitation exclusively to the social sciences risks introducing a self-imposed barrier to these goals; while these nascent partnerships promise to stretch behavioral design's perspective to some degree, their shared grounding in theory-driven, analytic methodology and operational problem-solving mindsets threatens to deliver more of the same.

In contrast, the disciplines of strategic design research and design thinking and their generative, abductive approach to problem solving has been recognized as well-suited to tackle the ambiguous, adaptive systems challenges (Buchanan, 1992) that behavioral design yearns to address. In particular, its expansive conceptions of context, evidence, and problem framing to supplement behavioral design's strengths in evidence-driven approaches and testing rigor make it a potentially formidable potential co-conspirator.

Design research is not entirely unfamiliar to behavioral design, which already incorporates limited design activities into current practice (Hampton, Leung & Soman, 2016; Tantia, 2017). However, too often this collaboration forces design research to confirm to behavioral design's analytic problem-solving methodologies, rather than working in true productive tension as interdisciplinary partners. This not only reduces design's potential effectiveness when addressing individual behavioral challenges, but also prevents the intersection of these two disciplines from maturing into a truly interdisciplinary pursuit that can amplify the best of both fields.

2. Expanding context through problem framing

Behavioral design has historically emphasized discrete instances of behavioral change and an advocacy for "think small" solutions [Soman, 2015], leaning heavily on adjustments to environmental choices contexts to inform solutions. While this focus on improved choice architecture has been shown to effectively support behavioral "nudges" (Thaler & Sunstein, 2008), and there has recently been an increased appreciation for the ways in which cultural context can impact individuals' behavioral tendencies has contributed additional nuance to how and when we expect interventions to work (Banerjee, Promothesh, Mishra & Mishra, 2019; Haushofer, Jang & Lynham, 2017), it tends to neglect other important contextual considerations (Feitsma & Whitehead, 2019). This can be highly problematic when, in focusing on achieving precise and isolated behavioral change, we insufficiently acknowledge and address contextual clues that may initially seem unrelated or inconsequential, but which have outsize impact or contribute to unintended system effects.

The value of using design research to expand behavioral design's conceptions of context can

be illustrated most clearly by instances where interventions informed only by behavioral research neglected to consider important social, cultural, or personal contextual issues that are the bread and butter of design research. Organ donation, long used as an exemplar of behavioral design success, presents a clear case where this proved to be an issue: Although "opt-out" interventions can be an effective lever in increasing the number of people designated as organ donors, they are less successful in delivering the impact that actually matters—successful transplants—if they fail to consider the critical context that donor's families' often do not perceive opt-out mechanisms as a valid form of consent (Lin, Osman, Harris & Read, 2018).

The ongoing US water crisis in Flint, Michigan, where lead-tainted water supplied by the municipality has resulted in significant health issues, particularly in children who are more vulnerable to the effects of lead positioning (Green, 2019), presents another case in point. Early efforts to focus on discrete behaviors like hand washing or the use of water filters and bottled water failed to gain community traction in the absence of considering broader perceptions and barriers to adoption that had a material impact on the uptake of new desired behaviors (Stillman, 2017). In both the organ donation case and in Flint, while narrow behavioral framing in the interests of nudging behavior may well have achieved some gains, expanding the definition of what problem we are solving for through introducing design research insights would likely increase the potential success and impact of interventions.

2.1 Limitations of narrow framing

Behavioral design's urge to narrowly frame problems is inextricably tied to its disciplinary roots in a technical, scientific-method problem-solving approach, where a tightly defined focus on behavior change has multiple compelling methodological benefits. First, tackling discrete problems and last-mile behavior change effectively narrows the gap between *internal validity* gained from the specific, reproducible experimental findings that are often used to inform interventions, and *external validity*, or the likelihood that those findings are a good fit for the vagaries of real-life context (Camerer, 2011). In addition, when the delta between an original state (Behavior A) and a new desired state (Behavior B) is highly quantifiable and evaluation-ready by the "gold standard" of randomized control trials (RCTs), we can more easily compare different interventions against one another to gauge their relative success.

But while these attributes may increase researcher confidence, they also pose constraints. When complex problems are conceived of as technical issues, or when a perceived fit with analytical methodology becomes a primary determinant for problem selection, we also may create an overly reductive model that artificially limits what problems we solve for by prioritizing measurability over reality. The contextual nuance commonly surfaced through design research is often not perceived to be directly related to behavioral change efforts, and thus is often kept to the periphery where it may be inadvertently dismissed or interpreted as noise when, in fact, it is actually a critical component of the problem to solve. Research on organ donation, for example, has found that in addition to considering behavior at the family

unit, rather than that of the individual donor, the introduction of donation coordinators at hospitals may have a more significant impact on increase successful organ transplant rates (Fabre, Murphy & Matesanz, 2010; Rudge, 2018). In other words, even if opt-out default interventions that directly address behavioral change effectively increase the number of people designated as organ donors, at best they may be solving only part of a problem; at worst, their focus on behavior at the expense of other contextual conditions may mean they are solving the wrong one. This effect is amplified when solving for wicked problems, whose contextual complexity, unique composition, and multiplicity of perspectives tend to be notoriously resistant to analytical and data-driven approaches. But if the complexity and uncertainty of wicked problems resist reduction to behavioral change and methodological "fit," this should perhaps be perceived as a limitation of behavioral design methodology rather than an indication that the problem begs to be simplified.

2.2 Expanding on problem framing

In behavioral design, the notion of "framing" is characterized by "the manner in which the choice problem is presented as well as by the norms, habits, and expectancies of the decision maker" (Tversky & Kahneman, 1986, p. 257). This is typically positioned as a strategy to improve choice architecture solutions by recognizing, for example, that positioning an operation has having an 80% success rate versus a 20% chance of failing often leads to different interpretations and subsequent actions.

The notion of framing as a form of problem definition is already familiar in design (Alexander, 1977; Dorst, 2015). Much like a photographer frames a composition by choosing to include certain elements and omit others, we can actively choose to define our solution space to determine what's in and what's out. This also means designers can develop multiple frames to conceptualize the matter at hand from a variety of perspectives.

When we apply this concept to problem definition, we can establish how we conceive of a challenge, its potential solutions, and even what qualifies as a viable problem. For example, positioning urban renewal of public housing as either a congenital disease to be eradicated or as an organic community in need of cultivation (Schon & Rein, 1994) is not merely a semantic distinction but the implantation of two distinct mental models that conceptually bound what contextual considerations, proposed solutions, and resultant actions qualify as valid in radically different ways. Similarly, framing Flint's water crisis as an issue of hygiene versus one of water containing contagions (Nimishakavi, 2016) leads to two very different conceptions: the first implicitly promotes the universally recognizable binary opposition of cleanliness (good) over filth (bad), but also puts the onus on citizens to be the responsible agents of change and elides the realities of bottled water costs. The second recasts an entirely different narrative of villain (municipality as poisoner) and victim (citizenry as poisoned) and suggests more nefarious, even criminal, motives and need for reparations.

In the organ donation context, the addition of non-behavioral frames would have likely more quickly identified the disconnect between opt-out mechanisms and family wishes and the

need to expand the problem scope beyond behavior much change earlier on. An institutional frame like "Increase the number of successful organ transplants" could have delivered systems-level, strategic outcomes by suggesting that we must get donated organs in the right bodies to benefit the entire donation system in addition to individual recipients, while a human frame, such as "Help people take actions that align their personal values with the societal value of donating organs," could have focused on end users' latent aspirations and needs related to personal values and kinship—such as the fact that donor's families' often did not perceive opt-out as a valid form of consent—that was not reflected in behavioral design's narrow focus on behavior (Parsons, 2002).

3. User insights as evidence

Achieving the right unit of contextualized problem definition through this process of reframing relies on qualitative forms of evidence gained through open-ended, ethnographic methodologies that are currently under-leveraged in behavioral design. Generative design research activities can also provide valuable insight into humans' latent needs and beliefs in the same way that behavioral science research provides evidence of these latent behavioral tendencies. It's well recognized—and essentially the premise behind nudging—that what people say they want or how they intend to act does not always match their actual behaviors (Sunstein & Thaler, 2008). Qualitative explorations through design research can provide valuable contextual evidence in the form of misconceptions, a perspective on what people value, and sense of self that offer an oblique view into why this "irrational" behavior occurred.

Design's alternate conception of "evidence" also differs from traditional behavioral design methodology in that its intent is largely to generate new approaches, rather than to evaluate existing ideas to determine the chances of their probable success. In case of Flint's water crisis narrative, for example, only evaluating the incoming hypothesis that water filters and hand-washing were appropriate targets for behavioral change interventions (Nimishakavi, 2016) would have resulted in overly narrow solutions. Expanding the unit of analysis through design research approaches such as open-ended conversations allowed the team to recognize that community skepticism with regard to the government's motives and a long history of distrust toward public services would need to be addressed if *any* solution was to stand a chance of being effective (Stillman, 2017). This re-centered the focus of attention from behavioral change to the community, and solving for a human context rather than simply for a new behavior.

3.1 Human(ity) centered design

While both the organ donation and Flint water examples illustrate the value of expanding beyond individual behaviors, they also suggest a parallel need to take the biased nature of systems that develop and implement policy into account. The fact that public officials and hospital administrators are also human, and thus may also struggle with bounded rationality

(Simon, 1957), is both unsurprising and crucial to recognizing when solutions might perpetuate or even amplify existing system inequities.

As an analytic, theory-driven problem solving approach, behavioral design tends to work top-down from principles derived from published experimental findings. While this reliance on empirical results can bolster confidence in proposed interventions, it often inadvertently excludes evidence from the citizens or end users at the receiving end. This can result in policy based on an assumed shared base of values that does not exist, or smart-on-paper solutions that fail to consider contextual and evidentiary elements that are fundamentally obvious to those on the ground but harder to recognize from above.

Unlike design research, which typically acknowledges the need to solve challenges at a systems level, behavioral design has traditionally been concerned with individual behavioral biases and tendencies. In the case of more complex or "wicked" problems, therefore, the use of design methodologies may be especially beneficial. In particular, methods from "systems design" such as value webs (Kumar, 2009) leverage points and feedback loops (Meadows, 1999, 2008), and the examination of multiple forms of capital and the flows between them in the context of circular economies (Flora, Flora & Fey, 2004; Noguiera, Ashton & Teixeira, 2019) can help practitioners break down complexity and construct effective solutions for emergent and adaptive systems, allowing solutions to achieve a balance between capacity-oriented top-down resources (such as financial and infrastructural assets) and human, social, and cultural values that are more likely to be defined bottom-up by from within communities.

4. Strange bedfellows: Achieving disruptive interdisciplinarity

While it is generally accepted that a primary criterion for interdisciplinarity is the integration of knowledge from multiple disciplines (Jacobs & Frickel, 2009; Barry, Born & Weszkalnys, 2008; Choi & Pak, 2006), some suggest that achieving true interdisciplinarity requires meeting three additional attributes: application to real-world challenges, a comprehensive perspective, and a fundamentally disruptive element (MacLeod & Nagatsu, 2018).

Even with its closer cousins in the social sciences, behavioral design faces potential barriers to this deeper form of interdisciplinarity that may be partly explained by the nature of its origins. Two constructs have historically characterized the intersection of economics and psychology: the first positions this hybrid as a parallel, but distinct, approach to traditional economics [Simon, 1988], while the second situates this emergent discipline as a counterpoint to economics' rational norms in order to explain "irrational" deviations (Sent, 2004; Feitsma & Whitehead, 2019). As a representative of the latter school of thought, this creates something of a bind for behavioral design. By positioning itself in contrast to economics and focusing on exceptions to the rule where rationality fails to hold, other fields that have little to say about this "rational versus irrational" duality may simply seem irrelevant (Bruch & Feinberg, 2017) to its *raison d'être*.

However, behavioral design's receptivity to fully partnering with design is further limited

by another hidden-in-plain-sight issue: attempts to expand the roster of potential partners have historically tended to include only other analytical disciplines—public administration, sociology, anthropology, political science, and cultural studies—to the table (Feistma & Whitehead, 2019). This implicitly designates an analytic and empirical mode of inquiry as the singular legitimate approach, and suggests that only analytical mindsets and methods need apply. Intended or not, the resulting implication is that potential partners are doubly bounded, first by behavioral design's worldview and mantle of "not economics," but also by the assumption that only the social sciences and other fields grounded in an analytical approach are viable candidates for interdisciplinarity.

Yet introducing behavioral mechanisms and choice architecture in the context of real-life environments is a *synthetic* task that benefits from generative sensibilities, not merely analytic ones. Embracing under-defined areas of context and a richer diversity of qualitative and quantitative evidence is essential to our ability to construct, not merely select, solutions that are both effective and equitable (Schon & Rein, 2005; Winner, 1980). If we are to disrupt behavioral design methodology to achieve more impactful ends, it may very well come from being more integrative and recognizing where invention can extend insights from research (Golsby-Smith, 1996). In other words, just because design did not receive an invitation to the table doesn't mean it can't crash the party.

4.1 A comparative model for problem solving

As noted above, design is not entirely absent from behavioral design, showing up in the occasional call for "empathy" or user insights (Tantia 2017; Soman, 2015). Yet while design methods can still provide value in this limited form they are clearly subordinate, playing a support role in service of what is still an analytical problem-solving approach, and thus not truly interdisciplinary (Barry, Born & Weszkalnys, 2008). As a result, this approach is unlikely to upend behavioral design's core assumptions or methodological approaches.

How might strategic design research play a more impactful role as partner and provocateur? A closer look at the methodological arcs of behavioral design and strategic design can provide some insight, through a simple framework that positions notions of abstract and concrete against the activities of making and thinking (Kumar, 2012) depicting quadrants in which we can situate common problem-solving activities:

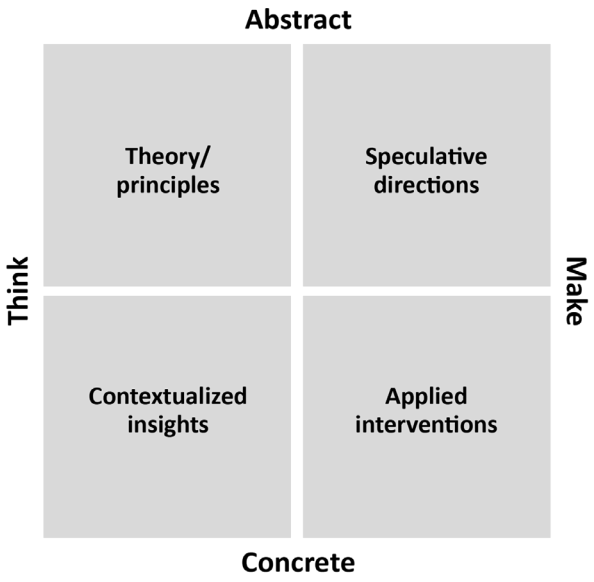

Figure 1 *A model for mapping problem-solving processes*

Visualizing the problem-solving arcs of behavioral design and strategic design illustrates how these paths contribute to different processes, and subsequently to different mindsets and outcomes. Given that behavioral design was developed largely as a response to economics, it is useful to include a conceptual model for economics as well.

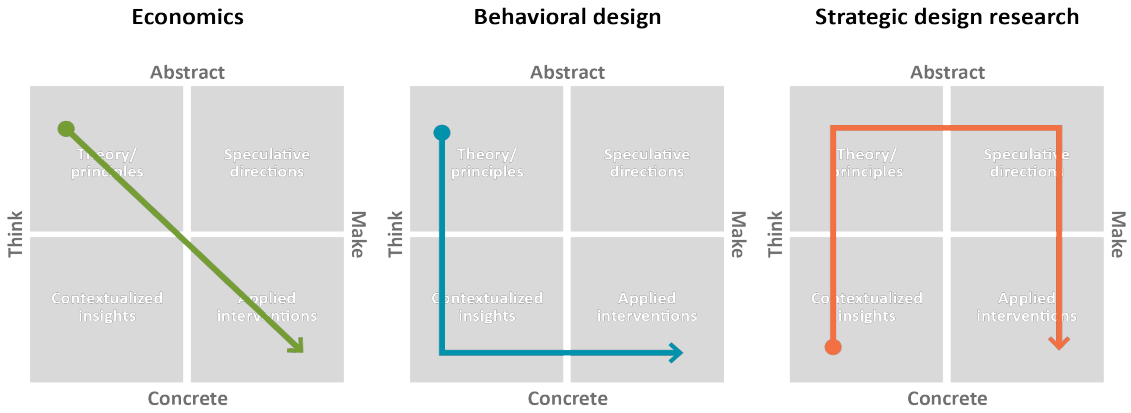

Figure 2 *Economics, behavioral design, and strategic design research process arcs*

Where economics moves swiftly and optimistically from theory (UL) directly to application (LR), behavioral design uses the scientific method, in which theory developed through lab experiments (UL) is combined with problem-specific contextual insights (LL) to inform hypotheses for potential solutions that can subsequently be evaluated (LR). In contrast with this analytic approach, design first begins with sussing out latent needs of individual stakeholder groups and problem framing (LL). Rather than directly feeding solution development, as it does in behavioral design, these findings from generative research are

first abstracted into more general insights and thematic guiding principles (UL). Only after creating these design principles do practitioners devise speculative, directional conceptions of what could be (UR), which then inform specific solutions that can be prototyped and tested (LR). What it lacks in first principles, design gains in its ability to synthesize concepts from disparate inputs and prior examples to inform nascent perspectives. In other words, rather than applying *known* principles to *known* problems in search of "best fit" solutions, a design lens allows us to use *generalized* criteria that can help shape heretofore *unknown* solutions.

