

3. Hands-on hands-off: on proximities to materials and systems in design research

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Abstract

Much attention has been paid to the important role of materials experience in design practice. For many designers, hands-on materials exploration is one of the main sources of knowledge used to innovate meaning. Yet proximity is not always possible or appropriate. We are in a time where proximity to materials is being eroded, through zoom calls, MIRO boards and digital sampling; through necessity and choice (not all designers are materials-led). Meanwhile, new models of *design for change*, towards social wellbeing and sustainability require closer engagement with ‘systems’, meaning multi-stakeholder, multi-disciplinary collaborations. By exploring the characteristics of proximity to materials and proximity to systems this chapter seeks to better understand the relationship between *hands-on* materials methods and *hands-off* supportive methods, to reveal the best conditions for design research that brings about systemic change as well as innovation at the level of materials. The relevance of each method for different phases of a material development timeline is also considered, which has implications for project design and planning. The transferability of this concept to other contexts of design research and practice is discussed; fundamentally, what do design researchers need proximity to, to support transition and change?

Introduction

Much attention has been paid to the important role of materials experience in design practice. For many designers, hands-on materials exploration is one of the main sources of knowledge used to innovate meaning (Karana et al 2015; Verganti 2009; Ribul, Goldsworthy & Collet 2021). Materials have a primal draw for designers: the artifact in the hand, the feel, the look... they have a powerful enzymic role in the creative process. Materials, as the subject of investigation or application, epitomize the need and desire for proximity, more so perhaps than any other work-related ‘thing’. Yet proximity is not always possible or appropriate. We are in a time where proximity to materials is being eroded, through zoom calls, MIRO boards and digital sampling; through necessity and choice (not all designers are materials-led), to prevent the spread of disease, transport emissions and the waste of excessive physical sampling and prototyping.

Meanwhile, new models of *design for change*, towards social wellbeing and sustainability require closer engagement with ‘systems’, meaning multi-stakeholder, multi-disciplinary collaborations. In the context of circular textile design in the Trash-2-Cash project¹, I observed that this can draw textile designers away from materials and making, leading them to deny that part of their knowledge and practice that could be fundamental in framing the project, and the discovery of new ideas and meanings which have the potential to bring about change. I have found that in some cases facilitation and mediation is necessary to bridge gaps in understanding

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(Hornbuckle 2018). This raises the question: what is the relative value of *proximity to materials* and *proximity to systems* in design research for materials development? Where is the balance? When is proximity to materials most important and when can we manage with mediated support? What tools and tactics do we have at our disposal to enable materials development with and without hands-on materials experience?

By exploring the characteristics of proximity to materials and proximity to systems this chapter seeks to better understand the relationship between *hands-on* materials methods and *hands-off* methods, to reveal the best conditions for design research that supports systemic change as well as innovation at the level of materials. This will first involve a deep dive into the concepts of ‘proximity’ and ‘circular textile design’ in Part I to understand the specific design research context to which the concept is being applied. Part II will take a closer look at how *hands-on* and *hands-off* approaches are treated in the materials design and development literature, to reveal their characteristics. The relevance of each approach for different parts of a material development timeline is also considered, which has implications for project design and planning that accommodates design methods to engaging with materials and systems. Finally, I will briefly contemplate the relevance of the findings beyond materials development. Central to the transferability of this concept is understanding what can be substituted for ‘materials’ in other contexts of design research and practice; fundamentally, what do design researchers need proximity to in order to support transition and change?

Methods

My research focuses on developing design methodologies for complex collaborations (Hornbuckle 2022). Although I have worked with textile design researchers on projects aimed at circularity for the past seven years, my practice does not involve designing materials, but using my design skills to support material interactions and collaborations which bring about knowledge exchange and innovation. The premise for this chapter comes in response to the challenges my colleagues at the Centre for Circular Design and I faced during one large multidisciplinary consortium project – Trash-2-Cash – which aimed at a holistic collaboration involving diverse disciplines. I refer to this type of collaboration as ‘complex’ (where an attempt was made to involve actors from the whole material lifecycle) and the type of materials development as *systemic*; recognising the equal importance of all stakeholders in ‘driving’ the innovation (Hornbuckle 2020). Some of the challenges in Trash-2-Cash related to the different epistemological stances of partners, cultural backgrounds, languages, terms, mindsets, traditions and so on. In a more practical way, it was also to do with the tension between the *hands-on* experiential methods of materials-led designers, the form/function-first approach of industrial designers, garment designers and the project methodology. The availability of materials, and therefore a consequential mismatch between the provision for the consortium as a whole and provision for *hands-on* materials approaches (see Tubito et al 2019, Dell’Era et al 2016). The result was that materials experimentation had to be fought for, by the materials-led designers that desired it, and the opportunity for mutual learning and meaning-making through materials experience were sometimes missed (Barati, Karana & Hekkert 2019). As in many circumstances where the material or technology is unfamiliar to the designer, *hands-off* methods (facilitation/mediation/translation/interpretation) were used to bridge these gaps in materials understanding (see Hornbuckle 2018). A similar pattern is being observed in the current project

Herewear² which also seeks to develop circular textiles but with a regional focus. It is too soon to include an analysis of methods here, but anecdotally I was able to use the lessons of Trash-2-Cash to build in methods which addressed the themes raised in this paper, albeit with some remaining challenges.

