DESIGN THINKING – FROM POST-ITS TO FINGERTIPS: RETHINKING EMBODIED COGNITION IN DESIGN

Aija FREIMANE
TU Dublin School of Art and Design, Ireland

ABSTRACT
Design thinking is applied across various domains, including product, service, interior, experience, UX, and strategic design. It is commonly taught in educational institutions and professional training programmes as the core design method. Design thinking has been voiced as a transformative approach essential for innovating products and services, shaping effective policy planning, developing products, and fostering meaningful community engagement. Design thinking is commonly implemented through ideation sessions that rely heavily on the use of 3M Post-it notes for brainstorming and idea organisation. This theoretical study questions which design method more effectively shapes cognitive processes in design practice: hands-on crafting or the use of 3M Post-it note-based design thinking tactics. Designer thoughts and decisions can be influenced significantly by their interactions with various objects and cognitive processes that rely solely on the brain, like thinking through 3M Post-its in design thinking, which differ significantly from thinking that integrates the brain, eyes, and hands. Engaging multiple modalities in the thinking process - visual, motor, and cognitive can lead to a more profound and dynamic approach to problem-solving and decision-making, emphasising the role of physical interaction in shaping thought and action. Design embraces crafting objects that require anticipating actions and predicting sensory feedback, which is vital in the stages of design thinking: empathising, defining, and prototyping. The connection between sensorimotor processes and higher-order cognitive functions, like language and social interaction, underscores the role of physical abilities in supporting complex behaviours and thinking. This research aims to critique the design thinking approach, where hands-on crafting practices in design education appear to be increasingly replaced by prototyping and research visualisation using 3M Post-it notes. Consequently, this paper expands the concept of *embodied design thinking* to a model of cognition conceived as an integrated process that interweaves physical interaction, social context, and cultural influence.

Keywords: Embodied design thinking, cognitive processes in design, design thinking, 3M Post-it notes, hands-on design

1 INTRODUCTION
The design process, once characterised by a diverse range of methods, has increasingly been reduced to the singular tactic of design thinking as a standardised approach. It has been widely adopted across organisational contexts, including business model development and the design of interventions for introducing new concepts into complex systems [1]. Although design thinking emerged as a designerly way of thinking, today, it is promoted as a success factor, method, and a framework to be applied by every profession and across many disciplines [2]. According to Tim Brown, Nigel Cross, and David Kelly, design thinking proposes that everyone has the potential to be a design thinker or visionary, just like a professional designer, when the design thinking approach is applied. Some researchers view design thinking as a 'panacea for the economy' [3], promoting it as a powerful tool of radical innovation, often misunderstood by practitioners and the public [4]. Design thinking has presented design as a predominantly intellectual activity while overlooking its practical aspects [5] applied in any design discipline. Pentagram designer Natasha Jen argues that design thinking has led to a significant problem: designers now depend heavily on a single tool - 3M Post-its - and lack the use of tactile model-making as evidence [6]. However, thinking through making and crafting practices is a fundamental aspect of design, where skills and knowledge of craft are a foundation for model-making or prototyping a design

object or a service [7]. Viewing design as purely an intellectual activity of ideation undervalues the essential role of hands-on making. This theoretical research investigates which design approach more effectively shapes cognitive processes in design practice: hands-on, situated, and embodied making, or the use of Post-it note-based design thinking tactics.

The five-phase design thinking approach, known as IDEO's framework, seeks to identify human needs and develop innovative solutions by adopting the methods and mindset of design professionals. Initially, design thinking distinguished designerly thinking, which involves the specialised practices and skills of designers, from design thinking, where non-designers use these methods to address specific challenges [8]. However, in recent years, design thinking has largely overshadowed the designerly approach, replacing the diverse and complex methods traditionally used in the design process throughout design education. This theoretical study examines multidisciplinary research to uncover insights into the human cognitive processes involved in designing as a practice. This study explores an embodied cognitive approach to design thinking without reliance on 3M Post-it notes, aiming to reveal connections between fundamental sensorimotor processes and higher-order cognitive functions to expand the concept of *embodied design thinking* [9].

2 THINKING AS AN EMBODIED COGNITIVE PROCESS

It is argued that Post-it notes enhance semantic long-term memory during clustering exercises by visually illustrating research category groupings to more structured classifications, thereby advancing the design process and discussions [10]. It is also argued that the use of Post-it notes during design activities may be similar to sketching in the way it supports a range of cognitive processes [11]. However, Lindgaard and Wesselius explore the intersections of design thinking and embodied cognition, emphasising metaphor theory, visual gestalt, and felt experience as core cognitive processes. They examine how material design practices foster innovation by linking them to a cognitive science-based theory of meaning-making, and explore how design methods, such as sketching and prototyping, enhance understanding by connecting experience with knowledge formation [12]. While Post-it notes help organise ideas, material practices like sketching and prototyping may foster deeper cognitive engagement by linking body experience to knowledge.