This may be especially useful in the context of wicked problems: Even the most rigorous instances of past successes will struggle to confidently deliver solutions for complex and ambiguous challenges in contexts that are new or emergent, where precedent is hard to come by and future adaptation is a necessity. In contrast, "by hypothesising desired outcomes or functions, [design activity] moves towards proposing forms and structures that can realise such desired outcomes" (Cramer-Petersen, Christensen & Ahmed-Kristensen, 2019, p. 39), functioning as a lens to conceive of future solutions that are informed by past data, but not limited by it.

4.2 Contributions to generalizability

While the field of behavioral design has grounded much of its success on the systematic discovery of patterns in human behavior through lab experiments, it has not historically been as enthusiastic to create new patterns by abstracting up from aggregated solutions after they have been implemented. However, design research's "bottom-up" lens may also contribute to improving *generalizability*, which can address a known limitation in the field (Bates & Glennerster, 2018; Hauser, Gino & Norton, 2019) with the promise to support broader scaling of behavioral design solutions.

Behavioral design's struggle to achieve greater generalizability stems, in part, from its rationalist perspective on the use of evidence to build confidence in solutions. On the one hand, behavioral interventions that marry contextualized insights with relevant experimental findings are often more likely to be successful due to their optimization for the setting in which they will be implemented (World Bank, 2018). On the other, too high a level of specificity can contribute to the perception that it is difficult, even impossible, to translate or transfer solutions that worked well in one context into another one due to beliefs that localized insights can only feed localized solutions, or that localized evidence is always more reliable than—and therefore preferable to—generalized insights (Bates & Glennerster. 2017). But precision can be the enemy of progress, reinforcing the useful notion that site-specific insights are a valuable input to individual solutions, but also the less helpful one that these insights are irrelevant to anything but the localized context from which they came (Deaton and Cartwright, 2018).

While valuable as a means to quantify and communicate the relative success of solutions—an attribute design could frankly use more of, at times—the use of intervention-level

evaluation as the unit measure can also dissuade practitioners from considering how knowledge might be transferred to other settings in order to amplify its impact (Biesta, 2007). This challenge is not entirely new (Angrist & Pischke, 2010; Ludwig, Kling & Mullainathan, 2011), but behavioral design's ability to scale its successes may be persistently inhibited if solution efficacy and outcome metrics continue to be treated as the end point of a linear development process. Here, again, design's inherent comfort with abstraction and iteration can play a valuable role, re-centering a new emphasis on the cyclical process of aggregating and abstracting learnings across a variety of interventions rather than treating evaluation as a terminus.

4.3 Induction v. abduction

Previous attempts to define the relationship between top-down/analytic and bottom-up/synthetic disciplines have been articulated many ways: as a difference of goals, where co-existent practices occupy different territories across a landscape defined by analytic/synthetic and symbolic/real dimensions and "the scientist sifts facts to discover patterns and insights, [and] the designer invents new patterns and concepts to address facts and possibilities" (Owen, 2007, p. 17); in the form of productive tensions between divergent, or exploratory, and convergent, or evaluative, problem-solving modes (Csikszentmihalyi, 1996); and famously in Simon's efforts to create a science of design that restores rigor to "devis[ing] courses of action aimed at changing existing situations into preferred ones" (Simon, 1988, p. 67). It has even been argued that design can feasibly be considered a factor in the shaping of *all* human experiences, even extending "into the core of traditional scientific activities, where it is employed to cultivate the subject matters that are the focus of scientific curiosity" (Buchanan, 1992, p. 8) to inform hypothesis formation.

Another way to capture this distinction is to contrast behavioral design's inductive style of problem solving with strategic design research's abductive one, as defined by CS Peirce (Feibleman, 1970), where solutions are predicated on pulling inferences from both known context and 'best guess' speculations (Fann, 2012; Frankfurt, 1958). Where inductive problem-solving's strength in recognizing existing patterns helps us use our contextual knowledge to inform *probable* solutions, abductive problem solving encourages us to develop *plausible* hypotheses through the creation of new patterns, allowing us to conceive of what does not yet exist.

Peirce states that "induction is an argument which starts out from a hypothesis, resulting from a previous abduction, and from virtual predictions, drawn by deduction, of the results of possible experiments, concludes that the hypothesis is true, in the measure in which these predictions are verified" (Frankfurt, 1958, p. 593). This suggests that rather than thinking of inductive (behavioral design) and abductive (design research) modes of inquiry as parallel but separate methodologies, we might instead consider how they can be productively combined, augmenting evidence-based behavioral first principles with qualitative forms of evidentiary research and an expanded conception of context.

Using the framework introduced earlier, a new proposed new hybrid could look something like this, where design and behavioral design activities are interwoven to bring the best of both.

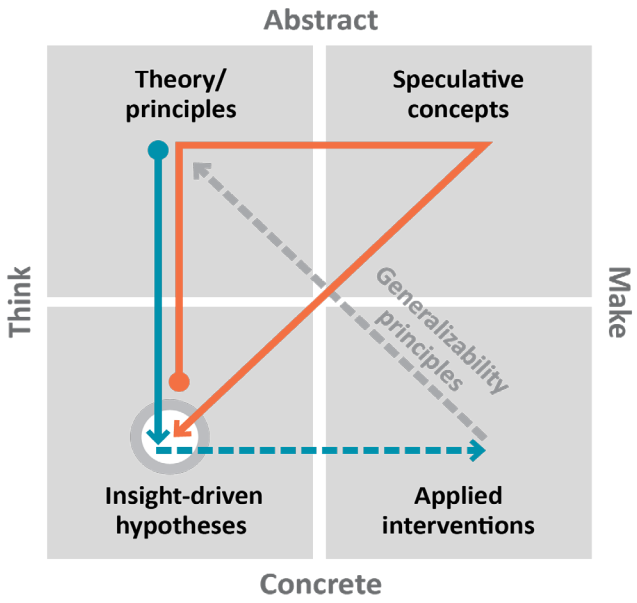

Figure 3 A proposed new behavioural deign/design research hybrid process model

This new model reveals a potential new methodological arc, in which problem definition consists of multiple frames to accommodate latent human and institutional conditions in addition to behavioral change, and where design-led perspectives on context and evidence inform behavioral hypothesis generation. In this reconceived mode of inquiry, behavioral findings and first principles still supply potential approaches (UL) in a top-down fashion, but are supplemented by qualitative design research that provides deeper insight into relevant contextual factors (LL)—in essence, Pierce's deducted "predictions." Concurrently, we can synthesize bottom-up contextual insight from on-the-ground discovery research (LL) into directional principles of *what could be* (UL) that inform speculative approaches for problem solving through a process of abduction (UR). These speculations and behavioral insights are then considered collectively, resulting in potential hypotheses for interventions (LL), in accordance with both behavioral first principles and design research insights. Finally, interventions are constructed and tested (LR), after which patterns gleaned from the evidence of contextualized solutions can be configured into generalizability principles (UL). Through this systematic accumulation of evidence from more and various "cousin" examples, we can move from empirical evaluation of individual instances to sense-making across many (Angrist & Pischke, 2010).

4.4 Extending the model through participatory design

Traditionally, behavioral design interventions focus primarily on present-tense contexts and issues in stable systems, yet one hallmark of wicked problems in particular is their tendency

to shift and reshape over time. This bolsters the notion that resolving, rather than solving, challenges may be a more likely goal and outcome (Huppatz, 2015). Here again, design's abductive lens has has the potential to provide a more longitudinal perspective on these challenges through the tradition of participatory design.

Overcoming the tendency to design *at* people and instead design *with* them by integrating top-down expertise with the bottom-up perspectives through lived experience has the potential to redistribute ownership of behavioral design solutions (Sanders, 2002; Spinuzzi, 2005), despite the fact that the very dynamics that can make it powerful—shared ownership and investment, reversals of authority through the inclusion of non-expert views—may be counterintuitive or even objectionable to those accustomed to being de facto decision-makers (Blomkamp, 2018). Taken to a logical extreme, participatory approaches might even extend beyond present-tense settings to futures- and systems-oriented socio-material systems that reconceive of the public as full active agents in re-shaping policy (Björgvinsson, Ehn & Hillgren, 2012), reducing the all-too-common situation in which those most in need of interventions suffer from research malaise due to the regular, if well-meaning, poking and prodding of researchers (Chicago Beyond, 2018). Even in its less aspirational version, problem framing and hypothesis development can surely be improved by increased involvement by those who know the context best. As the case in Flint clearly demonstrates, deeply embedded skepticism, a high likelihood of long-term health and financial consequences, and a highly politicized social context begs for a human, not merely a behavioral, approach (Stillman, 2017).

Proposing a hybrid model will admittedly force behavioral design to embrace a potentially uncomfortable level of qualitative evidence and contextual ambiguity, but it is not an advocacy to toss out empirical evidence and methodological rigor (Deaton and Cartwright, 2018). Just as analytic and synthetic problem-solving modes both bring strengths, each also brings deficits. In improving the quality of hypotheses to be tested by wedding behavioral design's inductive hypothesis development process with design research's abductive one, we can identify new approaches to knotty problems that need it most by informing what *could work*, rather than only what *worked* (Biesta, 2007). Where design research lacks the top-down theory of first principles, behavioral design can step in with evidence-driven approaches; where behavioral design frames problem too narrowly and may overly adhere to what's worked in the past, design research can provide plausible speculative hypotheses to stretch thinking beyond the tried and true to construct, not just select, solutions.

The good news is that behavioral design is still a new field, and not yet codified. As such, it's an ideal time to test how these strange bedfellows of behavioral design and design research may transform into an integrative, comprehensive and disruptive force.

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SYNERGY

Designing Cross-Disciplinary Relationships for Improving Safety

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Abstract: This paper describes how design research has been deployed to stimulate and facilitate two cross-sector collaborations between industry and academia. Two research projects conducted by the School of Design at the Royal College of Art illustrate how the engagement of more than 200 cross-sector experts fostered the development of a design led strategy to prevent and mitigate future global risks through a new culture of safety. This is a strategy designed upon the synergies of collaboration that value people and their resilient capability of bouncing back through adaptation and creativity. These research projects evidence the need for creative methods that use culture, knowledge and experience as assets to construct a human-centred safety approach.

Keywords: design for safety; cultural collaboration; inconsistent synergies; human intelligence

1. Introduction

Tackling safety is an issue without a uniform viewpoint. As working procedures vary from sector to sector, safety is not consistently legislated and free from failure, as regulatory organisations often report (HSE, 2019). One of the most frequent factors contributing to risk is human error for its variable nature which is difficult to foresee and plan. For this reason people are often considered the weak part of health and safety procedures (e.g. people using mobile phones while driving). However recent strategies including the UNESCO's City Reconstruction and Recovery (CURE) Framework, Henk Ovink's Rebuild by Design or Eric Klinenberg's approach to social spaces revise the role of human behaviour under a different lens, which gives people the agency to tackle complex issues and promote safety. These examples demonstrate how people's culture, knowledge and cross-discipline collaboration can play a strategic role in developing sustainable and resilient strategies to complex issues

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through creativity and knowledge exchange. To leverage complexity from this particular perspective requires new methods that can reframe procedures as a human intelligence led process. This paper aims to describe how design research can investigate and construct a new method of tackling and mitigating safety with culture and collaboration as its main assets. While the authors previous papers on design for safety deal with the educational, methodological and the design for safety subject, this paper specifically focusses on community culture building and how this research strategy uncovered new opportunities and understanding of design for safety.

1.1 The Lloyd's Register Foundation Safety Grand Challenge and Design for Safety Foresight Review

In 2016 the Royal College of Art School of Design (RCA) was commissioned by the Lloyd's Register Foundation (LRF) a Safety Grand Challenge (SGC) to redesign the ladder that ships pilots use on a daily basis to transfer from a pilot vessel to a larger ship to safely navigate in and out of port. The LRF considered this tangible and well defined task a complex and urgent safety challenge which is still the cause of significant fatal accidents in ports around the world (Hall, Ferrarello, Kann, 2017). The SGC was the first grand challenge the Foundation ever launched and the first open investigation on safety through the lens of design research. The project engaged 6 RCA researchers and 38 cross-disciplinary postgraduate students who collaborated with partners from the Royal National Lifeboat Institution (RNLI), Port of London Authority (PLA), International Maritime Pilots' Association (IMPA), United Kingdom Pilots' Association (UKMPA) and Confidential Hazards Incident Reporting Programme Confidential Reporting Programme for Aviation and Maritime (CHIRP) to research the development of new solutions that could rethink pilot transfers. Through the combination of action and participatory research – i.e. interviews, field trips, observation, project reviews and workshops - students, researchers, partners, stakeholders and experts exchanged experience and knowledge which took the shape of 7 models and prototypes. These illustrate how collaboration and knowledge exchange between academia and industry can deliver applied and design led approaches to saving lives like, for instance, materials that improve the sturdiness and portability of the pilot ladder (Dynaweb) or a rigging mechanism that globally fosters trust between pilots and ship crews (CLS) (Hall, Ferrarello, Kann, 2017) (Figure 1).

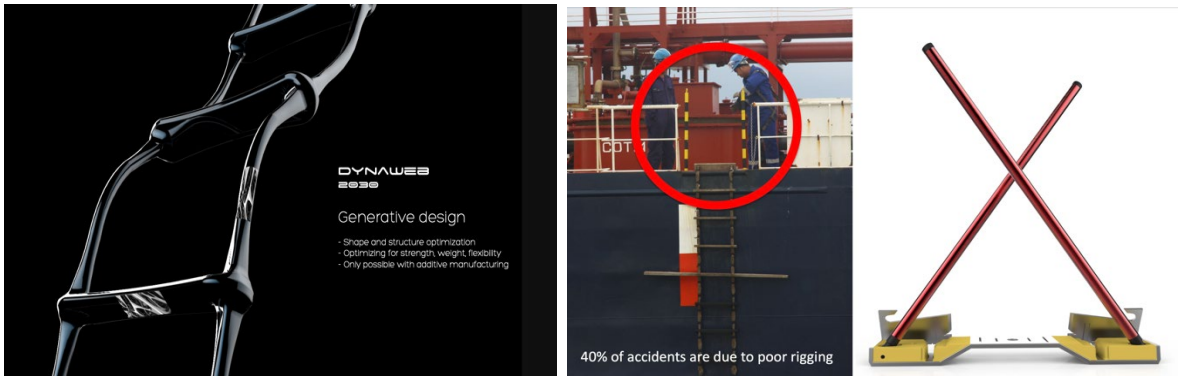

Figure 1 Dynaweb and Cross Lock System (CLS) combined as the Helm Innovation start-up

In this research the role of design was not limited to the development of the solutions but also to the governance of the project (Hall, Ferrarello, *et al*, 2017). The series of activities coordinated by action and participatory research generated a collaborative platform in which academic and industrial knowledge was exchanged, transferred and created through first hand experience. This was supported by the dynamics of these collaborations which generated critical and creative debates (Ferrarello, Hall, *et al* 2017). Design research helped *unsilo* the different kinds of knowledges across partners, stakeholders and experts by constructing an inclusive peer to peer mutual learning process; each participant had agency and voice independently from the expertise, geographical location, age and gender. Through collaboration design research leveraged the industrial partners' motivation to participate in the project, which was improving safety, to foster curiosity and creativity; this helped overcome the initial scepticism and lack of trust in the academic institution. With this strategy the experts' interest and number increased during the course of the project thanks to the proactive behaviour partners and stakeholders demonstrated in promoting and championing the research in affiliated sectors and organizations through different media (e.g. exhibitions and public lectures). For instance, a group of students was invited to participate and were shortlisted in the Seatrade award which is the most influential award in the maritime industry (Seatrade Awards, 2019). Furthermore, part of the SGC network still collaborates through Helm Innovation, which is a start-up founded by two designers participating in the research.

Industry's positive response to the SGC has been built upon the development of the design solutions and prototypes which helped cross-disciplinary experts understand how safety can be tackled by means of creativity. The SGC demonstrates that design can be a strategy to tackle safety as both an applied and strategic approach by governing the dynamics and relationships of its participants (strategy) through the design of products (applied). This defines a different approach to risk and safety which makes the beneficiaries of innovation proactive and creative components of the process.