The aim of this chapter is to reflect on the challenge posed by large collaborations which aim at a holistic or systemic perspective and identify support mechanisms, tactics and approaches for design research in materials development. ‘Systemic’ here is used to refer to the involvement of multiple stakeholder perspectives within a given system; in the case of Trash-2-Cash, the system is defined as ‘the material lifecycle’. Although this is a broad descriptor, there is an assumption common to circular approaches that the interdependence of the actors within the lifecycle, and the impact of their decisions on the outcome for the material, means that it is important to involve those actors in the development of materials, to bring about systemic change (Karell & Niinimäki 2019; Goldsworthy & Ellams 2019). Typical of European funded research, the system definition in Trash-2-Cash can be seen as ‘techno-economic’ (Birch 2017). It is not within the scope of this chapter to question that assumption or to review approaches to systemic definition or change, however it is important to acknowledge that understanding the relationship between design and systems is the subject of ongoing debate and there is still work to do in critiquing and defining the boundaries and stakeholders of circular material systems (Hornbuckle 2020).

The Trash-2-Cash project methodology was studied from several perspectives involving ethnographic approaches and action research, as described in the resulting literature (Karell & Niinimäki 2019; Hornbuckle 2021, 2018a, 2018b; Goldsworthy & Ellams 2019; Niinimäki 2018; Earley & Hornbuckle 2018; Niinimäki, Tanttu, Kohtala 2017). The observations and insights emerging from this research, as well as from similar projects, and exposure to the practice of colleagues at the Centre for Circular Design, provides the background for theory-building in this chapter, focusing on the relationship between *hands-on* and *hands-off* approaches through the lens of *proximities* to materials and systems. I will draw on the literature relating to collaborative approaches within the context of multi-stakeholder and multi-disciplinary materials development projects as well as observations from the Trash-2-Cash project to explore this territory. I have coded the different methods as they emerged from the literature review and tabulated the results and key characteristics to delineate and draw comparison. I used visualisation practices to reflect on how the literature relates to my observations from the case of Trash-2-Cash, resulting in a series of speculative sketches of how these methods can co-exist within a material development timeline and project methodology, which allows for proximity to materials and systems. This mixed-methods approach allowed me to build theory in this new area of design research and practice.

PART I: Context

Circular Textile Design

“The practical buyer of wool fabrics seems unable, when looking at materials, to keep his hands away from them. He thinks and speaks in terms such as:

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pliable, supple, soft, kind, lofty, firm, hard, or harsh – and all these are associated with the sense of touch. It seems probable that the stress laid on ‘handle’ results from a close appreciation of the requirements of the purchasing public...” (Binns 1926:238)

Writing in the British Journal of Psychology, decades before conversations around ‘designing materials’ emerged, Henry Binns describes a unique behaviour afforded by textiles: the ability to understand subtle differences in the properties of a material through the ‘handle’ or touch. This observation signifies a rich history of textiles ‘handlers’ – including textile designers – in the hands-on experiential understanding of materials. ‘Hand’ is a term used to describe the tactile quality of textiles and predates the academic discussions about the experiential knowledge acquired through touching materials. For centuries textile designers have been quietly creating new characteristics for materials by combining fibres and yarns in different ways with varying functions, aesthetics, and experiential values. The ability to change the characteristics of a textile through making and craft is unique, giving textile designers a set of skills well-suited to navigating the terrain between materials design practice and industrial production (Dormer 1997). Until recently, the stakeholders with which textile designers might collaborate mainly comprised fabric mills and clothing brands. However, over the last decade aspirations towards achieving ‘circularity’ have led textile designers into new collaborative spaces, expanding their traditional stakeholder eco-system to include Life Cycle Assessment experts, social scientists, fibre scientists and recyclers to name a few (Goldsworthy, Earley & Politowicz 2019). Textile designers seeking sustainable solutions have come to the understanding that it is necessary to engage with stakeholders from across the whole material lifecycle in order to design textiles and clothing for circular systems. This new focus for materials development adds complexity to the knowledge landscape for the circular textiles designer, the materials developer or materials designer. The requirements of the new material move beyond the expertise of one person, one organisation or even several organisations. What is needed is the knowledge of a wide range of actors within the materials system. So, proximity to materials is important, but it is no longer enough. What designers need now, is an increased proximity to the system of actors *and* to the material and making process. This new context of design research and practice has necessitated the development of methods and approaches to support collaboration with materials and systems. Arturo Escobar observes, that the move to expand beyond traditional siloes of design practice in pursuit of change is symptomatic of a wider design approach to transition towards alternative futures:

“Shared by most transition discourses is the contention that we need to step out of existing institutional and epistemic boundaries if we truly want to envision the worlds and practices capable of bringing about the significant transformations seen as needed.” (Escobar 2015:13)

The aim of circular textile design is to develop materials that are better for people and planet, that can replace materials that perform poorly against sustainability criteria. Circular textile design seeks change through technologies, processes and behaviours – or *Materials Models and Mindsets* as articulated by Earley *et al* (2016) – that will prevent material loss and maintain material value, putting an end to ‘cradle to grave’ material trajectories. One of the central challenges is to make material technologies appropriate, relevant and applicable to the people who will make, use, capture and regenerate these materials.

Design research can play a central role in both the experimentation and the translation stages of material innovation for alternative future scenarios, for example circular systems. Perhaps what sets circular textile design apart, is that it represents a form of design research that has made the need for proximity to materials and systems explicit in order to change practice. Whether this concept is useful beyond the specific case of circular textile design to ‘transition design’ more broadly, will be discussed at the close of this chapter.

