Introduction

Making as reflecting through interaction with the material environment

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Why making is reflecting

Much debate in design research has evolved around the role of thinking, planning, problem-solving, creative ideation, and imagination. But where does the making of artefacts come in? What role does the act of making have in the process of thinking and reflection? Is making or crafting just the implementation of a particular idea in material form that takes place after the thinking phase is completed? Or is the act of making and crafting actually an integral part of the process of thinking that enables the ideation of an artefact?

Recent advances in cognitive sciences support the idea that cognition is not just happening in the head, but it is an embodied activity facilitated by a person's active engagement with their material and social environment (Baber, 2021; Malafouris, 2013; Varela et al., 1991). This "paradigm shift" in cognitive sciences might at first appear distant from the daily businesses of designers and craftspeople. However, theoretically, it means that planning and making or designing and crafting, which have traditionally been understood as separated (cf. Baber, 2021, pp. 39–43; Dormer, 1993, p. 9; 1997, pp. 18–19; Gedenryd, 1998, pp. 7–8), may now be seen as integrated and mutually intertwined activities. Design thinking is thus extended to involve a reflective material practice, and crafting is elevated from the status of mere manufacturing to that of facilitating reflection in action, thus closing the intellectual gap between designing and crafting.

The shift in cognitive sciences towards a more holistic and embodied view of the human mind has influenced many fields of study outside the cognitive sciences, including design and craft. For design and craft researchers, the recognition that cognition involves action and interaction with the social and material environment makes the notion of embodied cognition (EC) interesting and relevant, as it grounds the idea that making with a material is a form of thinking.

Craft, as one of humanity's oldest practices, forms the basis of human interactions with materials and the design and making of artificial environments that in turn make us who we are (Ihde & Malafouris, 2019). The theoretical framework of EC touches on notions in which pragmatic design and craft theorists have long been interested, including acknowledging the situated and bodily aspects of knowing, material engagement, affordances, expertise, and skill learning. While we could say that nothing is new here for the craft practitioner, that EC theories come too late, or that they are too limited, it is a relief for the field of craft research since what we knew all along has now been confirmed in other disciplines too. It also helps us theorize our own practice through alternative concepts. An even better understanding of these issues is critical in the digital era when the materiality of our environment is changing rapidly.

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Only a few of the authors in this book are cognitive scientists, thus the purpose of the book is not to enhance knowledge in the cognitive sciences. Rather, by involving authors from multiple disciplines, we hope to cross-fertilize the discussions on craft and design from an embodied perspective. Through research-based cases that involve the researchers' making experiences, different phenomena of human-material interaction are presented, analysed, and discussed. The practical cases exemplify ways in which embodied notions show up in action and are reflected upon by the authors. Through these cases, the book examines topics such as the embodied basis of craft activities and material manipulation, experiential knowledge and skill learning, reflection in and on action, and material dialogues. The book further discusses the role of affordances in making as well as mental imaging and rotation and how these may be scaffolded, teaching and learning situations, design collaborations, or resistances felt in material engagement. Several authors specifically discuss the hybrid forms of analogue and digital crafting that increasingly takes place in the field of craft.

The theoretical frame of EC is still developing and there are several directions with similar, but sometimes conflicting, standpoints (Newen et al., 2018). In this anthology, we do not promote any of these varying directions in particular; rather, we have given the authors autonomy to interpret the notion of *embodiment* in their own reflections. The topic of craft and design practice seen from an embodied perspective can be understood in several ways, thus some of the authors have written from their situated perspectives rather than addressing the theories of EC in depth. Others have utilized aspects of EC theory to reflect on their own practice in a wider sense, in relation to phenomena that they experience and consider important, such as wellbeing.

From design cognition to embodied cognition

Design and craft research and related theory have been heavily influenced by different cognitive orientations over time. Being a "planning" profession, design scholars have since the 1970s linked design practices to cognitive sciences, promoting a design cognition theory based on the fact that designers tend to work with problem-solving, i.e., they think and solve complicated and ill-defined cognitive tasks (Cross, 1982, 2001, 2011; Simon, 1988). The problem-solving paradigm was influenced by information processing models of cognition established in the 1970s–1980s that considers human problem-solving foundational (Newell & Simon, 1956, 1972; Simon, 1996). It views designing as a search process that applies knowledge to addressing a specific problem. These early theoretical underpinnings of design research often refer to the design cognition theory developed in conjunction with the design methods movement in the 1970s–1990s, a largely representationalist and computational understanding of the planning tasks, where ideas are first solved in the head or by calculations and then implemented in material (Kimbell, 2011; Rittel & Weber, 1984; Rowe, 1987). Design cognition theories have since merged to form a more applicable approach in what has been called "design thinking" (Kimbell, 2011).

