

Why Are They Able to ‘Design Thinking?’: Framing A Designer’s Practical Intelligence Linked to Their Thinking, Acting and Attitude

Takuo Ando¹ and Satoru Goto²

¹ Faculty of Business Administration, Toyo Gakuen University.

takuo.ando@tyg.jp

² College of Business Administration, Ritsumeikan University.

Abstract: This study aims at exploring the theoretical foundation of design thinking, especially from the perspective of a designer’s practical intelligence linked to their thinking, acting, and attitude. From the middle of the 2000’s, many efforts to apply design thinking to businesses have been made. The reason why design thinking is useful for business is that some of its aspects are considered to promote innovation. While rising such a business side movement, design researchers have tried to deconstruct design thinking for a long time (e.g. Rowe, 1987; Cross, 2011). The ‘designerly thinking’ discourse revealed that the core of this kind of thinking lies in the ‘abductive reasoning’, relying on a complex cognitive activity called, ‘reframing’ (Dorst, 2011). Reframing is, ‘shifting semantic perspective in order to see things in a new way’, (Kolko, 2010: p.17). It requires a unique mindset that constantly updates not only the knowledge and skills, but also its own ‘being’ (Adams *et al.*, 2011). While understanding design thinking is important, creating or discovering a framework that guides the designers’ practical intelligence (Strenberg & Wagner, 1992) including their situated action, learning style and attitude, to understand, ‘why they are able to indulge in such a thinking’, is more crucial. In this study, we attempted to create a theoretical framework that links their thinking, acting, and attitude, through a literature review.

Introduction

From the middle of the 2000’s, there have been many efforts to apply design thinking (DT) to businesses. DT is, ‘bringing designers’ principles, approaches, methods, and tools to problem solving’, (Brown, 2008). The reason why it has been introduced to business so aggressively is the demand for new ways of thinking that is unbiased towards a convergent approach (Boland & Collopy, 2004; Martin, 2009). In the field of management, there is a need to build ambidextrous organisations that realise not only efficient management, but also innovation (O’Reilly & Tushman, 2008). Some scholars have adopted this unique aspect and developed it as a business building tool (Brown, 2009; Liedtka & Ogilvie, 2011), and others have attempted to apply that to management-related education (Boland & Collopy, 2004). Design thinking is now considered as the new way of thinking that will lead the current stagnant situation to an ideal sustainable future.

On the other hand, some scholars criticise the lack of clarity about what DT ‘is’, and the discussion of DT in management discourses has no theoretical foundation (Carlgren, Rauth & Elmquist, 2016; Johansson-Sköllberg, Woodilla & Çetinkaya, 2013; Kimbell, 2011). Indeed, most researchers define it

from their own original perspectives (e.g. 'integrative thinking' (Martin, 2007; 2009), 'human-centeredness'(Brown, 2009), 'thinking out of the box' (Kolko, 2011)), with no references to the academic design discourse.

While rising such a business side movement, design researchers have tried to unpack 'designerly thinking' for a long time (e.g. Rowe, 1987; Cross, 2011). In this designerly thinking discourse, it was revealed that the core of this thinking is, 'abductive reasoning', relying on 'reframing', which is a complex cognitive activity (Dorst, 2011). Reframing is the act of 'shifting semantic perspective in order to see things in a new way', (Kolko, 2010: p.17) requiring a unique mindset that constantly updates not only knowledge and skills but also its own 'being (Adams et al., 2011)'. Of course unpacking designerly thinking is important, but the more important theme is to create a framework that guides the designers' entire 'practical intelligence' (Strenberg & Wanger, 1992) including their situated action, learning style and attitude, to answer, 'why are designers able to think in such a unique manner'.

In this study, we take the challenge to create a theoretical framework that links their thinking, acting and attitude, through a literature review.

Literature Review

The literature of 'Designing'

Adams *et al.* (2011) emphasised that 'the idea of "design thinking" has typically represented what designers understand about design and how they go about the act of designing based on this understanding' (Adams *et al.*, 2011: p.588). To frame the concept of a designer's practical intelligence, we first need to focus on the act of 'designing'.