Ways of thinking about ‘proximity’

Proximity has been considered in various fields of research and in different contexts of practice. The following discussion aims to navigate, on the one hand, what happens when there is proximity to materials, what forms of knowing and doing are enabled? On the other hand, how notions of proximity change with a systemic approach, where geographical distance – as well as other forms of distance – may threaten proximity to materials and system actors.

Proximity to materials

Beginning with what could be described as ‘extreme proximity’, Levinas contends that proximity brings the self to a feeling of responsibility for the other (in Bergo 2015). If we consider that materials can be seen as embodying ‘others’ with whom that material has interacted with either directly or indirectly during its journey from raw state to finished product, then it becomes clear why proximity to materials (and to the evidence of their impacts) can lead designers to act with a moral and ethical responsibility and in some cases to seek alternative scenarios of practice. Smitheram & Joseph (2020:303) have moved beyond being close to the material itself to a truly immersive process:

“These open experiments heightened our awareness of the dynamics of materials and how they combined with other things in the environment at Karekare, sparking new ideas and areas for research and practice. Walking barefoot on the salt-crusted beach sand led to experiments with salt crystals. Through trial and error, we learned what conditions aid or impede their formation, the materials and forms they like to grow on.” (Smitheram & Joseph 2020:303)

For Smitheram & Joseph, the material, its environment and the belief-system of the locality are also collaborators in their material development process, leading to a deep sense of respect and responsibility for materials, place, and local people equally. This is perhaps an extreme form of material proximity, beyond hands-on, yet echoing the sentiments of many designer-makers that experiencing materials provides an understanding of material affordances that is irreplaceable (Karana et al 2015).

Taking a step away from materials to the level of people and organisations, regional or local proximity is also seen as important for sustainable practices (Kuch 2017). In their study of stakeholders in circular lifecycle extension, Real, Earley & Goldsworthy (2018), observe the important ‘interdependence between practices, places and projects as practices are acting in places through potential projects, places support people’s practices and the development of

projects, projects acting as activators for practice and place changes.’ (2018:10). Regional proximity of actors enables activities seen as necessary for garment lifecycle extension to thrive.

Proximity to systems

The wider material innovation system currently operates beyond the confines of a local region and is geographically dispersed. For example, promising machinery, novel technologies and the leading experts in a given field of research, needed for transitioning systems could be located anywhere in the world. This brings with it obvious challenges for achieving proximity between people, knowledge and materials. Ron Boschma, an Economic Geographer, describes how Geographical Proximity has been a dominant concept in understanding organisational innovation where the prevailing stance is that ‘the more proximity there is between actors, the more they interact, the more they learn and innovate’ (Boschma 2005:62). Boschma argues that rather, proximity has a number of dimensions in addition to physical distance – cognitive, institutional, organisational, and social – which work in combination to create positive and negative impacts on the ability of an organisation to innovate. Often these do not require geographical proximity, are dynamic, evolve, influence one another and change over time (Balland, Boschma & Frenken 2014). The implication is that by making efforts to improve other dimensions of proximity, such as understanding one another on a social or cognitive level, some of the limits imposed by geographical distance can be overcome. Mars observes that this trend is largely enabled through enhanced communication technology:

“Such enhanced communicative capacities have fueled a growing trend in which diverse sets of organizations are engaging in system-wide design and planning at various levels and across expansive geographic distances.” (Mars 2012:274)

Moreover, geographical closeness has been said to limit diversity and stifle innovation, creating ‘lock-in’ and ‘a lack of openness and flexibility’ which prevents knowledge exchange and learning. ‘To start from difference’, is seen as an important feature of multi-disciplinary collaboration which enables the ‘emergent learning’ necessary for innovation and indeed for change (Light & Boys 2017:158). I observed this effect in the Trash-2-Cash project when a specific cross-industry exchange between industrial designers, fashion designers and materials engineers resulted in innovative prototyping and the emergence of a new composite material which could address the circularity issues with the PVC laminates used for rainwear (Hornbuckle 2018). Therefore, there is difference, there is geographically distributed expertise and knowledge, and there are diverse worldviews and stakeholder experiences, which are siloed and distanced, but nevertheless all implicated in the material innovation system. Bringing these into proximity is important if we are to find ways to transform systems. Conversely, this isn’t always conducive to maintaining the proximity to physical materials that is important for designers to innovate meaning and experience, and the regional proximity which is seen as important for sustainable and social innovation.

There is value in incorporating each of these different scales of proximity to achieve the ‘ideal’ systemic materials innovation project eco-system: ‘extreme’ proximity to materials; proximity to regional material flows and actors; proximity to wider system actors (which may be distant), as

illustrated in Figure 3.1. Approaches to increasing proximities to different system scales will be explored in Part II.

<Figure 3.1 here>

Figure 3.1. ‘Ideal’ project eco-system for systemic material innovation, incorporates three scales of proximity to materials and system actors.

In summary, proximity is a complex phenomenon, sometimes paradoxical, increasingly shifting (with advances in communication technology), and dynamic (one dimension may increase while another decreases). Extreme proximity to materials brings with it a responsibility and respect, while regional proximity can overcome some of the barriers to achieving sustainable actions and systems for clothing production, repair and recycling. However, diversification of expertise, and proximity to ‘difference’ is an important feature of innovation and change, and is often geographically dispersed. In addition to physical distance, there are other proximities at work: while ‘proximity to difference’ is important for innovation, there also needs to be coordination and emergent learning where expertise comes together and ‘cognitive’ distance is reduced. Social proximity is an important aspect to work on in support of the wider collaborative effort, as discussed by Earley & Hornbuckle (2019). While geographical distance can be overcome using communication technologies, it can also take the designer away from the material, following the fate of the majority of industrial design (Manzini 1986). The purpose of considering proximities to materials and systems in this context, is to better understand what we are trying to achieve when we choose design methods and approaches in materials development projects, and to help in answering the question: what can we do to support designers and other actors in these complex scenarios of practice?