With the SGC findings indicating how design can foster innovation in the maritime industry the RCA School of Design received a second grant from the LRF to further explore this approach when looking at future risks. The Design for Safety Foresight Review (DSFR) was

aimed at researching how design can play a strategic role in tackling global future risks (e.g. flooding, cybersecurity, migration, terrorism etc.) across different sectors. In particular the ambition of the research project was to investigate what role design can play in safety to formulate a strategy that could be shared, adopted and promoted across disciplines and sectors; the knowledge gap the research focussed on was the very concept of design for safety. The literature review outlined a gap for an accepted general principle for deploying design methods and practices towards improving safety between people and machines. As Jasanoff indicates in the "The Ethics of Technology" book a gun is safe up to the time a human shoots the bullet, or a car can't cause accidents if a human doesn't drive it. (Jasanoff, 2016). Even though literature has recognised the impact that people's perception, behaviour, understanding and exposure to safety have on risk assessment (Johnson et al, 2016; Jasanoff, 2016; Oltedal *et al,* 2004) at the time of the research there were not any examples indicating methods that deploy these wider factors to designing safety. For instance, the NHS funded Helen Hamlyn Design Centre research deploys design to prevent human errors in the medical sector, but this is a specific case study constructed for a specific scenario (Buckle *et al*, 2004).

Hence the DSFR ambition was to develop a cross-industry methodology that could design safety at a global strategic level and use this to develop methods to tackle future risks. Learning from the SGC, the DSFR placed the human at the centre of any safety procedures and issues and used the gap of knowledge found in the literature to initiate research on design for safety with more than 200 industry experts across 6 different sectors (Healthcare Technologies and Services, Consumer Product Technologies and Services, Transportation Technologies and Services, Food Technologies and Services and Manufacturing Technologies and Services) (Anderson, Hall, Ferrarello, 2018). Figure 2 represents how the research project framed risk from a human perspective taking as example a traditional and an IOT kettle; if in the former case the risk of skin burns or electrocution are known and tangible, in the latter one a third party data management is unknown and intangible.

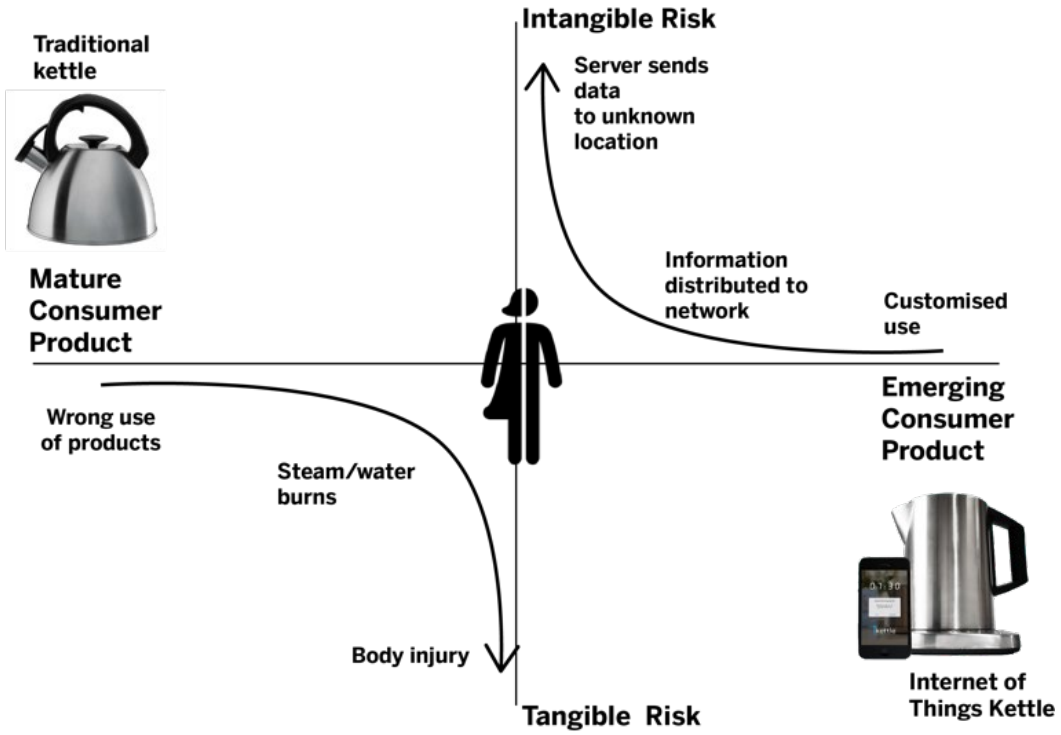

Figure 2 Diagram representing risk from the human perspective and the tangibility/intangibility of risk

By looking at the dynamic nature of human behaviour when interacting with technology the DSFR analysed the impact of these relationships on developing risk situations. This aimed to construct a people oriented strategy for improving design for safety through the collaborative cultural creativity of human experience. The research objective was not to define another procedure or regulation but to explore how the human capital can be strategic to safety and risk prevention and mitigation (Anderson, Hall, Ferrarello, 2018). By stimulating peer to peer learning and knowledge exchange design research co-designed design for safety through the dynamics of interactions between global experts across 6 selected sectors in the mature and emerging industries.

Both the SGC and DSFR research projects created the space and platform to generate synergies of collaboration for designing design for safety. Cross-sector collaboration was key, likewise the dynamics that transformed people into the resilient intelligence and assets to tackle complex problems (Ovink, Boeijenga, 2018).

2. Setting the Scene: Engaging Cultures through Cultures

Current strategies for tackling complex problems like safety often develop procedures aiming at regulating human behaviour. However, cases like the 2017 Grenfell Tower disaster in London outline that safety and risk are dynamic factors where prevention and mitigation struggle with the unpredictable nature of human behaviour in complex dynamic environments. In the Grenfell Tower example the fire was caused by a faulty fridge, however

the context of the accident is more complex than an appliance failure. Current investigations evidence that more than 60 companies and bodies and 383 organisations were involved in the refurbishment of the tower (Nadj, 2019). Hearings outline how the series of decisions this network of people took created the conditions where a faulty fridge among other cascading issues caused 72 fatalities. This case and others demonstrate that strategies for tackling complex problems need to take a different approach to human behaviour and the SGC and DFS offer an example on how a designed collaborative culture can leverage change in safety procedures. By designing the dynamics of transferring the experts' knowledge and experience the SGC and the DSFR construct a methodology that uses design as tangible artefact (SGC) and intangible strategy (DSFR) as a means to "unlock" and connect existing cross-sector knowledge. Through culture and engagement the SGC and DSFR gauge different attitudes to safety to foster creativity and transform divisions in synergies. This is achieved by accounting for wider factors not specifically related to the research main goals. For instance, the SGC recognised that partners and stakeholders were not particularly familiar with design research, but shared a clear interest in design as a product (the ladder) which was interpreted as a way to bring innovation to the sector. This clear and familiar objective was the opportunity that developed a different understanding of design and safety which a series of engagements incrementally constructed by shaping trusted relationships between academics and industry experts. Both projects indeed found that it was not sufficient just to adopt collaboration, but it was necessary to design collaborations acknowledging the experts' assumptions, behaviours and approaches. Hence trust played a key and fundamental role to construct innovation that "unlocks" and possibly reframes unknown knowns and mitigates the risk beneficiaries often perceive when exposed to unsettling scenarios. For this reason innovation in these research projects had to be inclusive, i.e. benefits needed to be acknowledged and accessible to the beneficiaries (Juma, 2016); this was achieved with a designed collaboration which dynamics keep the beneficiaries' perspective to also mitigate the disrupting nature of innovation. For instance the SGC design solutions represent a tangible language that beneficiaries understand. These products guided the experts construct heuristically a different culture of safety which was formed upon the governance and application of design enabling knowledge exchange. Hence the nature of these interactions evolved from designing products to ecosystems where discussion encouraged experts to question the existing culture of the maritime industry through their personal contribution to the products' development. Under these terms the final designs serve an accessible, inclusive and tangible culture to safety (Spencer-Oatey, 2012) as they strategically leverage through creativity the cultural conditions that trigger risk by outlining how roles, mindsets and interactions can affect or improve safety (Meadows, 1999). As cultural artefacts recognised by the maritime community, these design products are able to effectively nudge people's behaviour, values and attitudes towards risk and safety and develop a Syntax of Collaboration (the design of the dynamics of collaboration) that generates those trusted relationships necessary to foster inclusive innovation. The SGC and DSFR modelled this syntax building from Spencer-Oatey onion diagram structuring culture (Spencer-Oatey, 2000) and Hofstede (Dahl, S., 2003) as shown in Figure 3. This diagram guided the researchers' first

hand observations of pilot transfers and the analysis of the DSFR discussions on how safety is practiced across sector. Following this a new diagram represented in Figure 4 was generated to display how the insights constructed through the onion diagram guidance have been redeployed as strategy to develop the design solutions. The concentric layers illustrated in Figure 3 and 4 aim to develop a method that (1) shifts the understanding of design, (2) develops knowledge exchange encompassing roles, expertise and experience and (3) parks ownership to enable a shared process of knowledge exchange.

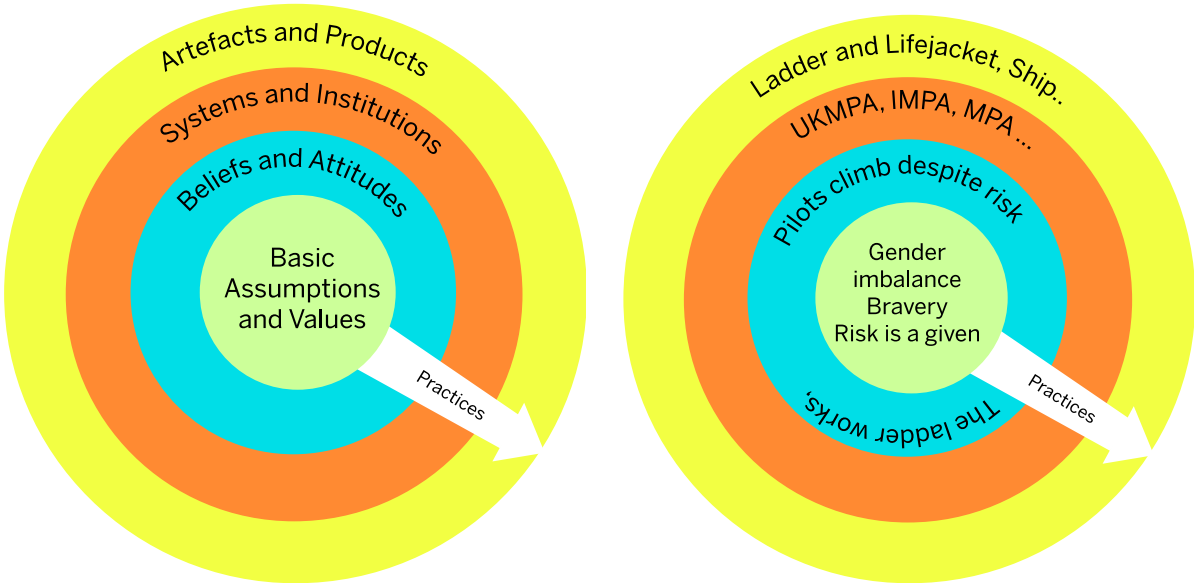

Figure 3,4 Spencer-Oatey diagram And its adapted version showing pilots' cultural layers with a safety focus .

The SGC and DSFR Syntax of Collaboration developed upon the Spencer-Oatey onion diagram supported the experts' engagement in the project, their trust, curiosity and motivation. Figure 4 shows some of the aspects the research considered to foster a different approach to safety and risk based on different beliefs, systems, regulations and artefacts.

A similar context applies to the DSFR which had to face the plethora of meanings, systems, regulations, behaviours, artefacts, etc, on design and safety across industries and professions. In this case the diagram helped define a method that embraces this fragmented context as foundation of a collaborative approach that transforms the diversity of meanings of design and safety in opportunities that stimulate change. This was pursued by reflecting on the types of relationships innovation creates, identifying who and what supports them, how any involved party learn and exchange knowledge and what kind of governance holds this ecosystem (Juma, 2016). In addition, in the DSFR case the Syntax of Collaboration stimulated personal agency across sectors to nudge change and ensure inclusivity. Within this context design for safety was conceived as a "product", like the SGC models and prototypes, whereas design research as the method generating the Syntax of Collaboration guided by the Spencer-Oatey revised diagram. As illustrated in Figure 5 design - as product, strategy and

product - enabled the development of the Syntax of Collaboration via the dynamic dialogue people exchange with their culture (as described by the Spencer-Oatey diagram in Figure 3) through design; this generates new behaviours and cultures and redesigns safety.

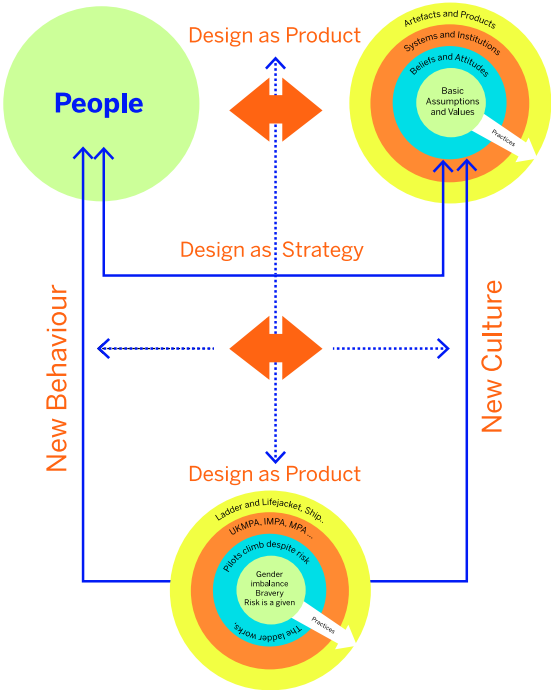

Figure 5 *Diagram representing how the Syntax of Collaboration is developed through design to generate inclusive collaboration*

The dynamics visualised in Figure 5 led to the development of the Figure 6 matrix which aims at interrogating what role design can play to prevent and mitigate risk when people and technologies between the mature and emerging sector interact. The matrix suggests that design can *unsilo* and reframe existing knowledge to draw strategies able to (1) nudge human behaviour, (2) question who owns safety and (3) holds responsibility.

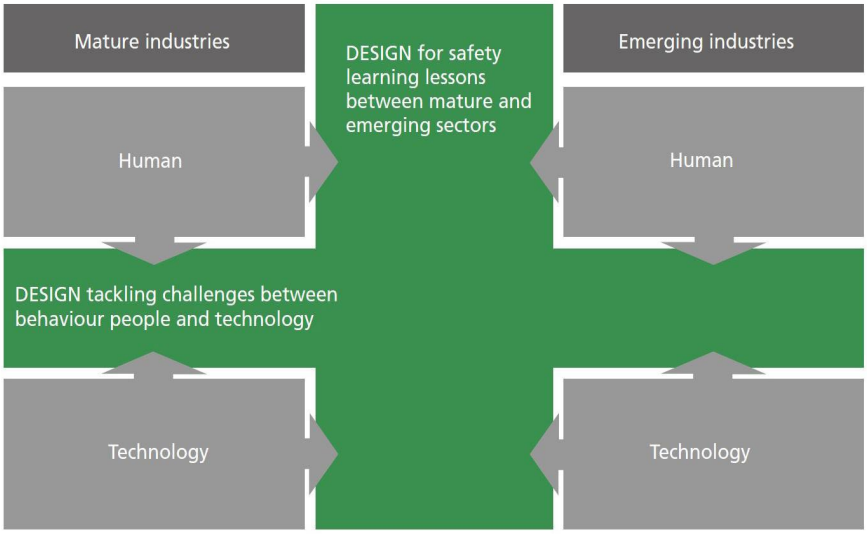

Figure 6 Design for Safety Matrix

Figure 6 reinforces the strategic role culture plays in safety prevention and mitigation for its capability to "speak" to different sectors at an individual and collective level. Nonetheless to be effective this dialogue needs clear and accessible communication; to generate change the DSFR meaning of design for safety had to be equally acknowledged and understood across sectors. Hence a manifesto of design for safety (quoted below) was developed to overcome fragmentation and ensure clarity in communication between experts of different sectors and academics:

> "We believe design for safety enables people and technology to operate safely. Design for safety is the actions taken to ensure that an item, system, system of systems or network is free from adverse impacts on individuals, organisations, communities and the environment, whether these happen as a result of implicit or explicit risks". (Anderson, Hall, Ferrarello, 2018, p.36)

Both the matrix and the manifesto disseminated the DSFR meaning of design for safety through an global online questionnaire and two symposia which the research project deployed to generate of an innovative approach to safety supported by cross-sector collective old and new values.

The DSFR Syntax of Collaboration collides and juxtaposes existing and potential design solutions with legislations and procedures to outline how the complementary nature of these relations can draw a new culture of safety (Juma, 2016). The cross-sector experts exposed to this strategy discussed safety approaches and legislations through artefacts representing safety issues. From a buoyancy equipment to a can of tuna, these cross-sector experts worked in co-design activities to learn from each other and propose a strategic cross-discipline approach to tackle future design for safety issues, like AI or climate change (Figure 7).