In Design studies, many scholars pointed out that one of its unique aspects is its process of 'problem-solving' (Simon, 1969; Buchanan, 1992; Hatchuel, 2001). While traditional rational problem-solving has a high determinacy for the problem itself and a one-way nature of running from a problem to a solution (Simon, 1969), the problems dealt with in design, are open-ended and highly indeterminate. Some call them 'ill-structured' (Simon, 1973) problems, and others term them, 'wicked' (Rittel, 1972; Buchanan, 1992) problems.

The so-called 'design problem' (Dorst, 2006) has a unique aspect that has not been discussed from the rational problem-solving perspective. For example, Hatchuel (2001) argued that the problems dealt with, in the real design situation have an 'extended rationality', compared to Simon's 'bounded rationality' (Hatchuel, 2001). He pictured the difference in the two types of problem-solving from the usual activities on a Saturday night, wherein one group of people search for 'a good movie' in town and another group plans 'a nice party'. The former, deals with a well-defined concept ('a movie') and could choose from alternatives already provided. The latter, needs to not only choose, but also create the concept itself owing to the lack of a dominant notion of, 'what a party should be like'.

Dorst (2006) termed this nature of such design-related problems that are hard to identify as, 'paradox'. A paradox is a complex statement that consists of two or more conflicting statements (Dorst, 2006: 14). In a real design situation thus, creating a solution also includes redefining a problematic situation.

Two types of knowledge of designing

To solve a design problem, what should designers do?

Cross (2006) described a designer's unique problem-solving approach as the, 'designerly ways of knowing'. This phrase indicates that the designer's way of tackling problems especially follows a

solution-focused mode of problem-solving. Through a continuous interaction with the practical situation, designers build their knowledge with direct reference to the experience and make decisions for the newly encountered design context (Cross, 2006). Some scholars explain this knowledge using the metaphor of a 'gambit' (Lawson, 2006). In a chess game, a gambit is the opening move to gain an advantage by sacrificing pieces. In the case of design, this is not the beginning of the whole process, but rather the starting point of the thought process of which aspects of the design need to be highlighted (Lawson, 2006: 176). Design is like chess with endless moves where, unlike chess, design neither has a fixed board size nor a limited number of pieces (Lawson & Dorst, 2009: 180). Through the process of 'learning-while-doing', designers constantly change and adjust their ways of acquiring information, which significantly impacts the future design decisions (Cross, 2011).

Many studies have shown that designers do not work on their own design problems in a 'tabula rasa' manner, but draw knowledge from their experiences (Darke, 1979; Rowe, 1987; Lawson, 2006). This kind of knowledge is called the 'guiding principle' (Lawson, 2006), which is an underpinning theory of design, based on some kind of moral certainty. This also includes the strong intellectual programmes behind their work including their own motivations, reasons for wanting to design, sets of beliefs, values and attitude (Lawson, 2006: 159). The content of the guiding principle is as diverse as the individual designers and varies according to their acquired experiences.

Some other scholars echo this notion as the 'primary generator' (Darke, 1979) or the 'organizing principle' (Rowe, 1984). The designer forms the first idea or interpretation at the beginning of a design problem. A primary generator is a principle that is applied at the starting point of a design activity and indicates the ability to justify design decisions from a rational perspective (Darke, 1979). In contrast, organising principles leave a vast scope for creating numerous ideas in the later design process (Rowe, 1984). Thus, the designers accumulate principles from their professional experience, called 'working principles' (Dorst, 2010).

These two types of knowledge are essential in dealing with highly uncertain problem situations, and this shows that design is difficult only with the doctrinaire approach.

The literature of 'Designerly thinking'

As mentioned above, in a designer's practice, two types of knowledge are employed: (1) designerly ways of knowing, and (2) working principle. By applying these, they could deal with complex problems. This is called 'synthesis' in design studies, which is a process combining market needs, technology trends, and client needs in an organised form (Kolko, 2010).

How do designers think while utilising the process of synthesis? Several studies have described this as 'reasoning' (Roozenburg, 1995; Martin, 2009; Dorst, 2010; Kolko, 2010), and especially in the form called 'abduction'. Generally, there are three inference types: 'deduction', 'induction', and 'abduction'. Deduction is, deriving specific knowledge from a general principle or a universal knowledge. For example, the so-called 'trilogy'. In contrast, induction implies deriving common hypotheses by listing certain observable facts. Abduction is a logical form of inference or, 'best guess' leaps (Kolko, 2010). Peirce simply explains abduction using the following example:

'This was a hypothesis. Fossils are found; say, remains like those of fishes, but far in the interior of the country. To explain the phenomenon, we suppose the sea once washed over this land. This is another hypothesis (Peirce, 1970:155).'