Hands-on or hands-off?

Contemporary systems theory conceptualises systems as ‘socio-material’ comprising interconnected human and non-human actors (Nold n.d.). Materials, and their natural and human entanglements, are not only considered to be a part of the system but also potential collaborators, and this can be further expanded to include non-human actors such as the environment of the raw material and local culture (Smitherman & Joseph 2020). Within materials innovation literature, a particular emphasis is placed on the role of materials in the design process, so much so, that they could be considered a ‘keystone’ actor in the materials design and development ‘eco-system’ (Mars, Bronstein & Lusch 2012). The centrality of the material to the system is discussed by Professor Kay Politowicz. Here she shares an insight from a materials innovation project where she worked with fibre scientists:

“The best thing I could think to do, because it was so unfamiliar to all of us - us and to them - was to present a material swatch as a brief [...] at each stage, we effectively referred back to that event as the holy grail of what we were trying to get to.”

(Politowicz 2020:24)

Within the literature, the attention to *hands-on* materials methods tends to focus on finding new approaches to enabling materials understanding through touching, sensing and ‘tinkering’ (Karana *et al* 2015). Conversely, very little of the literature relating to materials design and development considers the wider system of actors and stakeholders, and those that do aim for a

greater diversity of actors tend to be in the field of Circular Textile Design. As previously discussed, wider change or transition requires engagement with system actors, a range of stakeholders, including experts, citizens, organisations, policy-makers and workers, as well as potentially territories, environments and natural eco-systems. Therefore, methods and approaches to increasing proximity to these actors, to enable engagement and collaboration, are also important to identify and characterise; these are conceptualised as *hands-off* approaches because they tend not to be in proximity in materials innovation, in terms of geographical, cognitive, institutional, organisational, or social distance.

When?

A further consideration in the type of approach used to increase proximity, is at which stage of the ‘project’ design interacts with the materials development process. The literature suggests that the smallest *hands-on* collaborations tend to be oriented towards the experimental stage of materials development (TRL³ 1-2), although anecdotally small collaborations between designers and materials development stakeholders can occur at all stages of material development, particularly in industry and knowledge exchange contexts. This implies that *hands-on* design methods add value throughout the materials development process. However, larger system-oriented collaborations where *hands-off* approaches are most valuable, appear to be mainly pursued (and funded) when materials are further developed in line with scenarios of use, towards making them ‘market-ready’ and scalable (TRL 3-6). This is perhaps due to feasibility; stakeholder engagement and collaboration is time- and resource- intensive, meaning that there needs to be a clear value for the funding body and for the stakeholders. The important point here, is that system proximity does not currently appear to be prioritised early in materials development at the concept stage. It has been argued that a primary function of design research in the pursuit of change is to ‘reframe’ the problem, meaning that design research should be involved when the brief is ‘open’ (Lee *et al* 2018), therefore perhaps there is the possibility of extending the type of design research involved in the very early stages of materials development from experimental and materials-driven to also involving system-scoping, mapping and definition as a tangential but complimentary line of enquiry, which can help to scope the systems impact of a material innovation, as well as the barriers and opportunities for transition⁴.

One of the outcomes of this review will be to consider how different design methods might relate over the timeframe of materials development from raw material to end-use, to gather the material and system-level perspectives, to bring them to bear on material innovation and shape transition pathways.

PART II: Approaches to design research for systemic materials development

This section presents a review of the literature relating to materials design and development, to identify and compare the approaches taken in different contexts, and to understand the role of *hands-on* and *hands-off* methods for achieving proximity to materials and systems respectively.

³ TRL = Technology Readiness Level, the original definition is provided here:

https://www.nasa.gov/directorates/heo/scan/engineering/technology/technology_readiness_level

⁴ As a practical example, we ran a workshop on this topic at the Design Research Society conference 2022 in Bilbao, Spain: Hornbuckle, Earley, Real & Hall (2022) ‘Designing the Circular Design Team’. BBK Kuna, Bilbao.

Five categories have been identified to define the methods and are discussed in the subsequent sections. Each method is briefly outlined in Table 1, identifying the characterisation, the key benefits, whether they are primarily *hands-on* or *hands-off*, the typical TRL stage in the materials development ‘project’, and the typical scale of collaboration or engagement. These are now briefly discussed in relation to the literature. Figure 3.2 sketches the different methods along a scale from *hands-on* to *hands-off*. Although ‘remote workshops’ are not included as a separate category, these emerged as a crucial method in the HEREWEAR project during the development of this chapter (immediately after the COVID-19 pandemic). Research about the value of remote workshops for materials development (following the COVID-19 pandemic) is no doubt forthcoming, however it is not sufficient at the current time to include as a separate category in the literature review.

<Figure 3.2 here>

Figure 3.2. A Proximity Methods Framework for design research: methods for improving proximity to materials (or other ‘things’) and systems, ranging from *hands-on* to *hands-off*.