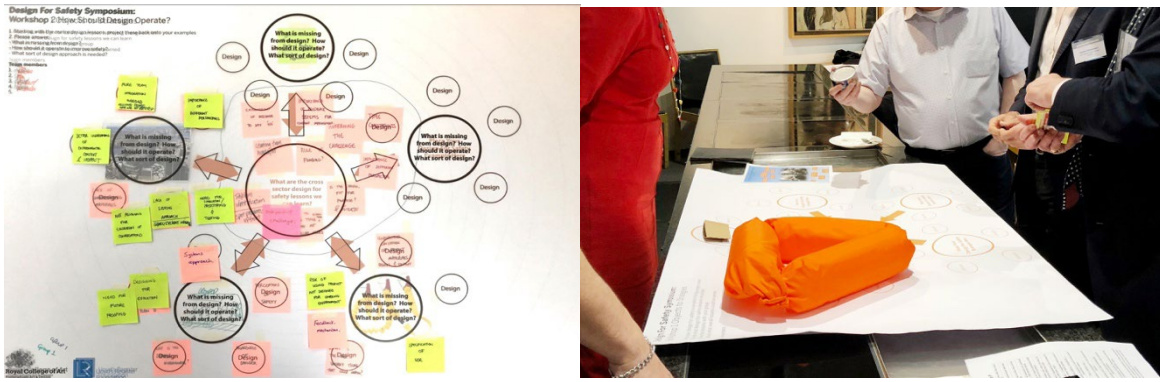

Figure 7 *Example of DSFR mapping tools and cross-sectors experts discussing safety through the symposium templates.*

4. Tackling Future Challenges through Designing Collaborative Culture

Both the SGC and the DSFR reflect how technology led innovation often increases human risk for failing to understand the nature of human intelligence and behaviour. Trust, accountability, ethics, values, morality and perception are some of the factors that can impact the success and failure of new technologies. The SGC and DSFR address this particular aspect with the deployment of a syntax of collaborative cultures as human intelligence becomes the asset supporting the transformation of multifaceted complex conditions (e.g. boarding a ship at midnight on an unchanged 300 year old pilot ladder design in -15c temperatures; climbing up 9m on a 3m sea state carrying an armoured laptop with GPS beacons and knowing you only have a limited time window to safely navigate a ship with $500m cargo into dock with only 3 engine reversals possible) into more desirable and human centred ones.

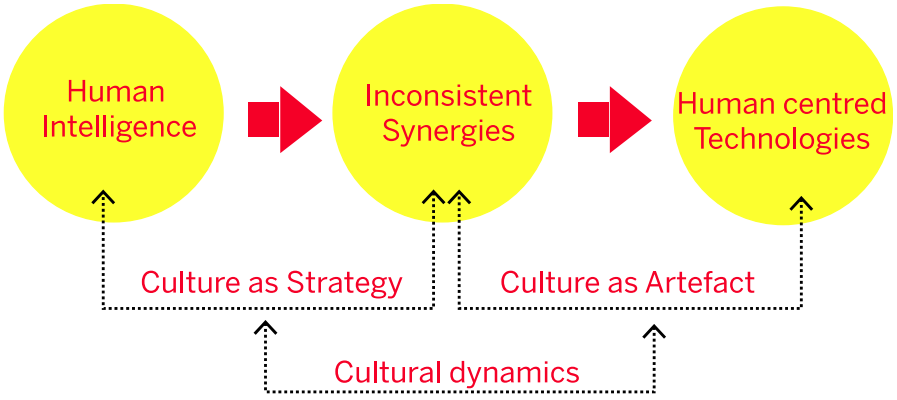

Figure 8 *Visualising how the Syntax of Collaboration shaped by culture as artefact and strategy can develop human centred technologies*

Figure 8 shows how culture is treated as a two-fold factor with a number of representations that can be both strategic and tangible artefact. The diagram identifies how the ambivalent

role of culture of "speaking" to individuals, communities and organisations through values and morals (artefacts) and influencing the decision-making process (strategy) develops a research approach that can nudge behaviour (Spencer-Oatey, 2012). In safety strategies this two-fold and double role opens new opportunities as complex ecosystems of safety emerge from the evaluation of both tangible and intangible factors, both technical and cultural, that seldom operate at the same time. For instance, the decision to climb a ladder at -+ 40C depends on factors which a pilot needs to assess in very short frame of time. Equally the security of processed and unprocessed food depends on decisions varying from cultures to culture that rely on tangible and intangible aspects (e.g. plastic wraps sign uncontaminated food in developing countries and unpackaged food signs fresh products in developed ones) (Jasanoff, 2016). Building and learning from the Spencer-Oatey onion diagram the SGC and DSFR generate an iterated version of this diagram that revises the relationships between the layers to develop change and transformation. Figure 9 displays the new SGC and DSFR Spencer-Oatey model, the spiral diagram. It is no longer a series of concentric circles but a spiral showing how the Syntax of Collaboration generates and guides knowledge exchange which shifts and reframes the experts' values and assumptions, beliefs and attitudes and institutions and organisations (dotted lines). The "ladder" in the outer circle visualises the change and shift of culture as it is both landing and departing parameter on an old and new culture. The spiral diagram combines the two-folded role of design products in shifting culture (SGC) and the value of dialogue in stimulating peer learning and knowledge exchange (DSFR) to generate the Syntax of Collaboration that stimulates transformation and change.

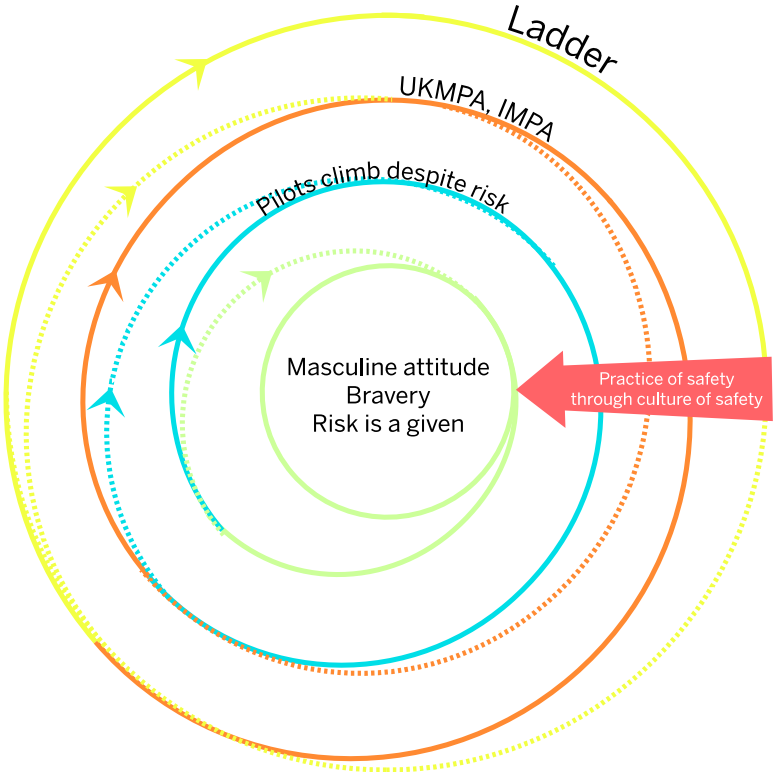

Figure 9 Reframing the Spencer-Oatley diagram to visualise the syntax of collaboration

This model is constructed upon the conditions that (1) risk could be something accepted and (2) social norms, traditional beliefs and rituals generate different perceptions of risk and safety (Garvey, 2008 – Jasanoff, 2016) (continuous lines). Despite these two conditions have been already identified as strategic in the literature, there is no particular indication on the methodology that deploys culture and people as asset. For instance, The Maritime Accident Investigation Branch (MAIB) recommends, but doesn't specify how, to challenge the practice of safety to avoid accidents following one incident in which a crew's bad safety practice caused the death of an overboarded trainee (MAIB, 2017). This is similarly outlined by the Nimrod Review which discusses but does not articulates the key role of personal responsibility (Haddon-Cave, 2009). The SGC and DSFR aim to fill this gap via the Syntax of Collaboration described in Figure 9 that reframes personal and individual morality, perception and rituals through proactive collaboration. This stimulates a heuristic and osmotic dynamic of knowledge exchange that assimilates risk as ingredient. Risk is indeed factored in terms of individual and collective values and habits inherited from norms, traditions and beliefs (Dahl, 2003).

4.1 Designing creative strategies to tackle complex problems

The SGC and DSFR Syntax of Collaboration builds from a literature that evidences successful examples of culture as an asset. Indeed the World Bank Culture and UNESCO's City Reconstruction and Recovery (CURE) Framework, Henk Ovink's Rebuild by Design and Eric Klinenberg research on American social infrastructure evidence that culture can play a positive and key role in complex strategies through collaboration and creativity. The CURE Framework outlines the importance of deploying the cohesive and shared domain of culture in the aftermaths of climatic or human caused disasters (World Bank; UNESCO. 2018); heritage, craft, rituals are indeed key artefacts that can reconstruct the social strati of shredded communities. Henk Ovink and Eric Klinenberg position the role of culture under the terms of knowledge and experience and point out that people of different backgrounds, expertise (and cultures) can design safer and resilient environments to climate and violence. In details Klinenberg points out that places for socialisation, like libraries and public spaces, can prevent violence and social isolation and support both the individual and collective sense of responsibility (Klinenberg, 2018). Henk Ovink's Rebuild by Design was founded to tackle the aftermath of Hurricane Sandy in 2012 with the intent to develop sustainable, creative, climate change resilient and implementable strategies for the city of New York. Through an architectural competition, that invited architects and engineers to collaborate with those local communities directly affected by the Hurricane, resilient strategies to climate change emerged from the dynamics of collaboration between local communities, cross-discipline experts and the government who altogether co-designed new strategies built on local knowledge (Ovink, Boeijenga, 2018). Under these terms the competition was a *cultural strategy* which deployed an inclusive approach to reconstruction through *cultural artefacts* (the architectural projects). "*Too big*" (Ovink, Boeijenga, 2018) problems, like climate change, have been tackled with culture as strategy and artefact to interface different kinds of people

and expertise rather than an isolated group of experts (Ovink, Boeijenga, 2018). Altogether these three examples articulate how human led Syntaxes of Collaboration can design a space that includes/engages with individual and collective identities through membership and sense of belonging. This makes beneficiaries part of the innovation process (Juma, 2016), stimulates resilience by helping individuals cope with the uncertainty of the future and generates an inclusive change.

4.2 The Syntax of Collaboration Human Centred Innovation

The SGC and the DSFR are two projects that look at existing safety issues with a future oriented mindset aiming to design a strategy that activates human intelligence across expertise, culture and gender (Hall, Ferrarello, *et al*, 2019). Figure 10 illustrates the different kinds of synergies of collaboration, represented by the red lines, that offer both tangible and intangible infrastructures to navigate unknown future territories. The iterative process represented in the figure displays a system in which the continuous dialogue across disciplines and sectors, whether in the form of procedures or mindsets, can design a human centred future-oriented safety culture.

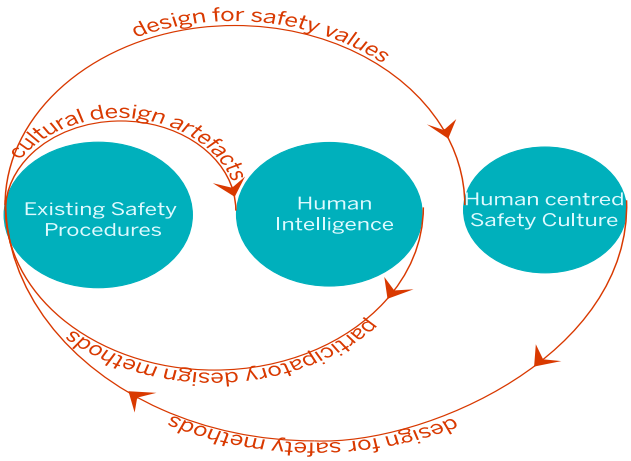

Figure 10 Diagrams showing how the syntax of collaboration develops new knowledge

Being human centred means being inclusive; under this framework innovation is outcome of trusted human collaboration exploring unsettling and/or risky territories. Through the narrative constructed by design beneficiaries of innovation are able to articulate heuristically new knowledge which is then perceived as an enhancement of existing knowledge (Juma, 2016). This approach, product of the SGC and DSFR methodologies (Hall, Ferrarello, Anderson, Cooper, Ross 2019) combined together, outlines how a group of people cohesive in its diversity and united towards a common goal can generate change in safety. This inconsistency stimulates an inclusive Syntax of Collaboration designing design for safety.

Despite the DSFR didn't have the opportunity to test its principles and recommendations,

at the present these still resonate across its participants at different levels, from shifted mindsets to new principles of funding. The SGC created the conditions to fund a new business, Helm Innovation, which to date is still collaborating with part of the network the SGC designed.

4. Conclusions

The SGC and DSFR research projects have described how design research can leverage inclusive dynamics of innovation between academia and industry to develop a new culture of safety. With one project looking at the redesign of the pilot's ladder and develop prototypes that increase safety along the river Thames by 2030 (SGC) and another one that focussed on investigating a strategic approach for tackling major future global risks (DSFR), these projects gave an example of how to deploy culture and people as asset to tackle complex future challenges. Through a process that aimed at generating and deploying creativity to reframe and enhance existing knowledge that develops a new understanding of risk, these projects formulated modalities of change and transformation which gave agency and engaged those required to change. This has been achieved by interrogating, challenging and reframing existing knowledge, experience and insights through designing cultural artefacts that design and promote the ecosystems of change. By deploying the inconsistency and variety of safety procedures the SGC and DSFR make the beneficiaries' culture (and their perspective) asset that supports change. The spiral diagram revisiting the Spencer-Oatey model describes the Syntax of Collaboration and how risk and complexity can be encoded in safety procedures through heuristic and inclusive creativity. The transformational events experts experienced during the course of the research projects mobilised their knowledge towards an innovation that mitigates unknown and future risks through the collective and individual governance of culture. In conclusion the SGC and DSFR research projects identify possible strategies through which design research can support the exploration of unknown and unexplored (and future) territories and challenges through the inconsistent synergies that enable participants construct a kind of knowledge that transcends sectors and disciplines. The culture these projects use to tackle safety is not merely the individual knowledge acquired through experience but also the capability to listen, dialogue and share failures. Under these terms the SGC and DSFR Syntax of Collaboration becomes an epistemological approach to safety for the guidance it offers to knowledge development through the synergetic and unbalanced exchange of existing skills, experience and practices.

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SYNERGY

A Diary Study on the Exercise Intention-Behaviour Gap: Implications for the Design of Interactive Products

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Abstract: Increasingly aware of the importance of active lifestyles, many people intend to exercise more. One of the main challenges is to translate exercise intentions into actual exercise behaviour, the so-called intention-behaviour gap. To investigate barriers and enablers that affect this gap, we conducted a 7-day diary study with 16 participants. In this study, participants indicated what their exercise intentions and behaviour were per day, and whether and why they changed retrospectively during the day. Through the diary study, we gain insights into (i) the intention-behaviour interplay, and (ii) the experienced barriers and enablers that influence this interplay throughout the day. Based on the findings, we contribute new implications for design in supporting people translating their intentions into exercise behaviour, and propose three design concepts as examples. In these, the focus is on positively influencing the interplay of enablers and barriers of exercising and how these can be exemplified through design.

Keywords: exercising; intention-behaviour gap; diary study; design implications

1. Introduction

Our society has become more physically inactive over the past decades, since our everyday lives have become more sedentary and less physically active (Martin et al., 2015). The adverse health effects of being physically inactive have led to an increased awareness and importance of striving for a healthy lifestyle within our society (Trost, Blair & Khan, 2014). Due to this increased awareness, more and more people have intentions of being more active (Rhodes & de Bruijn, 2013). This is notably reflected in the increased popularity of unorganized recreational sports (such as running, cycling, fitness) (Janssen, Scheerder, Thibaut, Brombacher & Vos, 2017; Scheerder & Borgers, 2016). Despite these positive

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intentions, for many people one of the main challenges remains how to translate their intentions into actual, preferably long-term, exercise behaviour (Rhodes & de Bruijn, 2013). For example, a previous study indicates that the drop-out rate to exercise programs within the first six months is about 50% (Biddle & Mutrie, 2007), thus missing out on important health benefits. An important factor influencing this intention-behaviour gap are barriers and enablers that are experienced between the intention and the exercise behaviour (Litman et al., 2015; Mueller, Tan, Byrne & Jones, 2017).

Barriers and enablers to exercising have been studied extensively (McArthur, Dumas, Woodend, Beach & Stacey, 2014; Morgan et al., 2016; Pridgeon, 2012). Barriers that hinder exercise are for instance: weather conditions, lack of confidence and lack of social support. Enabling factors are among others maintaining a routine, anticipating positive feelings and social support. Besides fine-grained ways of categorizing (e.g., internal, environmental, social and physical factors, Stutts, 2002), these barriers and enablers are most often categorized as internal or external. External factors are usually characterized as part of the environment and 'out of your control' (e.g., weather, lack of social support), whereas internal factors are associated to the persons themselves (e.g., lack of energy, past experiences) (McArthur et al., 2014). Previous research indicates external barriers are perceived more often as compared to internal ones (Arzu, Tuzun & Eker, 2006). These barriers and enablers, external or internal, are instrumental in successfully turning intentions into exercise behaviour (Litman et al., 2015; Mueller et al., 2017), also referred to as the 'intention-behaviour gap' (Sheeran & Webb, 2016).