In addition, Dorst (2011) pointed out that there are two forms of abduction reasoning in design thinking. One form reflects the 'problem-solving' aspect of the design. In this case, the designers know both, the working principle (How) and the value that should be obtained (the connection between

these two is called 'frame', in design research (Dorst, 2010: 132)). Therefore, the frame is applied to the problem to find the most suitable solution by trial and error (abduction 1).

The other is the reasoning that is applied when only the value that should be obtained, is clear. In this case, what needs to be created and the working principles generating the value, are unclear. Under such circumstances, abduction 1 and the creation of a working principle must be applied at the same time (abduction 2). Thus, design practice is done by the 'co-evolution' of both, the problem space and the solution space (Maher & Poon, 1996; Cross, 1997; Dorst & Cross, 2001). This dual creation is considered as being unique to designerly thinking.

In addition, the core process in this second form of abduction is, 'reframing' (Dorst, 2010; 2011). According to Kolko (2010), 'reframing is a method of shifting semantic perspective in order to see things in a new way', where, 'the new frame "re-embeds" a product, system, or service in a new (and not necessarily logical) context, allowing the designer to explore associations and hidden links to and from the centre of focus' (Kolko, 2010: 23). As Schön (1984) states that the, 'hypothesis depends on a normative framing of the situation, a setting of some problem to be solved' (Schön, 1984: 132), the key to designerly thinking lies in the creation of a new frame to capture the problem situations properly (Figure 1).

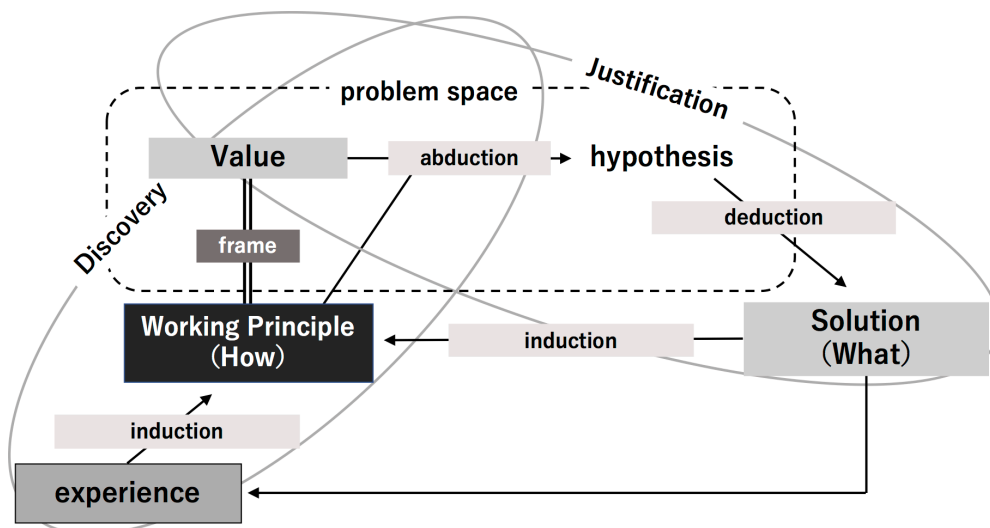


Figure1: Designerly thinking process from the previous research

Where is the problem?

Why are they able to 'Design Thinking?'

Summarising the above discussion, in design practice, designers apply two types of knowledge: (1) designerly ways of knowing, and (2) working principle. By using these two types of knowledge, designers can deal with complex problem situations. In addition, the set of a working principle and a value is applied in thinking, forming a hypothesis from abduction reasoning and the examination of that by deduction, would be performed. If the problem is similar to what the designers have already experienced, they could apply the frames immediately. Otherwise, the second form of abduction would work. Kolko (2010) states that the, 'design synthesis is fundamentally a way to apply abductive

logic within the confines of a design problem' (Kolko, 2010: 20), and this 'synthesis is an abductive sensemaking process' (Kolko, 2010: 17).