	<i>Characterisation</i>	<i>Hands-on or hands-off?</i>	<i>Stage (TRL)</i>	<i>Examples</i>	<i>Scale of collaboration</i>	<i>References</i>
<i>Residencies</i>	A design researcher (often a doctoral student) spends 1-2 weeks within the work environment of another discipline (typically a science lab) or vice-versa	Hands-on (mediation may be needed in between residencies)	1-2	Hands-on experimentation with the raw / semi-raw material or material transformation technologies	1:1 / 1:2	Ribul, Goldsworthy & Collet (2021); Kuusk, Tajadura-Jiménez & Väljamäe (2020); Henchoz et al (2019); Paine, Goldsworthy, & Baurley, (2017) Smitheram & Joseph (2020:303)
<i>In-person workshops (WS)</i>	Collaborators, often with different expertise and perspectives, come together to experience materials in a neutral space and co-create knowledge or understanding	Hands-on (mediation is needed in the WS and might be needed in between WSs)	1-6	‘Tinkering’ with materials, dialogue around materials properties and characteristics, framing and selecting materials within scenarios	Between 3 and 35 collaborators	Hornbuckle (2021); Groth et al (2020); Lee et al (2018) Camere & Karana (2018) Goldsworthy, Earley & Politowicz (2019)
<i>Site visits</i>	Collaborators briefly visit a key facility, such as a material production site, a science lab, a design workshop or a maker space.	Hands-on and / or hands-off depends on how much can be touched / seen / heard etc.	1-6	Visiting a fabric mill to see the finishes that can be applied or seeing the machinery used to transform cellulose dope into new fibres	Between 2 and 10 collaborators	Smitheram & Joseph (2020) Real, Earley & Goldsworthy (2018) Tubito et al (2019)
<i>Direct, remote exchange</i>	In the process of materials development established collaborators exchange materials prototypes and information directly but remotely, assisted by digital communication and collaboration platforms.	Hands-off (hands-on is enabled when samples are sent / received)	3-6	Using collaborative documentation to demonstrate thinking; WhatsApp or Slack to send images of prototypes, sending fabric samples to experiment with finishes	1:1 or a small group of 3-4 collaborators	Tubito et al (2019) Earley & Paine (2020) Goldsworthy, K., Earley, R. & Politowicz, K. (2019)
<i>Mediation & Infrastructuring</i>	A mediator (facilitator / liaison / translator / interpreter) or team of mediators address gaps in communication between collaborators by creating processes and tools to set-up materials dialogue, with the aim of supporting the mobilization of	Hands-off (with the aim of supporting existing and preferred methods such as hands-on)	In new / large collaborations	A mediator sets-up collaborative terminology, translate materials properties in design benefits or vice versa. They may set up a project materials collection or systematize samples through	Between 2 and 40 collaborators	Earley & Paine (2020) Haug (2019) Henchoz et al (2019) Hornbuckle (2018; 2021) Tubito et al (2019) Real, Earley & Goldsworthy (2019)

	different types of materials knowledge and preferred ways of knowing.			collaborative documentation, processes and methods.		
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Table 1: Outline of Five categories of design method for improving proximities to materials and systems during materials design and development for change

Residencies

Residencies are perhaps most commonly associated with fine art where an ‘artist in residence’ is invited into a space, such as an institution or scientific establishment where they can respond to the work or culture of that place. However, in the last 10 years *Residencies* as a form of intense physical immersion in an unfamiliar culture has been adopted in materials design and development, with designers spending time in science labs (Ribul, Goldsworthy & Collet 2021), in raw material environments (Smitheram & Joseph 2020), and in engineering workshops (Paine, Goldsworthy & Baurley 2017), where their access to raw or prototype materials, transformation technologies and expert knowledge becomes less restricted and they are able to more easily develop ways of working and communicating that allow for interesting discoveries and emergent practices. There is also an ethnographic dimension to residencies in the context of design research which builds understanding through experience and observation which is also carefully documented.

For example, Kuusk, Tajadura-Jiménez & Väljamäe (2020) explain that the residencies in their collaboration between human-computer interaction (HCI), neuroscience and smart textile design allowed ‘a generous period for getting to know one another, to gain a mutual understanding and find a common language.’ (Ibid:324) and involved ‘introducing relevant work from each other’s respective disciplines’ where ‘new ideas and practical considerations came into play, shaping a common space for sharing experiential knowledge. (Ibid:317).

One of the great potentials of residencies is to provide deeper areas of collaboration and mutual understanding in specific parts of a project, for example when the brief is still very open and design exploration can help to frame the opportunities for innovations that could be meaningful and change-making (Ribul, Goldsworthy & Collet 2021; Lee et al 2018). As Paine, Goldsworthy, & Baurley (2017) suggest, residencies provide access to equipment and methodologies that are traditionally inaccessible to designers such as ‘testing facilities and insights that will expand the reach of the work beyond the craft-design field’ allowing the researcher to ‘validate functional opportunities first gauged through experimental material investigation.’ (Ibid:np). This in turn makes the design research outcomes transferable between disciplinary and academic-industry boundaries.