However, already early on, parallel lines of thought offered a different view. Knowledge gained through experience and material interaction is called *procedural knowledge*, a kind of knowing *how* rather than knowing *that*, as explained by Gilbert Ryle (1971). Ryle was an early proponent of situated and embodied knowing as he shed light on the relevance of the procedural aspects of "intelligence" at a time when the word "embodiment" was on few lips. Another proponent of the embodied or "personal"

knowledge was Michael Polanyi (1958, 1966), who differentiated the "tacit" dimension of practitioners' knowledge from the more explicit and theoretical. Both Ryle and Polanyi felt the need to argue for their views in a knowledge landscape that was not entirely ready for an embodied view of cognition or the value of introspection and personal knowledge. However, both theorists have been amply referenced in research on crafts and making processes.

By the end of the 1990s, supported by Donald Schön's (1983) concept of reflection-in-action, and with the emerging practice-led research tradition, experiential and embodied views have surfaced in the research practices. Through this development, more phenomenological and embodied approaches have come to influence design and craft theories too, but these two strands were for a while in parallel existence, with the latter promoting a more material-based starting point for design (cf. Dorst & Dijkhuis, 1995). While Don Norman (1988) was inspired by James J. Gibson's (1986) ecological theory of affordances, Norman was not ready to abandon the traditional cognitive theories, as Bill Gaver (1991) did in the field of interaction design. Paul Dourish (2001) was one of the first to write a book on the embodied view in human-computer interaction. However, craft researchers, especially, have found the ecological and phenomenological cognitive theories relevant to their material interactions and reflections.

Researchers in the more phenomenological tradition have largely followed a pragmatist orientation that already 100 years ago acknowledge the role of the body in knowledge creation, such as John Dewey's (1938/2005) *Art as Experience* and other writings on art making, followed by Donald Schön's (1983) *The Reflective Practitioner*, Peter Dormer and colleague's *Art of the Maker* (1994) and *the Culture of Craft* (1997), Richard Sennett's (2009) *The Craftsman*, and many others. Due to the academicization of the arts and related PhD opportunities in the creative arts fields, this thread has lately been expanded by practitioner-researchers who reflect on material interaction from a first-person perspective and articulate their experiences as thinking through materials and processes (Mäkelä, 2007; Niedderer, 2007, 2013; Niedderer & Reilly, 2010; Niedderer & Townsend, 2014; Nimkulrat, 2009; Vear, 2022; Westerlund et al., 2022), thinking through hands (Groth, 2017), or a material dialogue (Fredriksen & Groth, 2022; Mäkelä & Aktaş, 2022; see also Brinck & Reddy, 2020). Personal and experiential forms of knowing are highlighted in such autoethnographic reflections, giving access to the practitioner's embodied perspective of the making and thinking process.

What is embodied cognition and how does this theory relate to research on design and craft practices?

EC is a group of related theories that generally holds the perspective that cognition is dependent on an organism's interaction with its environment via action and perception (Newen et al., 2018; Varela et al., 1991; Wilson, 2002). Based on phenomenological views first arising at the turn of the last century, there are now several lines of inquiry (cf. Newen et al., 2018). These separate "schools" of EC theories are founded in different domains, mainly in cognitive sciences and psychology, philosophy of mind, as well as ecological directions of psychology and neurosciences. Not only are different views connected to different scientific domains and traditions, but they also vary along an axis from so-called strong to soft interpretations, basically determined on how much they deviate from the traditional "intra" mental and representationalist or computational cognitive sciences (Newen et al., 2018, pp. 3–4). EC theories are often grouped

into the 4Es (embodied, embedded, enacted, and extended cognition), to show the more general issues that these theories promote as a group. While there are disputes within these sub-groups too, the general common standpoint is that the proponents of 4E cognition reject traditional cognitivism, i.e., the idea that thinking only takes place inside the head by manipulation of representations (Menary, 2010; Newen et al., 2018). To quote Chris Baber (2021, pp. 1–2):

> However, there is a broad consensus that humans, as cognitive agents, are *embedded* in environments in which they *enact* their *embodied* skillful coping in response to the scaffolding of artefacts that allow for the *distribution* or *extension* of cognitive activity.
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> (Italics in the original)