The "embodied cognition" [13] approach highlights the deep connection between body and mind, emphasising the body's essential role in shaping cognitive processes. Cognition cannot be fully understood without considering the body's interaction with the external world, as our thinking is fundamentally shaped by what the body can and cannot do [14]. Thinking is an embodied process that integrates the body and the environment in ongoing information processing, much of which occurs unconsciously. For example, musicians and performers often engage their memory through physical movement, highlighting the concept of whole-body thinking [15]. The same principles apply to the mastery of craft. Embodied cognition underscores the dynamic interplay between mind, body, and environment, shaping thought and action through sensory-motor experiences. Integrating embodied cognition into design highlights its deep connection to Michael Polanyi's concept of "tacit knowledge," which encompasses the sensory-motor knowledge of how to do things, with our body as hands-on practice, and with fine eye-hand coordination [16]. This perspective in design reinforces the significance of tacit knowledge, where implicit understanding and physical engagement drive creativity, problem-solving, and innovation beyond what can be explicitly articulated.

The experience of meaning originates first from our sensorimotor interactions, emotions, and visceral connections with the world, and second from our imaginative capacity to apply these sensorimotor processes in understanding abstract concepts [17]. Our physical interactions shape abstract thinking by forming cognitive patterns that serve as metaphors, extending into and influencing various domains of thought and understanding. Reaching and grasping are basic physical movements and form our physical experience with the world. Our physical experiences with real objects in everyday life form some of our basic cognitive concepts and linguistic frameworks [18]. A human experience embraces not only sensory perceptions but also the comprehensive array of physical, biological, social, and cultural factors that inform and shape any particular experience in a given context [19]. Meaning emerges first through our sensory-motor experiences and emotional connections with the world, then through our ability to apply these interactions to abstract thought. This embodied perspective highlights how physical experiences shape cognitive and linguistic frameworks, reinforcing the deep interconnection between perception, action, and understanding. This further suggests that sensorimotor and emotional experiences, as forms of embodied cognition, serve as the foundation for hands-on thinking.

Distributed embodied thinking in complex systems is crucial for higher-order consciousness and cultural interaction areas where mechanical models fall short [20].
The embodied mind concept redefines thinking as an integrated process involving physical, social, cultural, and environmental factors, rather than just an isolated mental activity. Visual thinking is closely connected with cognition and indicates the concept of embodied cognition, emphasising the importance of physical interaction in our visual-spatial understanding [21]. Through creative activities such as drawing, writing, and prototyping—core practices in design education, designers develop embodied cognition that transcends the limitations of organising ideas through tools like 3M Post-it notes. It suggests the potential to expand the concept of *embodied design thinking* into a cognitive model understood as an integrated process that interweaves physical interaction, social context, and cultural influence. This will be further examined through the lens of design and cognitive processes as forms of sensorimotor activity.