Residencies, therefore, allow a focused response to a specific problem at the material and technology level involving a small collaboration with a few people and usually only two or three organisations. A common problem is that ‘often lab-scale equipment is insufficient to produce prototype-ready materials for designers to use in their work’ (Hornbuckle 2017:2). Moreover, the small scale of the collaboration means that for the researchers to be responsive to the material system, there needs to be scope for the residency to be connected to the framework of a larger collaboration or community of stakeholders. Residencies are time and resource-intensive for the researchers involved, which makes them ideal for doctoral students who can then develop the area and feed the knowledge and understanding back into their respective fields. Ribul, Goldsworthy & Collet (2021) observe:

“A designer can mimic scientific processes, but tools or materials may not be available, leading to speculative outcomes. Embedding the design practice into a materials science laboratory is recommended even if in the form of short visits and testing, whilst complementing the research with studio practice to

anchor the new processes and results in the design disciplinary domain. The challenges here can lie in designers establishing collaborations with materials scientists, access, time, and costs in order to develop new material design processes.” (Ribul, Goldsworthy & Collet 2021:14)

In-person workshops

Workshops are a central method in collaborative design and can be used to bring multiple perspectives to focus insights, experiences and expertise on a range of topics: ‘workshops can act as catalysers for stakeholders to understand and relate with each other’s perspectives and needs.’ (Akoglu & Dankl 2019:14). The great opportunity of the workshop is the versatility it offers in ways of working with materials and the numbers of participants than can be involved; between 2 and 35 participants is a realistic scope for a manageable co-design workshop and this can be in research projects, with industry partners or in education (Parisi, Rognoli & Sonneveld 2017). In materials design and development, access to materials samples is often limited and so workshops may be the only place for all participants to experience key materials first-hand (Tubito et al 2019). Once the materials have been ‘experienced’ the memory of that material encounter can enrich the in-between remote work with experiential knowledge far richer than data, images and text (Hornbuckle 2021).

The workshop design, the methods and tools used, depends on the aims and the intended outcome of the interaction. For example, in the Trash-2-Cash project the focus was very much on using materials samples to support the cross-disciplinary discussion:

“Workshops represent a key asset to set up and developing the interdisciplinary dialogue among the different competencies involved into the project. Each workshop is experimental and exploratory, and is set up as a “platform of discussion” referring to design culture and tools.” (Tubito et al 2019:6)

The role of materials samples in this context is further elaborated in Hornbuckle (2021) observing that:

“when framed within a codesign workshop setting, it becomes clear that materials samples mobilise different forms of knowledge making them available to a range of participants, not only to designers. Materials samples embody scientific knowledge – the ‘know-why’ and ‘know-what’ – but also knowledge about the collaboration and the roles of other participants within the group – the ‘know-who’.” (Hornbuckle 2021:16)

Meanwhile designers working in materials development have argued for a more playful and experiential focus for materials in workshops (Camere & Karana 2018; Wilkes et al 2016) where playing and tinkering with materials can enable a shared understanding of what is possible (Parisi, Rognoli & Sonneveld 2017). These types of experiential workshops can provide an opportunity to kick-start collaborative communication and social proximity through the dialogue that arises from a light-hearted exchange where the outcome is open-ended, as if we were children at the kitchen table with Play-Doh. It can enable collaborators to see the materials

through other peoples' eyes and position themselves as a point of difference in mindsets and approaches (Kuusk, Tajadura-Jiménez & Väljamäe 2020; Hornbuckle 2021; Light & Boys 2107). Just as with residences, these types of socially-oriented shared experiences are particularly useful at the beginning of a collaboration and early on in the TRL of a material, or even before a material has been identified, when the brief is open and can be shaped.

In-person workshops are one of the most flexible and valuable formats for *hands-on* methods and can be used at any stage of material development, but they take a lot of planning, scheduling, travel, time and energy from a large number of participants. A final point can be made about workshop expectations: different disciplines and cultures use workshops for different purposes and so the aims and outcomes need to be very carefully communicated to all participants (Tubito et al 2019).

Site visits

A site visit to a manufacturing facility, a lab or a technical workshop enables collaborators to have a first-hand experience of how a material is made or transformed, and challenges their assumptions of what happens in a collaborator's work. This allows an insight into what is involved in the process, which opens the technology up as something that is tangible and accessible. Seeing a collaborator's workspace may also build the *social proximity* of the collaboration: seeing how another works, opens a window on their day-to-day. Participants in the Trash-2-Cash project asked for more opportunities to visit facilities and welcomed them when they were organized, as this participant comments:

“Visiting the laboratory was very useful to clearly understand the processing technology and the effort beyond its implementation and the production of base materials.” (Tubito et al 2019:154)

Particularly for designers, seeing equipment and processes first-hand enables understanding that can help them to see opportunities and provide inspiration for creative work. This can also be an opportunity for experiencing artefacts and materials at a scales not possible in sampling, making this a method with the potential for *hands-off* / *hands-on* experiences in equal measure. However, visiting sites of design work can be equally valuable and enable a shift in understanding which can evolve into collaborative language and knowledge sharing. Kuusk, Tajadura-Jiménez & Väljamäe explain that a visit to the design studio led a scientist to reveal some aspects of her work that became key to the mutual understanding and framing of the project:

“the lead scientist explained her work in neuroscience and proposed several keywords to provide focus for the project: ‘self-esteem’, ‘body appearance’, ‘physical strength’, ‘body flexibility’ and ‘body agility’. (Kuusk, Tajadura-Jiménez & Väljamäe 2020:317)

Although not as immersive as workshops or residencies, site visits offer the opportunity for ad-hoc interpretation (mediation) and experiential learning side-by-side, as well as a provocation. However, as with workshops, site visits can involve considerable travel and resources unless they coincide with other in-person meetings but can be hugely beneficial in place of longer residencies (Ribul, Goldsworthy & Collet 2021).