The question here is, 'why are the designers able to think like that?' Especially, in the process of abduction 2 mentioned above (only the value should be obtained is clear), they generate a working principle that does not exist in the process of reframing (Figure 2). However, while the process and mechanism of design thinking is clear, the factors enabling their thinking are not.

The Clue: Theory of Practical Intelligence

Why are the designers able to reframe when they encounter new problems? The key to this lies in the understanding of not only the designer's thinking but also the working synthesis (Duncan & Hmelo-Silver, 2009; Adams *et al.*, 2011), such as their 'practical intelligence' (Strenberg & Wanger, 1992).

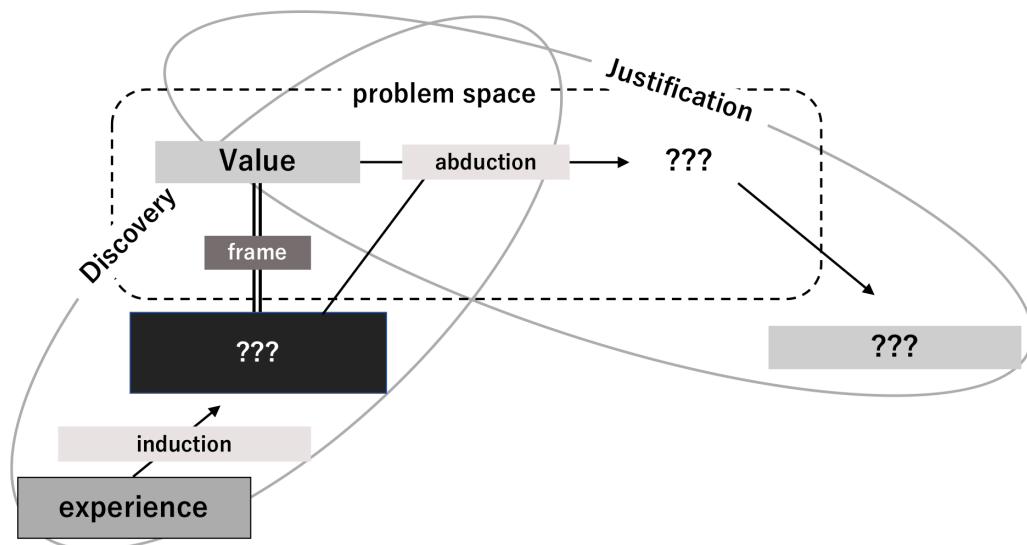


Figure2: Designerly thinking process of abduction2 (Dorst, 2010)

In cognitive psychology, knowledge is usually divided into declarative knowledge and procedural knowledge (Anderson, 1983). Declarative knowledge is the knowledge about facts. Procedural knowledge is the knowledge that is difficult to express verbally, such as know-how or skill (for example, the knowledge that 'the bicycle is a vehicle for moving' corresponds to the former, 'how to ride a bicycle' corresponds to the latter). Ryle (1949) explained this difference using the phrases, 'knowing that', and 'knowing how'. He pointed out that 'knowing that' is acquired only after critical review practices; hence 'knowing how' to act appropriately in practice is a more essential intelligence in humans (Ryle, 1949). The practical intelligence referred to here, is not an ability that an individual originally possesses, but is acquired through practice and learning (Christiaans & Dorst, 1992; Ericsson, 1996; 2001; Lawson, 1979). The concept of practical intelligence perceives knowledge as being in the body.

In addition, according to Ryle (1949), those who are skilled in the way of practice have the same 'disposition'. Disposition is the intellectual attribute of a human being that enables the repeated performance of appropriate actions in a given situation. The embodied disposition enables unconsciously keeping the rules aside for proper practice and doing the logical reasoning responds to varying situations (Ryle, 1949). A similar concept is seen in Bourdieu's work about the 'habitus' (Bourdieu, 1979). The habitus is a set of individualised dispositions, a collection of ideas, ways of feeling,

and the modes and styles that have been shared among social groups. According to Bourdieu, the norms such as rules, faith or conviction do not generate the practice, but the schemas inscribed in the body, do. These embodied schemas that accumulate within an individual through past experiences of a certain group or class, shapes their way of thinking, perception, and action unconsciously like a 'sense of games' (Bourdieu, 1979).