In line with the rise in recreational sports, there has been a growth in the development of sport-related wearables (such as activity trackers, sports watches and applications), aiming to motivate and support people in maintaining long-term exercise behaviour. These wearables mainly attempt at supporting people with their exercise session by allowing them to monitor and eventually keep track of their progress (Jensen & Mueller, 2014). Through the quantification of this progress, these products provide the possibility to track performance, enable competition and social support (Jensen & Mueller, 2014; Shih, Han, Poole, Rosson & Carroll, 2015). The question arises however, whether these wearables only reach a limited target group that already has a strong affinity and identify with exercise and thus is more interested in capturing health and sports-related data (Ellis & Piwek, 2018; Vos, Janssen, Goudsmit, Lauwerijssen & Brombacher, 2016; Menheere et al., 2019). Additionally, even though for some people keeping track of their progress is motivating in itself (Sheeran & Webb, 2016), it does not address barriers that might be experienced prior to the exercise.

Although barriers and enablers to exercise have been studied extensively, the methodological approaches adopted in previous studies (mostly surveys or interviews, as in Larson, McFadden, McHugh, Berry, & Rodgers, 2018; McArthur et al., 2014; Pridgeon & Grogan, 2012) entail limitations to explain the interplay of enablers and barriers as well as the antecedents and correlates of exercising behaviour. Longitudinal methods, such as diary studies, could provide additional insights to inform design opportunities. The benefit of using diary studies is that it not only allows for obtaining commonalities and differences among

participants, but also within-person changes over time (Bolger, Davis & Rafaeli, 2003) as well as a lower recall bias from memory decay (Thibaut, Vos & Scheerder, 2019).

The aim of this study is to further investigate the exercise intention-behaviour gap among young adult women and when and why barriers and enablers to exercise occur. Additionally, we aim to provide new insights for design in supporting people translating their intentions into exercise behaviour, and provide three design concepts as examples.

2. Method

To further investigate barriers and enablers that affect the exercise intention-behaviour gap, and how design might potentially support in overcoming these, we use a 7-day diary study for which we designed an Exercise Diary. The participants were asked to report their daily exercise intentions and behaviour.

2.1 Participants

We recruited 19 women between the age of 23 and 30. Three participants dropped out during the study, resulting in a sample size of N = 16. Participants were recruited via social media platforms (Instagram and Twitter) and did not receive an incentive for their participation. We purposively sampled participants from a homogeneous age and gender group to more easily find commonalities and differences. Although the exercise intention-behaviour gap is experienced by both men and women, over various ages, there are reasons to believe these target groups have different motivation triggers. As a previous study on completion rates of exercise programmes indicated that young women were the least likely to complete their intentions (James et al., 2008), we decided to focus on further investigating the gap among young female adults within this study. Inclusion criteria were defined as being active in exercise while encountering motivational problems. The type of exercise they practiced was not a selection criterion. All respondents indicated to sometimes experience motivational problems before going to exercise. Data was collected in Spring 2019. Respondents' demographic and exercising practices are presented in Table 1. Participants were all working or studying a minimum of 24 hours per week and living independently (alone or with partner).

Table 1 Detailed overview of the participants

ID	Age	Kind of Household	Occupation	Exercise	Times
P1	28	Living with Partner	Office job, 40 h/w	Fitness, Walking	3x
P2	27	Living with Partner	Office job, 40 h/w	Golf, Fitness	3x
P3	27	Living with Partner	Student, 40 h/w	Hockey, Fitness	5x
P4	30	Living with Partner	Office job, 40 h/w	Fitness	3x
P5	25	Shared Apartment	Office job, 32 h/w	Running, Pilates	2x
P6	29	Living with Partner	Teacher, 32 h/w	CrossFit, Running, Weightlifting	3-4 x
P7	27	Living with Partner	Office job, 40 h/w	Home Fitness	1-4x
P8	27	Living with Partner	Teacher 30 h/w Hospitality 10-15 h/w	Horseback riding	3x
P9	27	Living Alone	Student, 30 h/w	Dancing, Yoga	3x
P10	27	Living with Partner	Office job 40 h/w	Weightlifting	2-3x
P11	23	Living with Partner	Shop Assistant 24 h/w	Fitness	1-2x
P12	23	Living with Partner	Student, 40 h/w	Dancing, CrossFit, Fitness	4x
P13	27	Living alone	Office job 40 h/w	Fitness, Running	2-3x
P14	26	Living with Partner	Office job 40 h/w	Running, Yoga	4x
P15	30	Living with Partner	Day-care 32 h/w	Volleyball	2-3x
P16	29	Living with Partner	Office job 40 h/w	Boxing, HIIT	1-2x

2.2 Exercise Diary

We designed an Exercise Diary ("Sport Dagboek") covering three dimensions: (i) demographics, (ii) exercise-related variables, and (iii) daily setup about intentions and exercise behaviour. The demographics and exercise-related variables were asked once, while the intentions and exercise behaviour were asked daily.

Demographics and Exercise-Related Variables

At the beginning of the study, participants were asked once to provide some demographic information including age, household type and occupation (Table 1). Exercise-related information was also collected, including what type of exercise they practiced, how often and how many minutes per week and what their primary reasons were to go exercise. Through these variables we aim to get a better understanding of the participants' exercise pattern and motivations.

Daily Setup

In the daily setup of the diary (Figure 1), participants were asked to (i) indicate what their intentions to exercise were that day and at what moment of the day, (ii) indicate whether they eventually went exercising, what type of exercise, with whom and how long, and (iii) complete the following sentences.

1. My intention to exercise *has changed/has not changed* because I....

2. I was *motivated/demotivated* to exercise because...
3. I was hesitant of going to exercise the moment I...
4. Eventually I *did go/did not go* exercising because...

We used the sentence completion method, a cost-efficient way to collect rich qualitative insights (Kujala, Walsh, Nurkka, & Crisan, 2013), to trigger spontaneous responses from participants. This method is more inviting than open-ended questions, and thus can be adequate for diary entries (Lallemand & Gronier, 2018) where users have to provide feedback on a repeated basis. Through the four sentences, participants indicated why their intentions have or have not changed retrospectively and how this had been affected through barriers and enablers that they experienced.

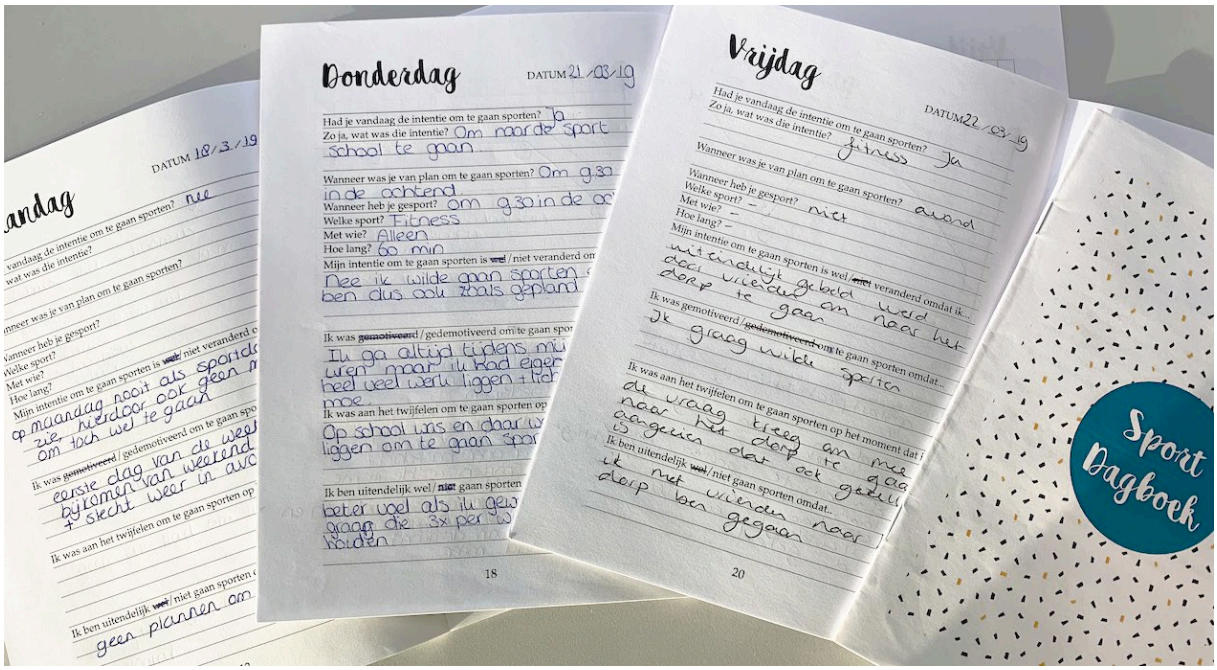

Figure 1 Example of the daily setup of the Exercise Diary

3. Results

Within the diary study, we prompted the daily intentions and exercise behaviour separately, providing a clear overview of the interplay of intentions and exercise behaviour, and how this changed throughout the day and week. This interplay results in four types of days, following 2 axes (intention vs. no intention and exercise vs. no exercise). When intention and exercise behaviour are aligned there are two options: (i) someone can have no intention and did not exercise ('Non-Exercise Day'), or (ii) can have the intention to exercise and actually went ('Exercise Day', *successful intender*). When intentions and exercise behaviour are not aligned, it might be that: (iii) someone can have the intention but didn't go ('I Didn't Go Day', *unsuccessful intender*) or (iv) did not have the intention but did go ('Went Spontaneously Day').

In the Exercise Diary, the participants also indicated why their exercise behaviour were (not) aligned with their initial intentions, providing insights in the perceived barriers but also in the enablers that help them overcome these. Through the diary study, we thus gain insights into (i) the intention-behaviour interplay, and (ii) the experienced barriers and enablers that influence this interplay throughout the day.

3.1. Intention-Behaviour Interplay

Distribution During the Week

Figure 2 represents the distribution of the four different type of days resulting from the diary study. It is visible that the two types of day: 'Exercise Days' and 'Non-Exercise Days' occurred most often, with more 'Non-Exercise Days' (total of 43%) compared to 'Exercise Days' (total of 38%). The day on which most women went exercising was on Monday. The total amount of 'Exercise Days' decreased over time until Thursday. Thursday was also the day where the least number of women went exercising. The only day where everybody stuck to their initial intentions was on Monday. On this day nine women intended to go exercising and seven women intended not to. The days of the week involving the most 'I Didn't Go Days' were Tuesday and Friday. On these days, four women intended to exercise but eventually did not go. The times women went sporting without having the intention upfront, all took place during the end of the week, on Friday, Saturday and Sunday. In total, the intention to go exercise was set 57 times among the participants, of which 25% of the time participants were not able to convert their intentions into exercise behaviour.

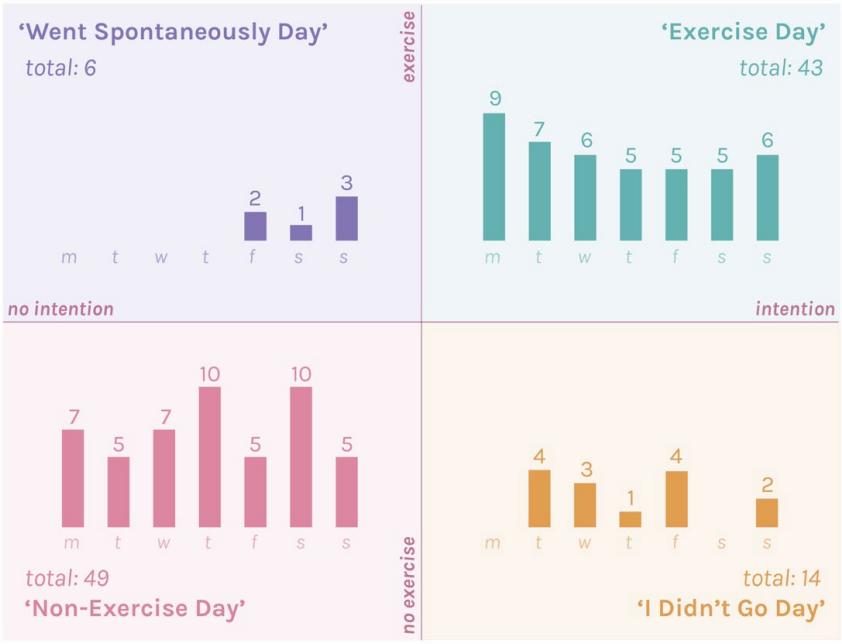

Figure 2 *Distribution of the four different quadrants throughout the week, following 2 axes (intention vs. no intention and exercise vs. no exercise)*

To make a clear distinction between the intentions and exercise behaviour throughout the

week, we represent all the days where an intention was present on Figure 3a, making a distinction between successful ('Exercise Days') and unsuccessful intenders ('I Didn't Go Days'). On Figure 3b, we represent all the days where an exercise action was present, with an initial intention to do so ('Exercise Days') or not ('Went Spontaneously Days'). The difference between the Figure 3a and 3b illustrates how consistent the participants were in pursuing their intentions.

Figure 3a shows that the higher number of intentions were made on Tuesday, eleven women intended to exercise that day. This was followed by Monday, Wednesday and Friday, with a total of nine women having the intention to exercise. The days with the least amount of intentions to go exercise are Thursday and Saturday. Figure 3b shows a decrease in women who went sporting intentionally over time, with the highest amount on Monday. There is an increase in exercise behaviour visible again towards the end of the week, on Friday, Saturday and Sunday. When comparing both Figure 3a and 3b, a noticeable gap is visible between intention and exercise behaviour on Tuesday, Wednesday and Friday. Indicating these are the days where participants were least consistent in pursuing their intentions.

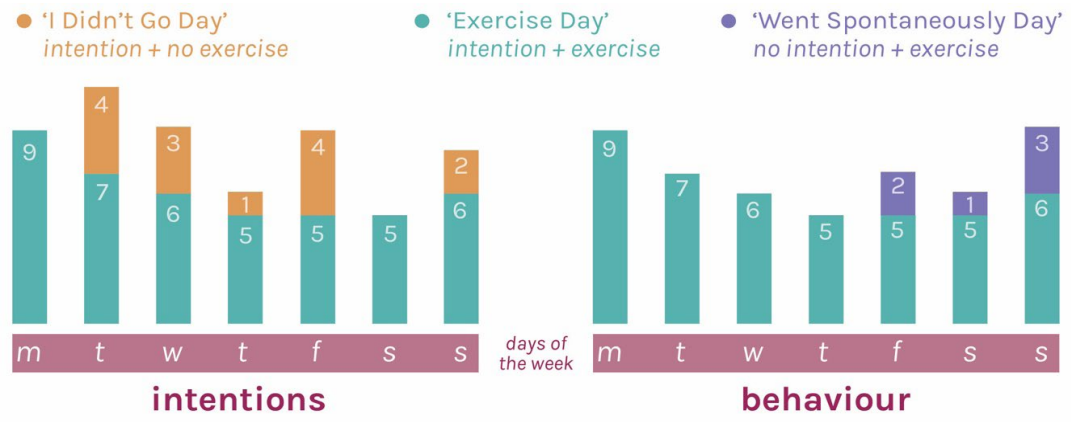

Figure 3 *Distribution of exercise intentions and behaviour over the week*

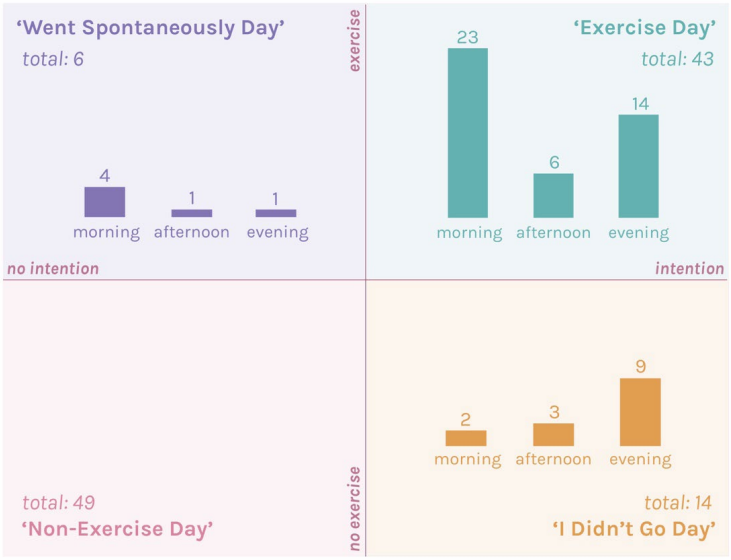

Figure 4 *The amount of different types of days experienced throughout the diary study and during which part of the day the intentions were originally set*

Intention-Behaviour Gap During the Day

Since the participants were asked when (i.e., part of the day) they intended to exercise, and if/when they actually went exercising, we were able to analyse on which part of the day women were less likely to convert their intentions into exercise behaviour. Figure 4 visualizes the different part of the days for which the intention was made to go exercise, but clustered in the eventual type of day (e.g. 'I Didn't Go Day'). In this figure, the 'Non-Exercise Days' are excluded, since participants did not set any intentions to go exercise for this type of day. Figure 4 shows that 26 times, someone set the intention to go exercising in the morning throughout the week, and these were pursued 23 times. However, when setting the intention to go exercising in the evening (total of 23 times), only 14 times, women were able to keep their intention and went exercising. Respondents who made plans to exercise in the morning thus were more likely to convert these intentions into actual exercise behaviour than when intentions to exercise were set in the evening.