3 DESIGN THINKING AS SENSORIMOTOR ACTIVITY

The link between motor skills and cognitive processes traces back to Piaget's (1952) theory of cognitive development, which emphasises the role of sensorimotor experiences and early physical interactions with the environment in shaping and advancing cognitive growth. Recent studies support the idea that movement is vital for enhancing learning and problem-solving abilities [22]. This aligns with phenomenology, which emphasises that our understanding of the world is deeply rooted in bodily experiences and sensory perceptions formed through interactions with our environment [23]. Phenomenologists argue that empathy is fundamentally connected to our physical embodiment and develops through social relationships, such as those with family and friends. Authentic empathy necessitates an imaginative understanding that is deepened by awareness of the individual being empathised with [24]. By actively engaging in sensorimotor experiences, individuals develop cognitive structures that enhance problem-solving, spatial reasoning, and abstract thinking. This embodied interaction with the environment fosters deeper empathy and adaptive learning, both of which are essential for cognitive growth and social intelligence.
Enactivism as a cognitive science perspective suggests that cognition arises from the active interaction between a living organism and its environment, and sees learning as an active, embodied process. It emphasises that knowledge is formed through physical interactions with the environment, highlighting the body's important role in cognition and our ability to anticipate future outcomes through repeated experiences [25]. Similarly, Piaget's theory of cognitive development highlights sensorimotor experiences as foundational for learning, supporting the notion that cognition evolves through active engagement rather than passive reception. Enactivism in design underlines the importance of hands-on exploration, where knowledge is constructed through making, demonstrating that learning and innovation emerge from embodied action and experience.
Building on the phenomenology and enactivism perspectives, cognition is not solely a mental process but an embodied one, shaped by active engagement with the environment. That perspective aligns with craft as an exceptionally skill-based learning, where knowledge is acquired through hands-on experience, reinforcing the connection between movement, perception, and cognitive development [26]. Oehlmann discusses neuropsychological findings that demonstrate a strong connection between language and the body as tacit knowledge is acquired through experience and practical action [27]. Movement, perception, and sensory input are deeply interconnected, shaping symbolic thought. As a dynamic and interactive system, the sensorimotor network serves as the foundation of cognition, driving higher-order abstract thinking [28]. This embodied perspective highlights the deep interconnection between physical engagement, cognitive development, and knowledge formation, emphasising that learning is an active and experiential process.
Early locomotor experiences promote exploration and interaction, enhancing cognitive skills. This aligns with the embodied cognition theory, which suggests that cognitive growth emerges through sensory-motor interactions with both physical and social environments [29]. A child's ability to visualise objects relies on internalising tactile-kinaesthetic experiences. Tactile experience and touch are crucial in material selection, influencing decisions on multiple levels. The sensory interaction with materials is deeply connected to emotions, social values, and ethics, validating perceived notions and guiding the decision-making process [30]. It plays a fundamental role in cognitive development, shaping how individuals perceive, comprehend, and engage with their environment, thereby supporting hands-on design practices.

Groth examines how design and craft practitioners engage in the process of thinking through their hands. While some may argue that thinking is solely a cognitive activity, those who work with materials with their hands often perceive sense-making as an embodied experience. For them, understanding emerges through tactile engagement and the process of creation, rather than being confined to mental activity [31]. Design is rooted in the evolution of craft, which continues to serve as the foundational framework shaping contemporary design practice and is still used as hands-on practice in design education. Craft-based learning integrates movement, perception, and sensory input to enhance higher-order thinking, highlighting the essential role of hands-on experience in connecting abstract reasoning with practical skill mastery [32]. Groth asserts that creating is a form of self-connection, where "our body is in contact with a material that bends to our will". Through compromise and adaptation, the maker engages with the material's properties, so the final artefact reflects this dynamic process, embodying both the creator and the material [33]. Embodied cognition theory aligns with design and craft practice, emphasising that knowledge is rooted in action, experience, and material skills. Thus, separating hands-on making from thinking in design is unrealistic [34]. The act of making is deeply intertwined with thinking, as embodied cognition highlights the united connection between action, experience, and material engagement. Crafting exemplifies a refined form of design thinking, reinforcing the dynamic interplay between mind and hand, and strengthening the concept of *embodied design thinking*.

4 CONCLUSIONS: IS DESIGN THINKING IN FINGERTIPS OR 3M POST-ITS?

This research has critically examined the cognitive foundations of design, contrasting with the widespread adoption of design thinking, particularly its reliance on tools like 3M Post-it notes, with the embodied, hands-on practices rooted in craft. Although design thinking frameworks offer value across disciplines, their focus on abstract, linear processes often neglect the deep cognitive engagement enabled by material interaction and sensorimotor experience. Drawing from theories of embodied cognition, enactivism, and phenomenology, this study argues that cognition in design is not purely mental but emerges from dynamic interactions between body, material, and environment. Activities such as sketching, prototyping, and model-making are not merely representational tools; they are fundamental cognitive processes through which designers think, learn, and innovate. This research expands the concept of *embodied design thinking* by emphasising the role of tacit knowledge, physical engagement, and cultural context in the development and construction of ideas. By repositioning hands-on making as central to cognitive development, this study challenges conceptions of design as purely intellectual and reaffirms the role of hands-on design practice as foundational to both design practice and education. Ultimately, it advocates for a richer, embodied understanding of design that re-integrates the hand, the mind, and the material world in shaping creative thought.

Given that individuals' thoughts, decisions, and insights can be influenced by their physical interactions with objects, it can be argued that manual crafting and prototyping represent integral components of design thinking. These hands-on activities not only facilitate the generation and refinement of ideas but also actively shape cognitive processes through tactile engagement, fostering a deeper understanding of the design challenges at hand. Thus, manual crafting and prototyping can be seen as essential tools in the design thinking process, bridging the gap between conceptualisation and tangible, functional solutions. Cognitive processes that rely solely on the brain, like thinking through 3M Post-its in design thinking, differ significantly from those that involve the integrated use of the brain, eyes, and hands. The combination of these sensory and motor systems not only enhances cognitive functioning but also facilitates more embodied forms of thinking and acting. Engaging multiple modalities - visual, motor, and cognitive - can lead to a deeper and more dynamic form of problem-solving and decision-making, underscoring the importance of physical interaction in shaping thought and action.