Thus, the disposition or habitus associated with practical intelligence are embodied in the individuals, and in the designers. Indeed, many aspects of a designer's practice depend on their practical intelligence. Larson (2006) explains this point using the example of an architect.

'The artist is not someone who designs in order to prove his or her theory, and certainly not to suit an ideology... any building that tries merely to express a theory or any building that starts with a theory and works very deductively is very dry, so we say that we work inductively (Lawson, 2006: p.163).'

We consider these embodied dispositions to be one of the working principles that constantly generates improvisation in an individual, while being regulated by structures and rigid constraints. Moreover, these aspects enable designers to update themselves continuously and maintain their creative loop. This on-going openness (McDonnell, 2011) or unique mindset that constantly updates not only the knowledge and skills, but also the designer's own 'being' (Adams et al., 2011) are important factors enabling design thinking. However, this embodied disposition or intellectual system is not easy to understand because it not only includes clear knowledge such as, about objectives, factual information, but also the motivations, beliefs, values, and attitudes (Lawson, 2006).

The idea of Design attitude

How could we theorise the designer's practical intelligence? To filling the above theoretical gap, we focus on 'Design attitude'. According to Boland & Collopy (2004), who first proposed the concept, Design attitude is, 'the expectation and orientation one brings to design project (Boland and Collopy, 2004: 9)' and the effective attitude and behavioural characteristics relating to solving ill-structured problems.

In addition, according to Michlewski (2008; 2015), the design attitude is the culture, values, beliefs, and the mental models shared by design professionals. In addition, he states that the culture and beliefs that the designers possess are shared by professionals, entering various companies and taking the form of one subculture. In Michlewski's research, he proposed five elements of design attitude: (1) embracing uncertainty and ambiguity; (2) engaging deep empathy; (3) embracing the power of the five senses; (4) playfully bringing things to life; (5) creating new meaning from complexity (Michlewski, 2008; 2015). Table 1 summarizes the concept and the items of design attitude from the previous literature (Table 1).

According to Amatullo (2015), the important theoretical influence on the use of the word 'attitude' in the conceptualisation of design attitude is related to Bourdieu's ideas of the practice theory and habitus (Amatullo, 2015: p. 114). These conceptualisations not only imply an introspective position on design (Simon, 1969; Schön, 1983), but also the flow of important research on the issues of design agency, identity, and morals (Buchanan, 1992, 1998; Margolin & Buchanan, 1995).

Research on the concept of attitude has different perspectives, lacking a unified view except that it is an implicit personal characteristic (Banaji et al., 2001). However, the practice generated from the disposition lies somewhere between the unconventional embodied acts and the acts without thought.

Table 1: The several concept of design attitude

Literature	Boland and Collopy (2004) “Managing as Designing”	Michlewski (2015) “Design Attitude”	Amatullo (2015) “Design attitude and social innovation”
Concept and Definition	“Expectations and orientations one brings to a design project”	“Character of a professional culture shaped by designers”	“A set of abilities that impact innovation and organizational learning”
Attribute	Design attitude for Managing	Design attitude for Organizational Learning	Design attitude for Social Innovation
Items of design attitude	Invention of new alternative Questioning of assumption Resolve to contribute to human betterment	1) Embracing Uncertainty and Ambiguity 2) Engaging Deep Empathy 3) Embracing the Power of the Five Senses 4) Playfully Bringing Things to Life 5) Creating New Meanings from Complexity	1) Connecting Multiple Perspective 2) Creativity 3) Empathy 4) Engagement with Aesthetics 5) Ambiguity Tolerance

Discussion: The Theoretical Framework of a Designer’s Practical Intelligence

This is a theoretical framework of a designer’s practical intelligence derived from the above discussion (Figure 3). This model connected the perspectives on design thinking and disposition, especially from the discussion about design attitude. As aforementioned, in the design thinking process of abduction 2 (Dorst, 2010), the designers should find a working principle by reframing. The skilled designer is able to carry out this highly complicated thinking, continuously with an ongoing openness (McDonnell, 2011) or unique mindset that constantly updates its own ‘being’ (Adams et al., 2011). Without this mindset, the designer’s unique thinking is not triggered.