Individual Patterns

Figure 5 visualizes a comparison of two participants' individual patterns. These women were selected because they both experienced three or more different types of days throughout the week, with at least two days where the intention and exercise behaviour were not aligned. Initially we see that both respondents were able to convert their intentions into exercise behaviour. What is noticeable however is that when these participants experienced a 'I Didn't Go Day', this was followed by a 'Non-Exercise Day'. However, two of these 'Non-Exercise Days' were in turn followed by an 'Exercise Day'. This is visible in P9's week, who had an unsuccessful intention to go exercise on Tuesday, but actually went exercising on Thursday. This also holds true for P1, who wanted to exercise on Wednesday yet eventually went on Saturday and Sunday. When P9 experienced an unsuccessful 'I Didn't Go Day' on

Friday, this again was followed by a 'Non-Exercise Day'.

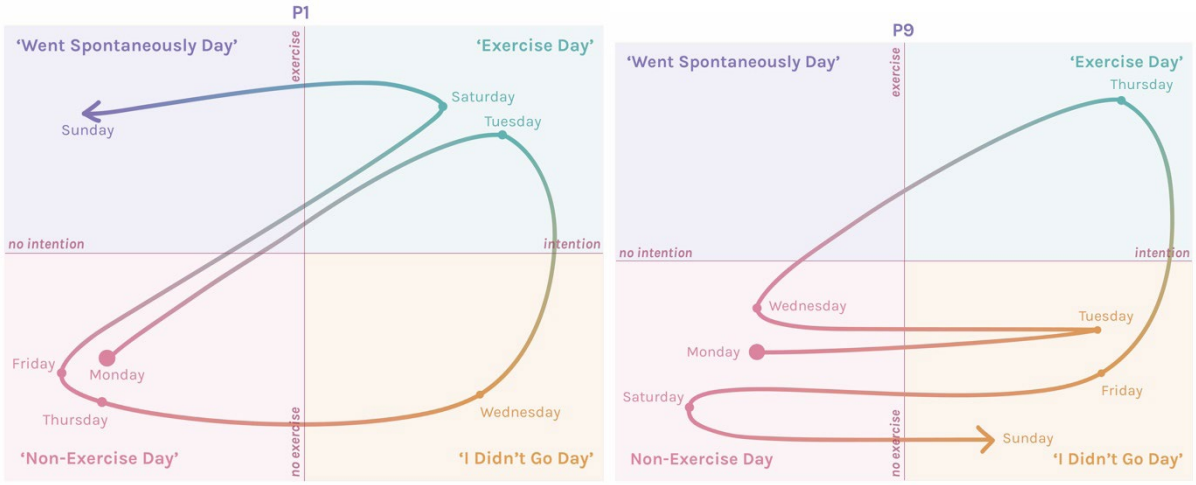

Figure 5 Left the individual pattern of P1, right the individual pattern of P9

3.2 Barriers and Enablers to go Exercising

We conducted a thematic analysis of the diaries' textual entries. This resulted in a general overview of the barriers and enablers experienced throughout the week, as described by our participants. Barriers that were indicated most often were 'difficulties with getting started', 'lack of time' or 'lack of energy'. Social factors like 'cancellation of exercising partner' or 'getting asked for a social activity' were also experienced as barriers often. Barriers that were indicated less often were 'weather' and 'long commute time'.

Enablers that were experienced most often were 'feeling like going to exercise', but also social factors like 'working out with a friend or trainer', or 'taking a class'. Participants also indicated to use 'self-commitment' as an enabler to go exercise. Another important enabler was participants' use of emotions when reflecting on previous behaviour, like 'regret' and 'guilt' or 'anticipating positive emotions' that one experiences after exercising.

Barriers and Enablers per Type of Day

We see a difference when analysing the barriers and enablers per type of day.

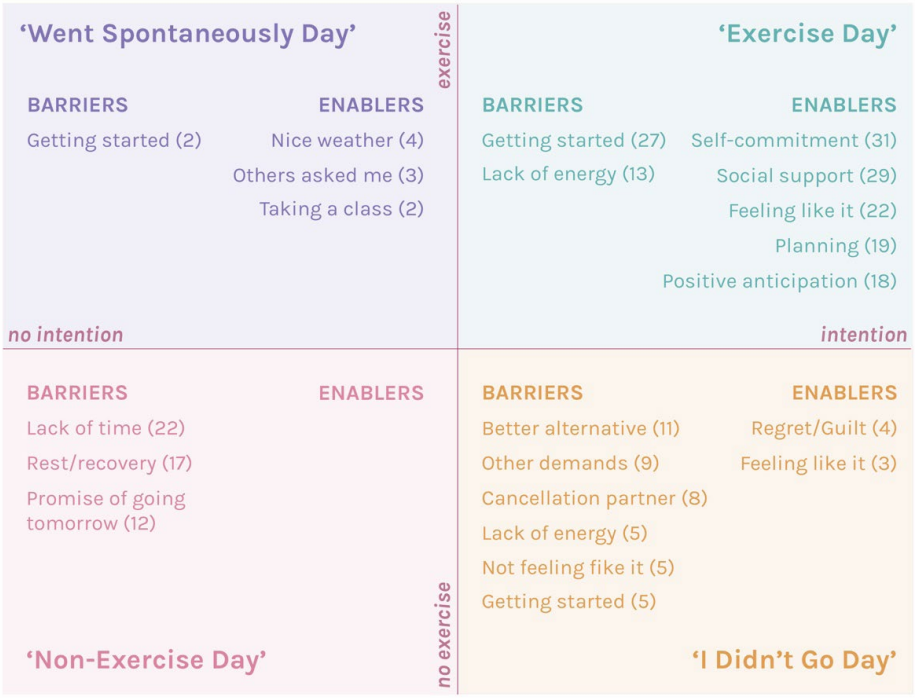

Figure 6 *Overview of the barriers and enablers experienced by participants per type of day, and how often they were indicated in between brackets*

'I Didn't Go Day'

The barriers that were experienced the most often on a 'I Didn't Go Day' were due to a better alternative or other demands like work, school or household related tasks.

> "I have not been exercising for 2 weeks already, so I felt I needed to go, however, I also felt I needed to tidy up the house." – P9
> "I had to work late for school, and I felt that was more important." – P12

Cancellation of their exercise partner and lack of energy was also indicated to be an important barrier among the participants.

> "When my sister-in-law cancelled up on me, my motivation dropped immediately"– P2
> "I was completely worn out from work and dragged myself home" – P10
> "I've had an exhausting day and made a different choice to just go walking with the dog" - P5

Additional barriers that were often experienced by unsuccessful intenders are when participants did not feel like exercising as well as troubles with getting started.

> "I was tired and was not feeling like changing my clothes" – P6

Even though the participants did not follow up on their intentions, they did indicate to experience enablers. The most important ones were the feeling of regret or guilt and feeling like going to exercise.

> "I was motivated to go exercise because… the rest of the week I went exercising only once" – P9

"I felt guilty towards 'name of trainer' that I had to tell her I was not able to come" – P12

However, on this day the enablers were not experienced as strong as the barriers, and thus resulted in a 'I Didn't Go Day'.

'Exercise Day'

When someone indicated to follow up on their intention to exercise, less barriers were experienced compared to a 'I Didn't Go Day'. The two barriers that were also experienced on this day were troubles with getting started and a feeling of lack of energy.

"When I came home I was doubting, because I was tired and I just wanted to lay on the couch" – P8
"I was doubting to lay in bed a little bit longer" – P13

However, on this successful type of day participants also indicated to experience more enablers, the most important being to remind oneself of the commitment made to exercise and social support

"I intended to do so and I do not want to postpone it further this week (procrastinating)" – P1
"I do not want to go, the couch is calling my name, but I HAVE TO!" – P15
"Even if I do not feel like it, I will go. You cannot bail on your team." – P3

Feeling like exercising, as well as the use of positive anticipation when reminding how good one feels after exercising were highlighted as essential enablers.

"I promised myself that I would go and I know that it makes me feel good all day long"– P13

The enabler that was experienced not as strong as the others was the use of planning an exercise session beforehand.

'Non-Exercise Day'

On a 'Non-Exercise Day', the participants indicated to only experience barriers, which were not experienced on the other three type of days. The most important one was the lack of time to go exercise.

"Even though I didn't go yesterday, I know I don't have the time today" – P5
"I know that I do not have the time because I have planned other things" – P9

Apart from time constraints, a physical barrier was experienced, where the participants indicated the need to recover or take a rest from previous exercise sessions.

"I felt that my body needed some rest" – P12

This was also the type of day were participants indicated to promise themselves to go tomorrow.

"I promised myself that I will go tomorrow" – P13

'Went Spontaneously Day'

On the days when women went spontaneously exercising without having an initial intention, they often only report enablers, for instance nice weather or other people asking them to go

exercise.

> "I actually did not want to go exercise, but I saw the good weather and thought; why not?" – P13
> "I spontaneously agreed with a friend of mine to go and play golf" – P2

These enablers were all rather unexpected, where the participants initially did not consider exercising due to internal reasons. The only barrier that was experienced on this type of day was to get started with exercising.

> "I was hesitant: I prefer staying in bed a little bit longer" – P12

4. Design Concepts as Enablers

In the following section we showcase how the findings from the diary study can inspire designs to support women in overcoming barriers to exercise. To illustrate this, we present three design concepts related to one of the four types of days we distinguished within the results section. When generating ideas, we attempted to focus on an experienced barrier on a 'I Didn't Go – Day', while amplifying an enabling factor through design. The enabling factors we aim to amplify are the ones being experienced on a 'Exercise Day'. The design concepts presented are work-in-progress, designed at the department of Industrial Design at the Eindhoven University of Technology.

4.1 Raya: Reminding of One's Commitment

Since self-commitment is mentioned as an important enabler on an 'Exercise Day', we designed Raya (Figure 7a). Raya is a personal tangible sports buddy designed to help women to plan their workout, through a scheduling feature, and additionally asks the user for her personal motivation to exercise on that day. When the user eventually is in doubt about making the decision to go or not, Raya sparks a dialogue remembering her of her initial commitment of wanting to go exercising and aiming to stimulate the actual intended behaviour through a conversation. Raya therefore specifically focuses on using the enablers of self-commitment and planning, when someone is experiencing the barrier of not feeling like it.

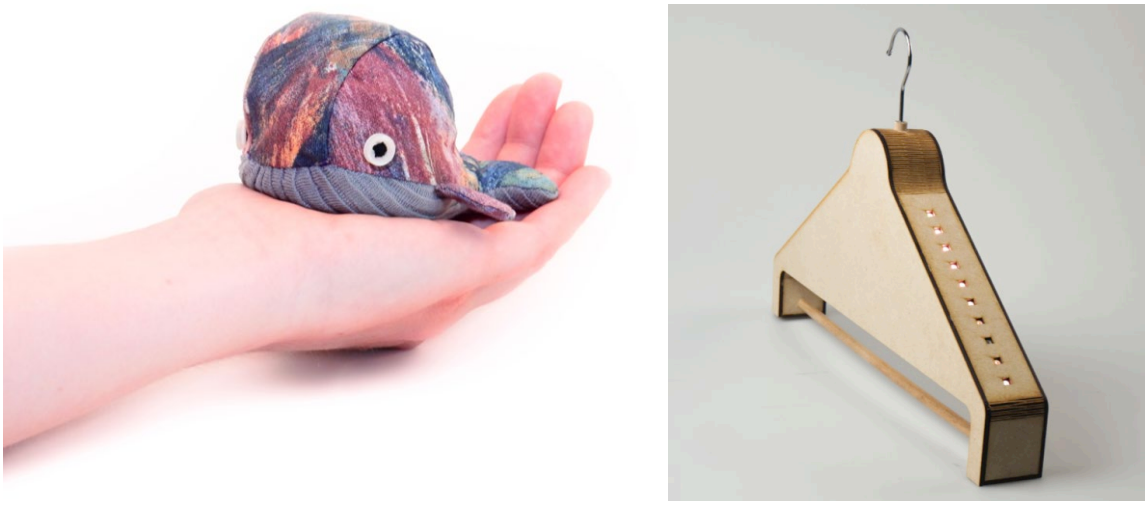

Figure 7 *a) Raya is a personal tangible sports buddy, designed by Alynne de Haan*
b) Iris an interactive clothes hanger, designed by Yvonne Bruin, Jorg Eikens, Lynne de Kluizenaar & Roos Vlaar

4.2 Iris: Emotional Design to Support Getting Dressed

Getting started was mentioned as one of the barriers on a 'I Didn't Go Day' by the participants. To overcome this barrier, we designed Iris (Figure 7b). Iris is an interactive clothes hanger that persuades women to change into their sport outfit when they are hesitant of getting started. With Iris, we focus on this moment and aim to lower the threshold of getting dressed. When someone has the intention to go exercise that day, she hangs her sporting clothing on the hanger. Later, when it is time to go exercise Iris will light up and starts moving to get attention from out the closet, to eventually stimulate the user to change outfits. Through Iris we target the getting started barrier through emotional design and planning, where Iris gets happy if the clothes are taken off the hanger and gets angry if they are put back too quickly. Iris could also support new types of enablers, not yet experienced now because there is no technological evaluation.

4.3 Laina: Positive Anticipation through Heatmaps

One important enabler on an 'Exercise Day' was the use of positive anticipation before the exercise session. To amplify this moment, we designed Laina (Figure 8). Laina is a shape-changing art piece that visualizes abstract running routes, by actuating pieces of wood integrated in the frame. By running different routes, users can change their art piece: Laina thus enables them to explore and be creative with every exercise. Additionally, the feedback of the last run is not immediate, rather slowly displayed over two days. Laina thus gives the user the opportunity to be more engaged in their piece of art, being able to change it by going for a run, but also by pressing the sticks back to their original position (as a reset of the art piece). Through Laina we target the enabler of positive anticipation, where the user is not only encouraged of how good she feels after exercising, but also how their run allows for

changes in the art piece.

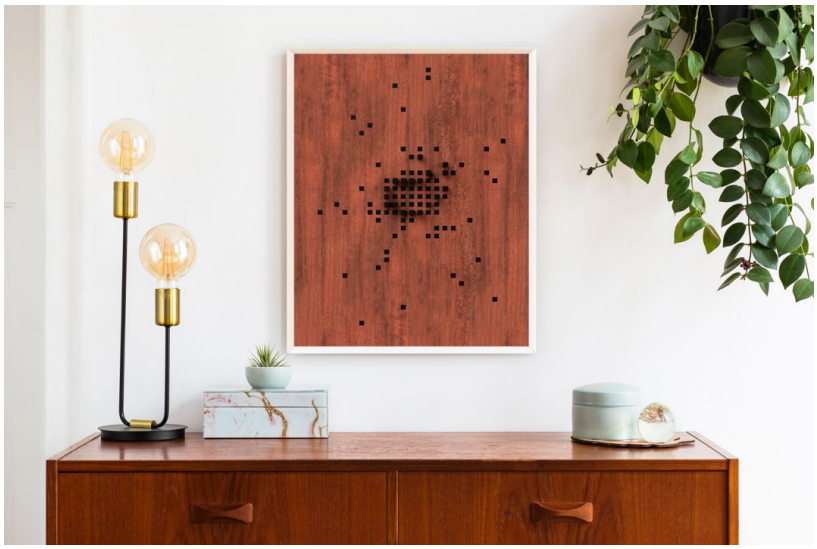

Figure 8 *Laina, a piece of art visualising heatmaps of previous running sessions, designed by Evianne van Hartingsveldt & Mads Birkebæk*

5. Discussion

We used a 7-day diary study in order to investigate the exercise intention-behaviour gap among young adult women, and when and why barriers and enablers to exercise occur. The results of the study provide new insights into the intention-behaviour interplay, and the experienced barriers and enablers that influence this interplay throughout the day.

By choosing to conduct a diary study we were able to gain insights in when the intentions were set and what part of the day seemed to be more successful in pursuing intentions. Intentions set for the morning were more often pursued compared to intentions set in the afternoon or evening. This reveals new opportunities for design with a focus to persuade people to set their intentions to exercise in the morning or more persuasive designs that implement the interaction in the afternoon or evening. Furthermore, our findings show a decrease in exercise behaviour through the course of the week. This is not considered a problem when people still maintain to exercise regularly, yet when this is not the case, it might be valuable to contextualize designs that offer different approaches when the week is passing, or focus on this specific part of the week.