The 4Es explained in relation to design and craft activities

Embodied

Thinking, or cognition, does not happen only in the brain; instead, the whole body and its sensory faculties play a constitutive role in cognition since they enable perceiving and interacting with the environment (Chemero, 2013; Noë, 2004, 2009; Wilson, 2002). Consequently, sensory experiences and the information handled through acting with materials and other beings are key to processing these experiences, hands and touch being especially relevant (Ratcliffe, 2018). For example, our ability to make sense of what we see is an embodied skill that we have acquired through interacting with our environment; even if we have visual sensory input, our vision does not make sense to us unless we have gained experiential knowledge in relation to what we see (Noë, 2004). Learning skills and becoming an expert involve a process of automating the interaction between actions, materials, and tools – to the point where actions become, so to say, "second nature" or "embodied". Tools used disappear from consciousness and become "ready-to-hand" meaning that the practitioner's thinking and making happens *through* materials and tools, just like when a blind man feels the irregularities of the street through his cane (Baber, 2021, p. 110).

Embedded

People exploit features of the physical and social environment to increase their cognitive capabilities (Malinin, 2015), thus cognition is always embedded in a social and material context, such as in a craft studio where there are other practitioners, tools, and materials. This becomes especially relevant to apprenticeship in which a craft learner is enculturated into a craft identity through what Jean Lave and Etienne Wenger (1991) called the "legitimate peripheral participation", a form of situated learning. Communities of practice, according to Lave and Wenger (1991), are collectives of practitioners who participate in an activity system by a set of relations between persons, activity, and the world (p. 98). Within such communities, we can speak of a shared embodied understanding that is the product of socialization and culturation over a long period of time. *Situated cognition* is not mentioned separately in the 4E group but is in a way an early concept for the idea of the 4Es, especially in the learning sciences (Brown et al., 1989; Robbins & Aydede,

2009). Situated cognition basically means that cognitive activity does not simply take place in the head but in the context of a real-world environment (Wilson, 2002). Varela et al. (1991) were seen as the first real introducers of the concept of EC; however, situated cognition and situated learning were introduced at a similar time, building on a phenomenological worldview. *Distributed cognition* means that thinking does not happen in a vacuum but is distributed across individuals and builds on a socially shared activity. It also means that we build our thinking on previous ideas we have gathered through our social interactions with other people and that these people's ideas help us think further. Similarly, an apprentice under the influence of a master craftsperson in the workshop is able to build on the master's knowledge and thus extend their own knowledge (see also Haraway, 2016).

Enactive

Cognition emerges from, is constituted by, and depends on sensorimotor activity (Johnson, 1987; Noë, 2004, 2009). The idea that an organism is in a constant interaction with its environment is originally an idea based in enactivist biological psychology, where the perception-action loop is an example of how this interaction is grounded in perceptual and sensory functions. Basically, an organism orients itself in the ecology by sensing its environment and by making sense of it through acting in and interacting with it and learning from this interaction (Varela et al., 1991). Babies' ways of learning through touching, tasting, and trying out different actions is an example of this. Engagement with different types of materials thus affects the nature of what is perceived, learned, and understood (Malafouris, 2013). Design and craft practices are bodily informed in multiple ways, not only in the act of making and manipulating materials (Malafouris, 2020) but also in the reception of designs and using of objects (Baber, 2021) as well as the general creative process (Withagen & van der Kamp, 2018). Even imagining is an active process that relies largely on previous sensory experiences, even if we are also able to imagine beyond these (Rucińska & Gallagher, 2021). As EC, and hence also embodied knowledge such as craft skills, are seen as implicit (i.e., tacit), they are not always readily available to us for our conscious reflection. However, a person can make their skills seen through the *enactment* of them, thus we can show how a craft practice is performed while we may not be able to explain all aspects of what is going on in our practice. Embodied knowledge can thus better be communicated through action and may, to some extent, be experienced through enacting other practitioners' practices (Almevik et al., 2013) feeling what it is like doing them with one's own body.