Direct, remote exchange

This category relates to formats of information, or modes of delivery and communication which enable an exchange directly between collaborators while remaining remote from one another. This can involve emails, video conferencing, databases and file sharing, documentation, phone calls, WhatsApp, MIRO⁵ and samples posted between locations. This is perhaps more commonplace for designers in industry when working with suppliers, where there are established lines of communication, practices and relationships. However, in all walks of life, activity in this area can be seen to have increased enormously since the COVID-19 post-pandemic era, greatly increasing the capacity to work effectively at distance.

In research projects, when relationships are new, and mutual understanding, ways of working and trust are yet to be established, it can take time to reach the point of direct remote exchange, especially in materials development where prototypes may be irreplaceable. Many of collaborations reported in the literature referred to some form of direct, remote exchange. For example, Kuusk, Tajadura-Jiménez & Väljamäe (2020) talk about the value of a ‘daily log of activities, including notes and photographs’, they say that they ‘periodically wrote blog entries with updates on the project, which helped [them] to maintain focus and continue to progress’ (Ibid:324). During Trash-2-Cash there was a moment of serendipitous exchange between a textile designer, composite engineer and polymer scientist, using email and posting samples in a materials-prototyping-triangle, resulting in collaboration which was tangential to the central research methodology. The COVID-19 pandemic has radically changed our acceptance and use of remote ways of working, there have been even more material sample exchanges of this type in the Herewear project, where partners only met in-person for the first time after 18 months working remotely; anecdotally it feels as if collaborators are more generous and less cautious about engaging in experimental remote methods when in-person collaboration isn’t possible. As we move forward, the imperative to reduce air travel will undoubtedly mean that remote methods will remain an important part of collaboration, albeit in careful balance with in-person encounters.

Mediation & Infrastructuring

Much work is needed to establish trust and generosity of spirit in just a few months at the start of a new collaborative project, which takes years of collaboration in normal circumstances. Groth et al (2020) comment:

“Our respondents’ experiences show how mutual understanding and the prerequisites for experiential knowledge transfer need to be built consciously, over a long period, by engaging in hands-on practices and cognitive activities that go beyond all the collaborators’ individual comfort zones, while the common goals and research questions are motivating for all.”(Ibid:340)

A period of mediation, before direct relationships are established, can help to ‘set-up’ the collaboration, communicate mutual benefits and values, support the development of a shared understanding and a collaborative language:

⁵ An online collaborative whiteboard platform

“The approach is one which relies on the ability of intermediaries to ‘translate’ design ideas, the potential of the material and characteristics between disciplines in a boundary-spanning role.” (Hornbuckle 2018:3)

This requires someone who is tasked with facilitating the collaboration; these multi-lingual people have been described as *Boundary Spanners* (Rieple, Haberberg, & Gander 2005), *Translators* (Hornbuckle 2013); *Liaisons* (Tubito 2019), *Interpreters* (Haug 2019), *Mediators* (Henchoz et al 2019; Real, Earley & Goldsworthy 2019) and *Intermediaries* (Groth et al 2020). Often their role can be to create the space for collaboration to occur, ‘infrastructuring’ using tools and boundary objects to capture and locate diverse knowledge (Simeone 2019). Yet Barati, Karana & Hekkert warn that mediation can become a substitute for experiential methods:

‘designers might be expected to understand new (and possibly yet-underdeveloped) materials and their potentials and conceptualize applications, while their access to the new materials is kept indirect and mediated.’ (Barati, Karana & Hekkert 2019:106)

With a mediated approach the aim should be to support collaborators in reaching the point where direct exchange comes more easily and without hesitance, enabling the flow of knowledge, information, materials and time, taking care not to keep collaborators at arm’s length. Mediation is the final piece in the jigsaw puzzle yet, as Karana suggests, mediation is not the end-goal. The ultimate aim should always be to support the processes of the collaborators, working with their methods not imposing on them. With experiential design therefore, supporting an atmosphere where *hands-on* methods can take precedence is the aim of mediation. Design researchers can move into these roles through their experiences in interdisciplinary collaboration, for example through residencies as reflected through Helen Paine’s experience: ‘Moving between the art-school and the scientific lab was embedded with this project – and surprisingly to me, had become my comfortable space’ (Earley & Paine 2020:np). However, engineers and people with a scientific background who have cross-disciplinary experience have also been observed transitioning into this role (Hornbuckle 2013: 2018; Niinimäki, Tantt & Kohtala 2017).

Hands-on / Hands-off: A Combined Approach

The list of methods described is not exhaustive, there are more ways of enabling multidisciplinary systemic collaboration than I have explored here, and within each there are numerous detailed methods and tools for conducting the work. Proximity is not the only consideration, but it is an important pre-requisite for design research. What I have tried to show through the literature is the range of methods which allow proximity to materials and to systems; the *hands-on* approach is well-suited to having a close experiential understanding of material and place whereas a *hands-off* approach enables numerous diverse system actors to work more closely together, overcoming cultural, cognitive or epistemological differences. However, this review has revealed that it is not clear-cut; direct remote work can spring up as a side-project of larger mediated consortium work, and small residencies which thrive on the close and direct *hands-on* methods can be helped along by mediators (Henchoz et al 2019). *Social proximity* is strengthened through the experiential methods which may also involve facilitation, such as in-person workshops and site visits, where a mediated level of immersion is mixed with expert-led interpretation creating a valuable experience for multiple collaborators. Remote working afforded through communication technology can overcome geographical distances, yet residencies can increase cognitive as well as geographical proximity. The dynamic nature of proximities reported by Boschma (2005) is therefore demonstrated very well by the dilemma of systemic materials innovation.