When investigating which barriers and enablers influence the intention-behaviour gap, our findings show similarities with previous studies. Lack of social support was perceived as a barrier on a ‘I Didn’t Go Day’ (Morgan et al., 2016; Pridgeon & Grogan, 2012). Maintaining routine, anticipating positive feelings and social support were all indicated to be important enablers on a ‘Exercise Day’ (McArthur et al., 2014; Morgan et al., 2016). As compared to previous work, weather conditions were not experienced as a common barrier among our participants. As the study took place during Spring, with a generally more pleasant weather,

we however cannot draw conclusions on this factor. Supplementary to previous studies indicating a list of barriers and enablers, we gained new insights in what types of barriers and enablers were experienced on different types of days. Even though some barriers are not easy to overcome through design (e.g., environmental barriers), we identified new opportunities for design, for instance adopting a strategy of amplifying enablers. Our illustrative design concepts all strengthened an enabler mentioned by the successful intenders group of participants in the 'Exercise Days'. The diary study thus gave insights in barriers and enablers placed in context, which constituted inspiring and actionable design materials to explore this topic further using a research-through-design approach (Koskinen, Zimmerman, Binder, Redstrom & Wensveen, 2011). Whether these design concepts actually empower people in pursuing their intentions when experiencing a barrier needs user-testing, but it shows promise of how contextualised findings inspire design concepts.

Using the diary study, we were able to obtain commonalities and differences among participants, but also within-person changes over time (Bolger et al., 2003). In these patterns, individuals sometimes did not follow up on their intentions but were still able to exercise on a different day later in the week. What is interesting to see is how much influence a 'I Didn't Go Day' might have on the subsequent days. Does it only affect the day itself, where the intention is not followed up, or does it also influence the days after, either positively or negatively? Since this study only lasted 7 days with a relatively low sample size, the generalization of our results is limited. However, further investigating how many days a 'I Didn't Go Day' affects motivation might give better insights in how big the intention-behaviour gap is.

We chose a diary study approach to overcome the limitations of previous work in the domain of understanding barriers and enablers to exercise, with a majority of studies following a survey or interview approach (Larson et al., 2018; McArthur et al., 2014; Pridgeon & Grogan, 2012). Surveying and interviewing people to understand the intention-behaviour gap, allows us to list several barriers and enablers in a retrospective way. Relying on memory, surveys and interviews might emphasise certain factors over others, which can thus be reported as less prominent. With our diary study, we investigate the antecedents and correlates of experiences, which is a prerequisite for the design of effective interventions. Through design, we aim to overcome the barriers perceived before exercising, and act in the moment: in the present study, we collected actionable insights on how these barriers and enablers are perceived in context.

One of the limitations of the use of a diary study is the duration, affected by the time investment for participants. Since we conducted the diary study for 7 days beginning on Monday, Monday was indicated to be the day where the intentions and exercise actions were most aligned. However, it is uncertain whether this was due to the study starting on Monday, or because Monday is a day where people are more likely to follow their intentions. Furthermore, the relatively small sample size and homogeneity of the participants made it less possible to generalize the findings to other groups of people (as compared the surveys involving large samples). However, the diary study method allows for more qualitative

insights, essential to inform and inspire design processes, where one needs more contextual material to design an effective intervention and more storytelling to get inspiration from people's life.

6. Conclusion

By conducting a 7-day diary study with 16 women, we gained insights in how various barriers and enablers affect the intention-behaviour gap in exercising. We divided intention and exercise behaviour into quadrants, creating four typical patterns of days in the exercise diary. Our findings emphasise the temporal dynamics of the intention-behaviour gap according to these types of days. We contribute new implications for design in supporting people to translate their intentions into exercise behaviour. Through three design concepts, we illustrate opportunities to positively influence the interplay of enablers and barriers of exercising. We also advocate that design can amplify enablers to exercise through tangible and emotional propositions. Design practitioners and researchers can use the insights presented as inspiration sources to develop new concepts.

In future work, we will use the presented design concepts as research artefacts in order to deepen our understanding of the phenomenon. Our aim is to generate design research knowledge which can feed back into psychological theories on motivation and further inform how to design for the exercise intention-behaviour gap.

Acknowledgements: We would like to thank all the participants who contributed to this study. Additionally, we also thank the talented students from the TU/e Vitality Squad supervised by Daphne Menheere and Carine Lallemand on the creative projects described in the paper: Alynne de Haan, Yvonne Bruin, Jorg Eikens, Lynne de Kluizenaar, Roos Vlaar, Evianne van Hartingsveldt and Mads Birkebæk. This work is part of the project Nano4Sports, which is financed by Interreg Vlaanderen-Nederland.

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Meeting Afoot – A Step Towards Transforming Work Practice By Design Of Technical Support

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Abstract: Over the recent decades, a gradual shift towards less physically active and more sedentary work tasks and environments has taken place in many professions. Low levels of physical activity are now one of the major societal challenges due to its negative impact on health. We report a case study generating knowledge on how to support a change of work practise from low levels of physical activity to an increased level by combining and integrating and not separating work tasks from physical activity. This approach resulted in Meeting afoot – a system supporting walk meetings developed in close collaboration with participants and a cross-disciplinary team. The study share generated knowledge from two design iterations and user experience that can be valuable for the design research community aiming at similar approaches.

Keywords: user experience design; transforming work practise; physical activity; physical literacy

1. Introduction

Over the recent decades, a gradual shift towards less physically active and more sedentary work tasks and environments has taken place in many professions (Church et al., 2011). The change is partly related to technology- and work organizational developments focusing on efficiency and safety (Cavill et al., 2006; Craig et al., 2012). The shift is positive from many perspectives. On the downside is that low levels of physical activity are now one of the major societal challenges due to its negative impact on health (Lee et al., 2012; Hallal et al., 2012). Many hours in sedentary screen based work postures leaves us without adequate physical stimulation or variation for our muscles and cardiovascular system (Thorp et al., 2011). The amount of energy needed for screen based office work is comparable with lying in bed (Ainsworth et al., 2000).

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Studies (Tobiasson, Hedman & Sundblad, 2012; Tobiasson, Hedman & Gulliksen, 2014) highlights that many initiatives to change the situation add physical activity as separated from work tasks with the sole purpose of being physically active. This approach is not always appreciated. It has been reported as a cumbersome addition to the work tasks and as an unwanted pressure having to include exercise during spare time to compensate for increasingly sedentary work tasks (Tobiasson, Hedman & Sundblad, 2014).

In this paper we report on a case study with 15 participants from three different workplaces conducted over the course of 18 months. The purpose has been to generate knowledge on how to support a change of work practise from low levels of physical activity to an increased level by combining and integrating and not separating work tasks from physical activity. This approach resulted in *Meeting afoot* – a system supporting walk meetings developed in close collaboration with the participants and a cross-disciplinary team. The study share generated knowledge from two design iterations and user experience that can be valuable for the design research community aiming at similar approaches.

2. Background and Related Work

Examining office work from a perspective of physical activity many professions can be defined as “office-work” as low levels of physical activity and sedentariness are present. A common activity in office environments is work meeting.

Work meetings are described as a way to, exchange information, establish a common ground, generate new ideas, sustain and manage relationships, build or break team feeling and work climate (Meinecke and Lehmann-Willenbrock, 2015). Often there is some technology for presentations and a structure dividing tasks among the attendees such as cheering the meeting, taking minutes. Commonly employees bring their mobile devices into the meeting and interact with them in different ways. This can be convenient but may also disturb the meeting both for the individual interacting with the device and for the peers (Middleton and Cukier, 2006, Camacho, Hassanein, and Head, 2013).

Meetings are also regarded as problematic and a waist of time. In a study including employees from 41 countries less than half of the respondents described meetings as an effective use of time. The analysis suggest that invitation to meetings are sent out to employees that find the meeting of low relevance for their work and that meeting design practices are not followed (Geimer et al., 2015).

Research and development aiming at increasing physical movement at the office focus mainly on the setting. What about walking meetings – how has that been considered?

In university settings Damen et al., (2018) has explored walking meetings and they suggest looking at services to take notes as a mean to further develop walking meetings. Ahtinen et al., (2017) developed and tested a technical application supporting walking meetings. They report it as an obstacle having to carry and look at a smartphone in order to interact with the system. Using a smartphone while walking poses extra load on the low back extensor muscle

(a muscle involved in supporting stand upright and lift objects, and helps keep the spine upright) compared to walking without holding smartphone (Choi et al., 2019).

A technical system aiming at simplifying documentation of activities while doing the activities are described by Milara, Georgiev, Ylioja, Özüduru and Riekki (2019). They are not discussing walking meetings. Although different in focus area this case share the same aim of designing a technical support to simplify documentation of activities.

Finally, Opezzo and Schwartz (2014) describe, how they through four experiments together with university peers studied walking at work, in relation to creative ideation and walking was found to support cognitive processes of creative thinking and at the same time opportunity for the whole body to be physical active.

There are many cases from industry, business and management developing methods for walking meetings. Some of these cases are communicated in business reports, on-line magazines and in blog-posts. Kara Goldin, 2018 in Forbes (https://tinyurl.com/y8o6os2y) discuss how presentation technologies make us reluctant to change meeting habits. Bob Graham, 2020 in Triveglobal (https://tinyurl.com/y7y4qqwt) shares his experience of walking meetings and suggests as short standing meeting at the end of the walk to summarize. Others recommend avoid making the destination a source of unneeded calories, do not surprise colleagues or clients with walking meetings, stick to small groups and have fun (Clayton, Thomas and Smothers, 2015).

2.1 Physical Activity

Physical activity (PA) is defined as any bodily movement produced by skeletal muscles that result in energy expenditure (Casperson, Powell and Christenson, 1985).

It is well established and communicated worldwide that PA has positive effects on several of our bodily functions including mental health. It lowers risk factors for ischemic heart disease, stroke, diabetes, and breast and colon cancer. It is also part of treatment and prevention (Lee et al., 2012; WHO Global status report on non-communicable diseases, 2014). PA is associated with activities that primarily aims at increasing muscle strength and improve cardio-vascular endurance. Tissues and genetic material in the human body look almost the same as 10,000 years ago and many systems (skeletal, muscle, metabolic, and cardiovascular) rely on physical activity in order to function (Booth et al., 2008).

Matheson et al., (2013) discusses that the area of prevention has been caught between healthcare and policy-makers discussing among themselves who should take action and responsibility for prevention. They propose collaboration with the design community and the human-centred design approach. This is a strong motivational factor for this case study.

2.2 Walking

The activity of walking is an everyday physical enactments, a somewhat un-reflected practice (Edensor, 2000) because we rarely spend time thinking of how, why and how much

we walk. Walking has for the past two centuries changed from being used as a common mode of transport, towards being described and used more as a leisure activity and a social practice to address sedentariness (Newman, 2003). The activity of walking has been used in large-scale public settings as a method to explore the setting and generate data (Kanstrup, Bertelsen, & Madsen, 2014).

Walking is also a social and cultural learning and meaning-making process performed by the entire body in motion including arms and hands that swing and lungs that support the activity (Ingold, 2004, 2011; Ingold and Vergunst Eds., 2008 and Sennet, 1994). From the perspective of tourism and outdoor activities walking can be related to different performativity norms that form the basis for a sense of identity (Adler, 1989). Walking in the countryside on routes that provides guiding for walkers creates patterns described by Seamon (2015) as a practical knowledge situated, seen from both geography and history as an embodied practice.

2.3 Sedentary office work and current remedies

Parry & Straker (2013) studied patterns of sedentary behaviour during both work and non-work activities in office-employee. They state that;

> *"Although office work has traditionally been considered a "low risk" occupation in terms of chronic health outcomes, it may in fact increase the risk of mortality and cardio-metabolic disorders due to overall accumulated sedentary time and especially sustained sedentary time at work."* (Parry & Straker, 2013, p.9)

Another approach within organizations aiming at increased levels of physical activity is to introduce competitions. Step competitions are one example. However, Calderwood et al., (2015) discusses this approach towards promoting physical activity and points out that there may be a downside to this approach since comparisons among the employees may not be positive to all employees.

When examining the literature of interventions at workplaces that try to reduce sedentariness through increasing standing or walking Parry et al., (2017) found three categories of interventions: 1) targeting the physical environment (e.g. treadmills and adjustable desks), 2) targeting the individual with advices to use the stairs in stead of elevator, break-reminding software, walking programs and 3) targeting the organization workplace policy changes such as standing meetings and active/walking emails. The multitude of interactive devices and systems that people handle on an everyday bases construct movements that are choreographed through the designs of the devices and systems (Loke and Kocaballi, 2016). They propose vocabulary to reason about qualities of movement related to decision-making in design of technology to support designers.

2.4 Physical literacy

The concepts of physical literacy (PL) originates from Whiteheads (2010) were PL is described from six dimensions; *Motivation, Competence, Environment, Sense of the self, Expressions*

and Interactions with others, and *Knowledge and understanding.*

Being active from a physical movement perspective enhances *physical literacy*. Being physically literate gives us confidence in our own physical ability and allows us to feel secure in trusting our movement abilities. Physical literacy is our ability to capitalise on our embodied dimension (Whitehead, 2010).

schraefel (2015) discusses how knowledge from sports could be translated and transferred to benefit knowledge workers. And treating body and brain as two entities is an error born from culture.

> "…this separation between sports as fundamentally physical, on the one hand, and knowledge work as exclusively cerebral, on the other, reveals a grave mischaracterization of how we excel at cognitive activity." schraefel (2015 p. 34).

This case study is inspired by PL as a frame of reference and as a bridge to overcome the dichotomous view on knowledge work and physical activity.

3. Method

This case study has generated knowledge on ways to transform work meetings into a more physical literate, health sustainable and physical active work practise.

In the project researcher and practitioner with competence in interaction design, preventive health, ergonomics, user experience and computer science collaborated with participants experienced in office work. The choice to explore ways to enhance and support walking meetings was made after reviewing literature and a brainstorming session with participants where the idea of walking meetings as an alternative came up and was discussed and problematized. One problem was documenting, taking minutes.

3.1 Participation and user experience

We approached the design space through user experience design influenced by the Scandinavian tradition of cooperative design (Bannon & Ehn, 2012, Björgvinsson, Ehn and Hillgren, 2012, Björgvinsson, 2007, Nygaard, 1990, Sanders and Stappers, 2014). Physical movement seems weak to speak for itself in relation to screen-based knowledge work until the results of a prolonged sedentary style of work are communicated through discomfort, pain or diseases. Seen from a participatory perspective - the body affected by a design should have a say in that design process.

Using different methods and materials generates experience that are discussed and reflected upon in order to understand the setting and guide design (Bannon & Ehn, 2012). In close collaboration with the participants and based on their comments and ideas the concept and the design of the prototype evolved following an iterative process. The design decisions where constrained and framed by time, competences and resources. Within these frames the project members and the participants collaborated to make the most out of the exploration. In this case study multiple perspectives, mutual learning and sharing of

reflections and suggestions for design has guided the work.

3.2 Inviting and selecting Participants

A mix of companies, municipalities and universities received information about the project through phone-call, emails or during meetings and were asked if they would like to participate. The selection of participants where guided by acceptance to our invitation.

Several of the companies replied that they could not set aside time to participate. Three different office workplaces accepted the invitation. The administration office at the school of Sports Science at Umeå University, The sports federation at the county of Västerbotten and the department for Public Health at Umeå Municipality. Umeå is a small town situated in the northern part of Sweden. As the selection was done through acceptance of our invitation the participating organisations already had some interests and experience of trying to augment levels of physical activity in their organisations. This may have influenced their responses and experiences in this case study.

There were 15 participants (5 male and 10 females, ages between 30-60). The participants where all working in office environment, although in different domains the work tasks where mainly screen based and individually performed or in work meetings.

During 18 months the case study has iteratively and collaboratively developed and evaluated prototypes aiming at supporting walking meetings.

3.3 Designing prototypes and generating data

Idea-generating workshops, iterative design- and evaluation sessions in which the ideas were tested in field settings provided data for the study.

In order to validate the usefulness of the first and second version of the prototype, the participants used the system for real walking meetings in both indoor and outdoor settings.

The mix of methods facilitated our understanding and provided means to gain knowledge how to proceed with the design in this unknown area of exploration (Bødker &Iversen, 2002; Silva, Hak, & Winckler, 2016). As described by Suchman (1993) work practice is a non-static activity and experience of the work tasks, generating of skills and knowledge is situated and complex.

3.4 The Meeting afoot prototype in two versions

This first version of the prototype was tested and the feed-back and comments guided the development of the second version of the prototype.

The first prototype was an Android application developed in Eclipse. The smartphones were relatively simple models from LG. An underlying MS SQL database stores data from the meetings as well as audio and video files. All data are uploaded to the database via the mobile data network. The user creates a login to the system and connects to one of

a number of predefined workplaces. During the meeting, geographical position, sound recording, photography and text input are logged. The data are uploaded to the server to be presented after the meeting. Once the meeting is created the user defines how long the meeting will last and the application uses a session timer to remind users that the meeting is in progress. Signals given by vibration and sound to alert the meeting halftime and when only a short time is left, providing opportunity to summarize and compile the meeting. For this, a website was created (ASP.net) where users can log in and see the session data.