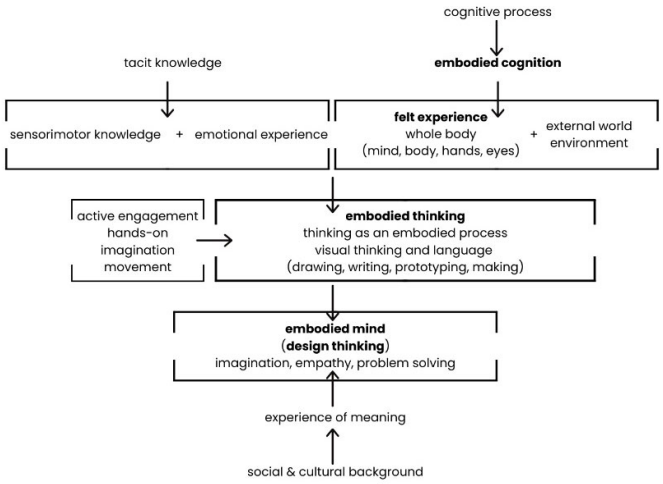

Figure 1. Embodiment of Design Thinking

This study provides valuable insights into the cognitive processes underlying design practice and design thinking without 3M Post-it notes (Figure 1). It reveals how the embodied mind, through sensorimotor knowledge, emotional involvement, and lived experience, plays a crucial role in shaping design thinking. Furthermore, it establishes that imagination, empathy, and problem-solving are integral components of embodied cognition in the design process. The findings align with the notion that the process of crafting objects fosters the anticipation of action sequences and the prediction of sensory feedback - cognitive activities that closely correspond to the design thinking phases of empathising, defining, and prototyping. In conclusion, the hands-on design process more effectively shapes cognitive processes in design practice than the use of 3M Post-it note-based design thinking tactics. Hands-on methods, through active engagement of the body and senses, cultivate deeper cognitive development by allowing designers to anticipate actions, respond to sensory feedback, and create design solutions. This embodied approach underscores that thinking in design is not solely an abstract or representational activity but one deeply intertwined with doing, sensing, and making.

REFERENCES

[1] Mayer L. M. (2015). Design Thinking. A view Through the Lens of Practice. *OD Practitioner* vol. 47, No. 4, 42-47.
[2] Dorst K. (2011). The core of 'design thinking' and its application. *Design Studies*, Volume 32, Issue 6, 521-532.
[3] Johansson-Sköldberg U., Woodilla J. and Çetinkaya M. (2013). Design Thinking: Past, Present and Possible Futures. *Creativity and Innovation Management* Volume 22, Issue 2, 121-146.
[4] Lindgaard K. and Wesselius H. (2017). Once More, with Feeling: Design Thinking and Embodied Cognition. *she ji The Journal of Design, Economics, and Innovation* Volume 3, Number 2, 83-92.
[5] Groth C. (2016). Design and Craft Thinking Analysed as Embodied Cognition. *FORMakademisk* Vol 9, Nr. 1, Art .4, 1-21.
[6] Jen N. (2017, June 7-9). Design Thinking is Bullshit, *99U Conference*. New York.
[7] Nilsson F. (2013). Knowledge in the Making: On Production and Communication of Knowledge in the Material Practices of Architecture. *FORMakademisk* Vol.6 Nr.2 Art. 3, 1-13.
[8] Brown T. (2008). Design Thinking. *Harvard Business Review*, Vol. 86 No. 6, 84-92.
[9] Jerry D. (2019). Embodied Design Thinking. *she ji The Journal of Design, Economics, and Innovation* Volume 5, Number 1, Spring, 44-54.
[10] Dove G., Abildgaard S., Biskjaer M., Brodersen Hansen N., Christensen B. T. and Halskov K. (2018). Grouping notes through nodes: The functions of Post-It notes in design team cognition. *Design Studies*, Vol 57 No C, 112-134.
[11] Dove G., Abildgaard S., Biskjaer M., Brodersen Hansen N., Christensen B. T. and Halskov K. (2018). Grouping notes through nodes: The functions of Post-It notes in design team cognition. *Design Studies*, Vol 57 No C, 112-134.