Extended

Cognition extends beyond the boundaries of the individual, for example, through the use of tools and technologies, such as a hammer, or a potter's wheel. Making is a form of thinking through actions, tools, things, and materials – or *thinging* – as Malafouris would write (2020). The tools we use naturally also affect what we can make with them and how our thinking is distributed through them (Baber, 2015). While digital tools may take time to embody, they also afford considerable opportunities for extending cognition beyond the body (Clark & Chalmers, 1998; Hutchins, 2010). However, even taking notes with a pen on paper is an example of such extension of cognition outside the brain. In design and craft processes, sketching, drawing, and prototyping work as explorative

"thinking through action" or "thinking with hands" (Baber, 2018). Not only do they enable us to better understand the physical strains and the "realities" of our designs, but they also work as mental "crutches" when imagining 3D rotations, i.e., what something would look like from a certain angle. By "externalizing" our ideas in material, we also communicate them to others and can discuss them concretely without having to imagine what ideas are going on in each other's minds.

While the 4E list does not include the *distributed* or *situated* nature of cognition as their own points, these are thought to be part and parcel of the EC theory in general, playing a part in the other "Es". Some authors like to write the 4Es ++ with plus marks, to indicate that there are even more aspects to this conceptual group, some even pointing to "emotions" and "affect" as missing from the original group (Newen et al., 2018).

It is also important to mention that, while the notion of EC highlights the human perspective in the practice of making, it is not "human-centric" or in opposition to post-human views on making. On the contrary, especially the *enactive* line of EC theory (Noë, 2004, 2009; Varela et al., 1991) highlights *any* organism's (human or animal/flora) interaction with the environment as a form of sensemaking. Material engagement theory (MET), for example, promotes the idea of material agency and the equal relationship between the maker and material (Malafouris, 2008). The way the "voice" of materials affects the making process also links the maker with their environment concretely in some cases (Fredriksen & Groth, 2022). Such "negotiation" with the material and dialogical reflection in action is central to many authors of the chapters in this anthology.

Material dialogues in craft and design practice

The contributors of this book discuss their embodied experiences and "material dialogues" based on a variety of concepts from EC theory, as well as from their personal experiences. Interestingly, it has become evident that, to discuss the topic, they largely adhere to similar concepts such as material dialogues, material engagement, affordances, as well as the changed materiality in hybrid crafting that involves physical and digital materials in the making. While these are not the only topics, we open these up a bit already here to aid in reading the chapters later.

Material dialogues

Many craft and design practitioners refer to their making as a process of negotiating with the material as if they are having a dialogue with it (cf. Malafouris & Koukouti, 2022). Inspiration may be sought in the material, in the properties or uses, or in technical aspects such as challenging the material resistance or applying it to a new context. Even if a design idea or image of a wanted result is developed before manipulation starts, oftentimes this idea will be modified in the process of prototyping or constructing the artefact as the situation unfolds. As Tim Ingold (2013) pointed out, the idea that a separate design and thinking part is followed by an unreflective making part is unrealistic; he criticized this as "hylomorphic" (pp. 20–21). Instead, he promoted a more interactive way of thinking about the making process in which he used the idea of "correspondence" to exemplify the maker's dialogical relationship with materials and situations (p. 107). Also, Donald Schön (1983) described the practitioners' reflective thinking in and on action, and in a later speech (1992), he further explained material dialogues as a "reflective conversation with the materials of a situation". Such a reflective stance is based on the ability to

be sensitive, open, and reactive towards the situated aspects of the making process that resonate with ideas of situated and embodied knowing.

Affordances

Gibson's (1986) affordance theory is at the core of the embodied mind thesis and has been a central concept in the understanding of material "dialogues" experienced by researchers in design and craft. In short, Gibson (1986) introduced the idea that the environment offers certain possibilities for action that different individuals may activate depending on their physical abilities and constraints. Affordances become important not only in the material dialogue between craft practitioners and their material situation but also when designers create future interaction possibilities for users of artefacts or services (Norman, 1988). Affordance theory has evolved after Gibson and is actively expanded to also encompass the active creation of affordances (Kimmel & Groth, 2023) and affordance landscapes (Rietveld et al., 2018).

Material engagement

In many ways, Lambros Malafouris' (2013, 2018, 2020) MET takes this idea of material dialogues further to create a theory around the dialogical relationship that practitioners have with matter, their tools, and their task ecology. However, this theoretical framework represents a different school of EC theories – the enactive view. This view is seen by some as incompatible with Gibson's ecological view (Alessandroni & Malafouris, 2022), while others try to build bridges between these, arguing that they have more in common than what separates them, and that both perspectives are necessary (Baggs & Chemero, 2021).