Following participant reflections from testing the first version two of the major revisions implemented in the second version were a flic (a soft programmable button https://flic.io/) and speech to text system, the Google Speech API (https://cloud.google.com/speech-to-text/docs/apis) in order to meet user desires.

Something the participants described as cumbersome during the test-sessions with the first version of the prototype was to handle and type on a smartphone as illustrated in Figure 1. To minimize the use we introduced a Flic button as illustrated in Figure 2 to provide user input to the mobile application running on React Native (https://facebook.github.io/react-native/) and to record voice, take pictures, and videos. Pressing the flic button the participants could start and stop the recording that communicated via Bluetooth. This made it possible to keep the smart-phone in the pocket during the walk and thereby free the hands and arms for gestures supporting the discussion and the walking through participating in the pendulum and the hip rotation.



Figure 1 *The first version of the prototype used a phone.*

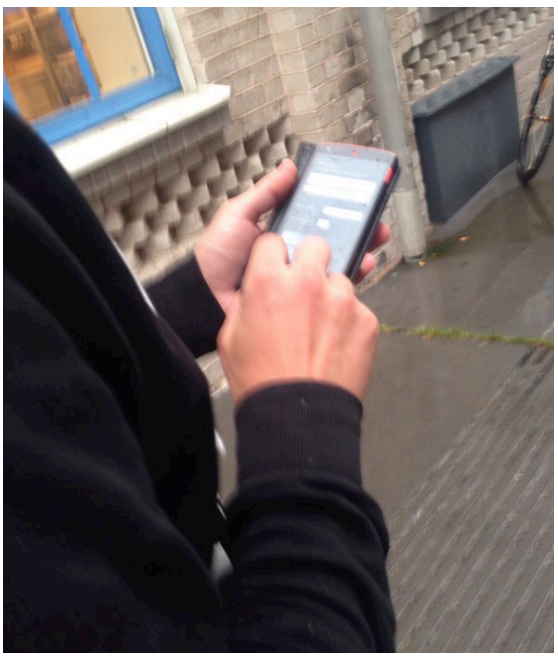

Figure 2 *The second version of the prototype used a flic.*

The recorded media files are then sent to Google Cloud via an API interface in order to produce transcripts of the meeting. A microphone with qualities sorting out some

disturbing sounds collected speech that through pressing the flic button was decided to be of importance to record. The Firebase database acted as a data-bridge between server and client components, thus maintaining data-integrity. Back at the office the speech to text is visualized at a web-based GUI in the format of text-boxes that makes it possible to detect who said what at what time of the meeting. Figure 3 illustrates the architecture (Back-end service workflow) of the system in the second prototype, apart from the flic.

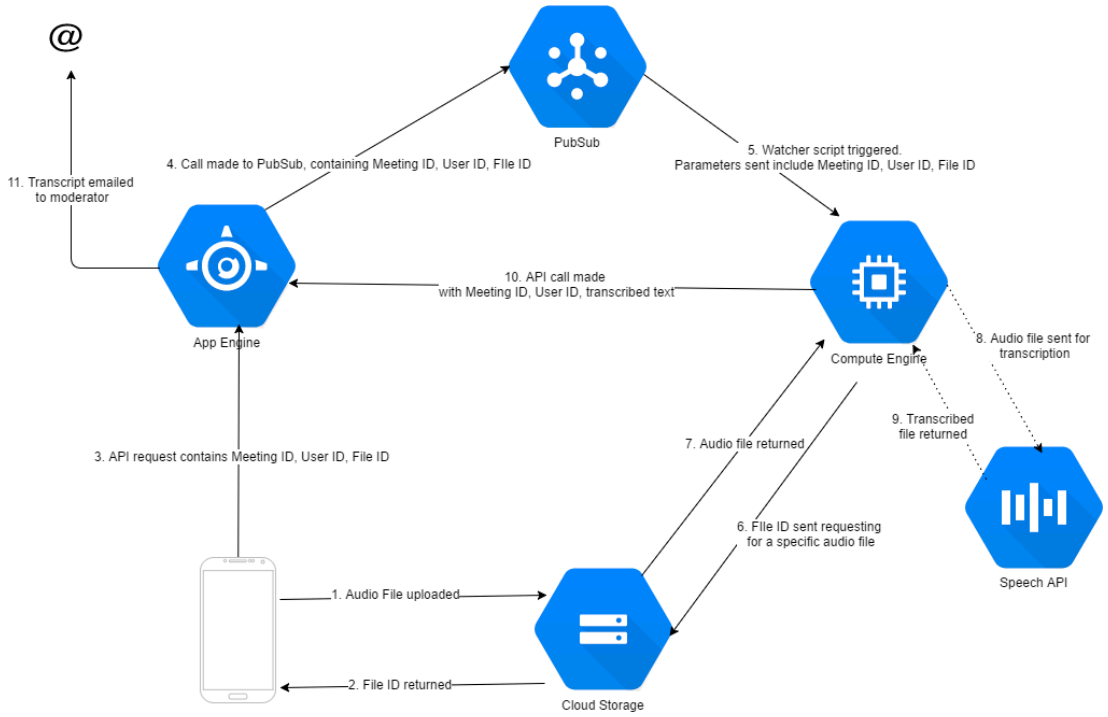

Figure 3 Back-end service workflow

Not all reflections and desires from the participants were implemented due to time-constrains and technical issues.

3.5 Analyzing generated data

A content analysis was conducted on the material generated from the users tests such as field notes, images and video recordings (Krippendorff, 2004). The narratives of the user tests were sorted through coupling data that described similar issues then clustering connected data under themes that evolved during the analysis. The digital images were printed out in order to facilitate the collaborative analysis among researchers and designers. Allowing time in order for the material to speak back as reflections-on-actions (Schön, 1987) supported the meaning making of the material that at the starting point was overwhelmingly diverse.

4. Results

When analysing the participants reflections and comments from testing the first and the

second versions of the meeting afoot prototype themes were identified. The results are here presented separately, then discussed in relation to each other and in relation to literature.

Themes that evolved from testing the first version of the prototype:

4.1 Interacting With The System

The walks often came to halt during cumbersome handling with the system through the smartphones. This was expressed to come in the way of the rhythm of walking and disturb the flow of the meeting: *"You do not want to keep on handling the smartphone – you want to talk and discuss with each other" (P4)* Typing on the smartphone was not received well. The need to hold the smartphone was described as frustrating and distracting for the flow of their walk meeting. Here expressed by one of the participants: *"Clumsy awkward cumbersome – you do not want to walk and hold the smart-phone in your hand" (P11)* Holding a phone while walking is a common scenario, here it was seen as disturbing for the flow of the meeting afoot.

4.2 Acceptance and Integration

Some participants shared reflections whether or not meeting afoot would actually be effective work meetings or mainly turn into a social activity and loose track of the agenda and action points. Here expressed by on of our participants: *"I thought that it would turn into a social chat and that we would not discuss the actual agenda for the meeting" (P15)*

Although participating in the case study was accepted on management level at the involved work settings. The actual activity of walking was perceived as somewhat problematic. It was communicated differently in the organizations. In the Municipality, one of the managers, not directly involved in the project, formally approved the activities which seemed to relieve some of the anxieties towards leaving the work-setting and go out for a walking meeting: *"It feels great now that it is anchored, established and that our manager has given approval that we can do this" (P7)* In two of the other organizations, managers where directly involved in the walking and more obviously approved the project.

4.3 Identifying Types of Meeting

Questions emerged concerning what types of meetings are suitable for walking meetings. Two types of meeting that was explicitly expressed as suitable were when *starting up new projects* and when *discussing particular issues*.

The participants expressed positive experiences from walking meetings but raised concerns for types of meetings: *"It went really well to talk but it is not suitable for all tasks" (P3)*

Some of the comments shared a concern that meetings involving large amounts of documents would be practically unmanageable as walking meetings. To bring along or display the material on a smartphone seemed not doable: *"This will not work since at our meetings there are a lot of materials that needs to be displayed" (P1)* There where also reflections on

open up meetings for walking as a part of the meeting: *"…well part of the meeting for sure can be done while walking" (P1)*

One participant shared a reflection on using the meeting afoot system for a single participant, and if that would be regarded as a meeting: " *I wonder if it would be okay just to walk by yourself – sometimes I need time to think to come to a conclusion how to approach a work-task" (P13)*

This was a new perspective and vividly discussed. At the end, meeting oneself during a walking afoot was decided as method to support reflection.

4.4 Afoot

Participants discussed how the meeting afoot would be arranged and work in practice from different perspectives including selecting a route, weather conditions to take notes to measure steps and compete. Concerning meeting during winter season: "*Not the best place to have a walking meeting" (P6)*

Reflections where shared on how to select a suitable route for a particular meeting and the agenda for the meeting. *"To decide or judge on the distance you need to walk in order to get through the issues or the tasks you need to deal with and solve through discussing seems difficult" (P2)*

A related concern was that it might be easy to loose the sense of time when having a meeting afoot and that it might be important that the system gives a reminder when it is time to head back to the workplace: *"Good to get the reminder about time to end the meeting in order to head back to the workplace within the set time of the meeting" (P3)*

Regarding the distance walked, several of the participants expressed a desire to know how far they had walked and that it could promote meeting afoot also from a physical activity perspective.

"Maybe fun to know the distance you walked" (P14) In line with this was a discussion if the activity could be used as a competition: *"We like to compete with the Office in Skellefteå – that would probably motivate us to walk more" (P12)* Measuring and comparing were discussed as motivating and related to generate something that could be communicated and shared with peers.

Themes that evolved from testing the second version of the prototype:

4.5 Control, Selection and Access

A recurring theme of discussion was whether there should be a single or multiple sources for recording the minutes: *"Should a microphone be provided to all? If everybody has a flic and a smartphone maybe that will leave room for misunderstandings?"* (P1)

"Having the record option only in the hand of one individual is in a way providing a power imbalance" (P8) Another issue was discussions on what should go into the minutes and how

it should be organised: *"How to find the most appropriate option for collecting the important parts of the meeting?"* (P10) Being the one taking the minutes during meeting afoot was described as being in control of the game.

4.6 Trusting technology

How is trust towards the technology established? How can you rely on it to function as intended? These questions and related issues were discussed and here illustrated by the comments below: *"Trusting the technology may depend on the background experience – tech or not tech"* (P8) There were comments related to trust and ease of use when introducing the flic: *"Yes, this is exactly what I had imagined"* (P1) Then reflections on technology in meetings: *"We all know that technology at standard meetings is still crappy and unstable – we joke about the projector, adapters that are missing."* (P9)

Trusting the technology were said to depend on the participants familiarity with technology and how at ease or secure they feel in having their speeches recorded.

4.7 Multitasking

There were some different views expressed on the way recording minutes was performed while walking. For some it worked well to walk and talk for others expressing something of greater importance stopped or interfered with the phase of the walking. Here exemplified as: *"Do not want to stop and talk – it gave me an impression that it is hampering the conversation."* (P9) *"Maybe one should stop when recording something of importance"* (P1). This may partly be related to getting to know how to handle the system.

4.8 Hold, Wear or Gesture Interaction

There were some perspectives on how the Flic button could be designed as a wearable or even left out in favour for gestural interactions: *"The button is small enough to get lost. It might be designed as a ring like Lord of Rings"* (P9) *"It might not need to be a button it might work with gesture-based interaction"* (P9) *"The flic is soft and nice to hold on to - it has a distinct on and off"* (P1)

The flic apart from being at risk of getting lost was appreciated and it did not seem to hamper gestures underlying speech during walking.

4.9 Preparation and Post-Work

Under this theme issues concerning preparation, planning and sorting of the minutes are discussed: *"What do I need to do before the meeting? Create a profile, invite attendees to the meeting, name the meeting. A plan and a discussion where to go/walk are needed"* (P5)

"Structure of the meeting – will it need to be organised in a different way?" (P5)

There were also reflections on what would be appropriate actions in order to access the minutes after the meeting afoot: *"The text that is generated might benefit from being*

coloured as to mark-up sections of higher importance" (P9) *"How do I get access to the audio-files?"* (P1) There were vivid discussions on practical questions.

4.10 Transforming Practise

This theme reflects comments on what meeting afoot could bring to the workplace: *"Break out of the office setting – was great"* (P8) *"Walking is more active than sitting in meetings for ends on where you may become so passive"* (P10) *"See potential user domain such as rehabilitation, business, personal development coaching"* (P5)

"You change in a way the behavioural of meetings" (P8) Many reflections were shared on the positive feeling of being in motion.

5. Discussion and Conclusion

Manner of working has in many professions become increasingly screen-based and sedentary. Work meetings are no exceptions. Research results communicate that levels of physical activity are low to the extent that it poses risks from a health perspective. Actions aiming at mitigating the situation mainly add physical activity as an add-on and suggest that the employees perform physical activities separated from work tasks.

In this case study we have explored ways to integrate movement capacities in office work tasks through designing support for walking meetings. Themes that evolved when analysing user experience from the two versions of the prototype are here discussed in relation to each other, theories and related work.

The theme *Interacting with the system* from the first version of the meeting afoot prototype. As pointed out by Damen et al., (2018) a service that simplifies taking notes may enhance the motivation to perform walking meetings. This is in line with what participants in this case study reported as important and they expressed similar experience as reported in Ahtinen et al., (2017) that interacting with a smartphone hamper the walking meeting. The changes made in the second version seemed to have overcome some of these issues as the participants expressed positive attitudes towards the changes.

Under the theme *Hold, wear or gesture interaction* changing mode of interaction from smartphone to the use of a flic triggered the participants to imagine other ways of interacting with the system. As described in Loke and Kocaballi (2016) the design of digital devices and interactive systems creates the movements in a way as choreographed by the design choices. This insight may not always be present throughout the process of design.

Another theme *Identifying types of meetings* from testing the first version consists of comments concerning what type of meetings would be possible to perform in a walking manner and if a meeting could be held with only one person attending. Would that then be tagged as physical activity or could it be viewed as an accepted work task? The activity of walking has been seen as a mean of transportation to and from a workplace and as such embedded in everyday activities. How can walking be more valued as a physical literate and

sustainable work practise?

The theme *Control, selection and access and the theme Trusting technology* relates to what would happen if all or only one of the participants had access to the recording part of the meeting afoot system? In sedentary meetings only one is often selected for taking the minutes. Here that position was more directly discussed from a power perspective. This can be connected to how Middleton and Cukier, (2006), and Camacho, Hassanein, and Head, (2013) discusses structure and power during standard meetings. Although in the second version all you did was pressing a button when recording material to go into the minutes, issues of trusting technology where discussed and how these might be related to levels of competence and experience of technology. The theme is also connected to the theme *Organisational Acceptance and Integration* from the first version in that levels of success may be influenced by how the organisations act and structure walking meetings, if it is seen as a work practise or mainly a social physical activity. In other words: From focusing on the individual when aiming at increasing levels of physical activity to design and integrate a physical literate approach to movement as a resource for a sustainable change of work practise - a transformation of work practice on organisational level. This is one answer on how walking can be more valued as a work practise.

On the move is the last theme from testing the first version. How phase of walking, time and distance were correlated was discussed. This can be related to the notion of competence from the physical literacy approach as knowledge of these three components and how they are connected will start to build up as the numbers of walks increase. The movement, the traces of distance, the change of scenario as the walk takes place – generates experience of the relation between time and phase of movement – if walking in a certain phase eventually that brings you back at work in time set. The theme *On the move* is linked to the theme *Multitasking*. While walking some of the participants shared that they stopped walking when they wanted to record something for the minutes. This might be related to individual preferences as not all participants stopped walking to record. As the literature describe walking as social and cultural learning and meaning-making process (Ingold, 2004, 2011; Ingold and Vergunst Eds., 2008 and Sennet, 1994) where the knowledge is situated in a relation between the walker and the context (Seamon, 2015) and that the walking may contribute in establishing as sense of identity (Adler, 1989) in may also create individual differences.

Issues related to *Preparation and Post-Work* would probably be of value to discuss to improve standard sedentary meetings as well. As described by Geimer et al., (2015) meetings are not always seen as a productive manner of working. Here the reflections came as a result of changing the structure of the physical movements.

Finally the theme *Transforming Practise* reflects comments on what meeting afoot could bring to the workplace.

If technology has been part of choreographing sedentariness could the design community with motivation from approaches such as physical literacy transform practises to break out

of habits, change behaviour? We have gained experience, insights and knowledge from the meeting afoot case study and we think it stands as one example of the power of mixing competences and to not forget competences on physical movement and physical literacy when designing in settings were moving bodies are present. One obstacle described as a hinder for walking meetings to be a more integrated part of the work-practice at the office is the difficulties to take minutes of the meeting. The Meeting afoot system offers opportunity to take turns in note-taking during the walking meeting through speech-to-text. It has been perceived as a good experience among participants and several companies and organisations in different parts of the country has showed interest in the system something that motivates us to try to continue develop the prototype into a ready available system.

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