It is the combination of these approaches which results in a strong methodology for complex collaborative design in systemic materials innovation. By embedding these methods at the ‘right time’ in a project, proximity to materials and systems can be enabled for all actors. Kuusk, Tajadura-Jiménez & Väljamäe (2020) reported that even in their small collaboration of three partners, each of the methods described were used both to connect to one another and to connect to the wider project community:

“we actively communicated mainly via email and videoconferencing. At the beginning of the project we met in person for a 2-day workshop in Tallinn University, Estonia, and then again during two 2-week residencies in Carlos III University of Madrid, Spain. [...] The scientists also visited the artist’s studio to get a better understanding of her work as an e-textile designer. [...] This meeting coincided with a two-day workshop organised by the team members, which brought together around 20 people of multidisciplinary backgrounds with a common interest in the project area.” (Kuusk, Tajadura-Jiménez & Väljamäe 2020:317)

To illustrate this point, I have made a speculative sketch, shown in Figure 3.3, of how these methods could fit together within one material development timeline. This is entirely dependent on the characteristics of the project/s but what I hope to show is that understanding these different approaches and what they aim to achieve (proximity to materials and/or systems) can help design researchers to communicate with potential collaborators about the best project scenario for design research to effectively innovate and support change at material and systems levels. It is worth noting, that these different approaches might involve a variety of design researchers with different competencies and research practices, for example systems and service

designers as well as materials designers to create an adaptable and responsive design research team. Real, Earley and Goldsworthy write:

“Systems designers act as observers, facilitators, and mediators, looking from the inside. They discuss ideas with designers, making visuals throughout the project. The role of such systems designers is as the intermediaries of innovation and the communication experts.” (Real, Earley, Goldsworthy 2019)

A final note can be made about materials collections. In materials development we have found that the emerging, ever-changing learning resource - *the project materials collection* - is central to enabling different types of proximity to materials and to the knowledge of other actors in the system. This is an important topic that deserves to be more fully explored in relation to the existing literature (see Hornbuckle 2021 and the references therein), and is the focus of ongoing research.

<Figure 3.3 here>

Figure 3.3. A combined *Hand-on/Hands-off* Approach: A speculative sketch of how *hands-on* and *hands-off* design methods might be applied to different points in a systemic materials innovation process. Ideally, proximity to materials begins from the outset and is maintained throughout. System-scoping from the start (or even before materials development begins) allows for ‘proximity to the system’ to build as the project progresses allowing the collaboration to grow to include system actors and stakeholders.

Towards a transferable proximities model in design research for change

Multi-stakeholder collaborations which seek local and systemic change are emerging in many areas of design research, involving a variety of design research competencies such as *Service Design* in healthcare in the *Pharma Factory* project (see Hornbuckle, Grimaldi & Prendiville 2020) and *Social, Urban Design & Planning* design in crime prevention (see Davey & Whotton 2016), for example in the *Cutting Crime Impacts* project. Both projects can be seen to be using the tactics described in this chapter to increase proximity to the system – both with the internal project partners and the wider stakeholder community. Signori writes of a DesignLab workshop on the *Cutting Crime Impacts* project:

“Imagine the opportunity the CCI (Cutting Crime Impacts) project and particularly the DesignLabs gave to LEAs (Law Enforcement Agency) partners: a dedicated space to clear your mind, a multi-disciplinary team, the support of expert designers, funding, and time.” (Signori 2020)

The tactics used by design researchers to achieve proximity between system actors, to some extent have universal characteristics. In projects where materials development is not the central focus then the *hands-on* element of the proposed framework is a different kind of ‘thing’ than a material. Nimkulrat et al (2020) comment that the different forms of knowledge are generated when designers have close encounters or ‘experiences’ with artefacts, places or people, and where ‘people’ are the focus, then the ethnographic dimension is perhaps even stronger as a methodology and approach that can be located to different degrees within residencies, site visits and workshops. The challenge in large systemic projects is access, to experience the context

first-hand in order to acquire or create experiential knowledge. There are ethical considerations here as well – to flip the question: do we really need proximity to ‘x’? What might be the negative impacts of our presence here? When direct access is not appropriate (practically or ethically) there are tactics that project developers and designers can use to increase that proximity, such as those discussed in this chapter: ‘these definitions all suggest that proximity to the experience in question has potential to create different ways of knowing.’ (Nimkulrat et al 2020:270). It might be a *police toolkit* (Signori 2020) or an *urban area* in the case of Cutting Crime Impacts, a *plant bioreactor* that will be used to transform the way that drugs are produced, a *patient journey* or a *regulatory process* in the case of Pharma Factory. Designers can ‘experience’ these things using tactics for closer proximity, and through this proximity they can reveal, translate and innovate new meanings and values for other groups of people, stakeholders and communities. Concurrently, designers can translate this understanding into scenarios of change.

When embarking on new research collaborations. design researchers should try to understand what they need *in their hands*, what they need proximity to, and the tactics they can use to achieve that proximity. Niedderer and Reilly write: ‘many researchers in art and design and related fields perceive experiential knowledge or tacit knowledge as an integral part of their practice. It seems therefore that research, in order to be successful in these areas, has to recognise this and consider relevant approaches to organised inquiry accordingly’ (Niedderer and Reilly 2020:1). It is hoped that this conceptual framework can help *design research for change* to be strategic, systemic and its methods more communicable to potential partners in complex collaborations. This can also give rise to new approaches and methods that support close proximities.

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