Malafouris's MET relates to all making, and his influence stretches over several domains such as anthropology, cognitive archaeology, philosophy, and cognitive sciences, but is perhaps especially visible in the craft practitioner's interaction with materials. For this reason, many of the examples in his writings are from the field of craft, in particular clay throwing on a potter's wheel. The main idea is that the situation of making a material artefact involves not only one actor (the maker) but also the material agency and properties, the tools, and the environment. These are all co-agents that are equally participating in the emergence of the artefact. Further, the theory promotes the idea that sensory evaluations and reflection in action are what grounds cognition in the actions of the practitioner (Malafouris, 2013, p. 225).

Hybrid crafting

When the material realm is moved into the digital and the virtual, affordances and ways we make with materials are changed. Virtual material experiences have become increasingly important due to the digitalization of design processes and fabrication technologies. As user interfaces are getting more seamless, embodiment of tools and actions are also experienced in virtual space – in different, but not always entirely dissimilar ways. The phenomena are familiar in human-computer interaction research and the gaming industry, but much less discussed in the craft context. Digital tools and processes may seem detached from the act of material making when they do not permit direct engagement with tangible materials. The process of working with digital technologies may even be seen as "'hidden' making understanding and controlling the process from concept to end product

seem more complicated", as pointed out by Ann Marie Shillito (2013, p. 9). On the other hand, Malcolm McCullough (1998) recognized that access to digital fabrication and tools in fact expands crafting possibilities, due to their capacity to "reunite visual thinking with manual dexterity and practiced knowledge" (p. 50) and that the practitioner's subjective decisions are still essential in the production of digitally fabricated artefacts. Several contributors to this book, who are craft practitioner-researchers working in the hybrid realm of craft making, illuminate the importance of prior experiential knowledge of handling manual tools and physical materials in the shift from analogue to digital/virtual processes in their practices. Where possible, they are able to adopt and adapt their experiential and embodied knowledge to the new context of practice.

When it comes to education, digital tools have many benefits for its users and may even extend the capacity of the users; for example, digital drawing tools enable fast and uncomplicated deletions of drawn marks and instant changes of colours without having to discard the first version of the paper drawing. However, for very young children's experiences of material interactions and tactile manipulations of materials, physical arts and crafts materials have more sensorial experiences to offer than a screen or a mouse. While students will certainly need digital competences in their future lives, material properties and constraints are different in the virtual space and need to be experienced bodily to be interpreted realistically in the virtual realm (Søyland, 2021). This is also important for design students in higher education, who might encounter new materials for the first time in their computer-aided design (CAD) programmes material toolbox.

A note on the use of terms

As made apparent in this introduction, thinking through making is not a new idea but has influenced research in crafts and design for a few decades, shaping the understanding of craft and design practice. When it comes to *craft research*, we need to clarify that craft theory from an insider's perspective is relatively young and was for some time not considered "research proper" due to its situated, experiential, and subjective nature (cf. Niedderer, 2007; Niedderer & Reilly, 2010; Niedderer & Townsend, 2014). This led to the use of the word "design" to refer to both the planning and making of artefacts and "design" or "design research" to indicate traditional craft practices in academia during the early 2000s. It is not our intention to make a stark contrast between these very interrelated domains of crafts and design. On the contrary, we would rather aim to show their similarities and that they have almost everything in common, especially when the designer is also making prototypes or possesses the material knowhow that we discuss extensively in this book. The reason for pointing out the use of these words in this introduction is because most authors of research literature in crafts or design tend to use the word "design" in their texts despite the craft-oriented content. We generally prefer to use the "creative practices" when relevant (to also include the arts) as we acknowledge that the domains overlap to a large degree.

The structure of the book

The book is structured into three parts, each of which has its role in synthesizing the embodied perspective in craft and design processes. Part I: Craft as Embodied Making and Learning provides a ground for theorizing craft practice as a process of thinking in action, by explaining the theoretical background for it, with examples from material

interaction and learning. Part II: Materiality of Materials and Non-materials in Craft scrutinizes the new and changing materiality of craft practice that we face due to digitalization and the possible challenges and benefits of hybrid material practices. Part III: Artefacts as Material Extensions of Craft Experience illuminates the roles of artefacts as carriers of memories and imprints of human-material interactions and material extensions of craft experience.

In the beginning of each of the three parts of the book, there is a short introduction to emphasize each part's concept and how it will be exemplified and elaborated on by the chapters included in the part. We hope that the discussions and reflections presented in this book will be transferable to many other practice-based domains and can support researchers, teachers, and practitioners widely in their acting and thinking with, and through, materials and artefacts.

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