[12] Lindgaard K. and Wesselius H. (2017). Once More, with Feeling: Design Thinking and Embodied Cognition. *she ji The Journal of Design, Economics, and Innovation* Volume 3, Number 2, 83-92.
[13] Lawrence S. and Spaulding S. (2021, June 25). *The Stanford Encyclopedia of Philosophy* (Fall 2024 Edition). Retrieved from Embodied Cognition: https://plato.stanford.edu/archives/fall2024/entries/embodied-cognition
[14] Bagnara S. and Pozzi S. (2022). The Body in Ideas: Implications of Embodied Cognition for Design. *Applied Human Factors and Ergonomics International*; DOI: 10.54941/ahfe1001303.
[15] Diethelm J. (2019). Embodied Design Thinking. *she ji The Journal of Design, Economics, and Innovation* Volume 5, Number 1, 44-54.
[16] Bagnara S. and Pozzi S. (2022). The Body in Ideas: Implications of Embodied Cognition for Design. *Applied Human Factors and Ergonomics International*; DOI: 10.54941/ahfe1001303.
[17] Diethelm J. (2019). Embodied Design Thinking. *she ji The Journal of Design, Economics, and Innovation* Volume 5, Number 1, 44-54.
[18] Lindgaard K. and Wesselius H. (2017). Once More, with Feeling: Design Thinking and Embodied Cognition. *she ji The Journal of Design, Economics, and Innovation* Volume 3, Number 2, 83-92.
[19] Diethelm J. (2019). Embodied Design Thinking. *she ji The Journal of Design, Economics, and Innovation* Volume 5, Number 1, 44-54.
[20] Diethelm J. (2019). Embodied Design Thinking. *she ji The Journal of Design, Economics, and Innovation* Volume 5, Number 1, 44-54.
[21] Lindgaard K. and Wesselius H. (2017). Once More, with Feeling: Design Thinking and Embodied Cognition. *she ji The Journal of Design, Economics, and Innovation* Volume 3, Number 2, 83-92.
[22] Macrine S. L. and Fugate J. M. (2022). Movement Matters: How Embodied Cognition Informs Teaching and Learning. Massachusetts: The MIT Press.
[23] Groth C. (2016). Design and Craft Thinking Analysed as Embodied Cognition. *FORMakademisk* Vol 9, Nr. 1, Art .4, 1-21.
[24] Dawn Frazier A. and Bryant C. (2019). Developing visual-spatial thinking in youth using sensorimotor experiences: Approaches from a Piagetian cognitive framework. *Journal of Pedagogical Research*, Volume 3, Issue 3, 99-112.
[25] Groth C. (2016). Design and Craft Thinking Analysed as Embodied Cognition. *FORMakademisk* Vol 9, Nr. 1, Art .4, 1-21.
[26] Kumar M. and Kumar A. (2019). Craft dedication in design. *International Conference on Engineering and Product Design Education*, University of Strathclyde, United Kingdom. Strathclyde, United Kingdom: Design Society.
[27] Oehlmann N. (2021). Embodied Knowledge, Tool, and Sketch: Intuitive Production of Knowledge in Architectural Design. *Dimensions of Architectural Knowledge* Vol 01, 37-45.
[28] Dawn Frazier A. and Bryant C. (2019). Developing visual-spatial thinking in youth using sensorimotor experiences: Approaches from a Piagetian cognitive framework. *Journal of Pedagogical Research*, Volume 3, Issue 3, 99-112.
[29] Gandotra A., Csaba S., Sattar Y., Cserény V., Bizonics R., Cserjesi R. and Kotyuk E. (2022). A Meta-analysis of the Relationship between Motor Skills and Executive Functions in Typically-developing Children. *Journal of Cognition and Development*, Vol 23, No 1, 83-110.
[30] Groth C. (2016). Design and Craft Thinking Analysed as Embodied Cognition. *FORMakademisk* Vol 9, Nr. 1, Art .4, 1-21.
[31] Groth C. (2016). Design and Craft Thinking Analysed as Embodied Cognition. *FORMakademisk* Vol 9, Nr. 1, Art .4, 1-21.
[32] Saxena A. and Pandey S. (2024). Designing for sustainability using a craft-based human-centric approach and consumer participation. *Journal of Visual and Performing Arts*, January - June 5(1), 489-509.
[33] Groth C. (2016). Design and Craft Thinking Analysed as Embodied Cognition. *FORMakademisk* Vol 9, Nr. 1, Art .4, 1-21.
[34] Groth C. (2016). Design and Craft Thinking Analysed as Embodied Cognition. *FORMakademisk* Vol 9, Nr. 1, Art .4, 1-21.