The discussion on design attitude brings several elements to light. For example, ‘ambiguity tolerance’, is an attitude that reflects the designer’s ‘optimism’ (Brown, 2009). Designers realise that creating something novel does not guarantee success. A truly creative process is not continuous, but rather complex and cumbersome. They feel comfortable getting through multifaceted and complex realities without relying on the process and framework that is seemingly perfect. This attitude enables them to gain new knowledge and confidence.

One of the other features of design attitude is, ‘engaging deep empathy’. Designers challenge to redefine the framework of users, clients, and the society by confronting the phenomenon with humility. Through the interaction with various stakeholders, they define the problem. They don’t pretend to know all the answers about users and rely on tools. Instead, they rely on their intuition to sympathise with people as deeply as possible. This attitude makes it possible to identify the value they should aim for (Michlewski, 2015).

‘Connecting multiple perspectives’, reflects a designer’s approach to complexity. Designers harmonise diverse contradictory viewpoints and information, leading to a completely novel perspective on things.

This attitude helps the designer in finding connections to different things at different levels and generate a valuable new network (Michlewski, 2015).

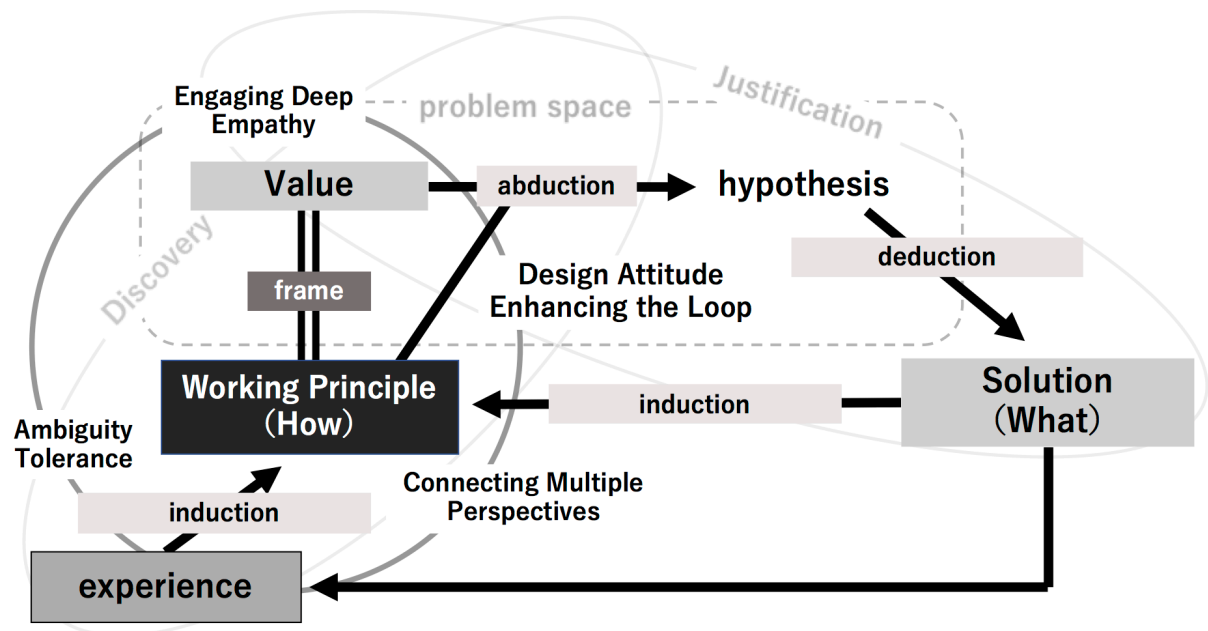


Figure 3: The model of designer's practical intelligence

Thus, a designer's practice is supported by not only their thinking, but also their attitude. Normally, it is considered that repeating such a creative loop is accompanied by difficulties due to the biases and tendencies shaped by routine work. For example, 'anchoring' and 'confirmation bias' have an influence on 'analogy reasoning', which is proximate to abduction reasoning (Gavetti & Rivkin, 2005). Anchoring indicates that it is difficult to wipe out fixed ideas in human thinking. This bias creates the possibility to retrieve the problem source that corresponds to their fixed ideas, without trying to gain a deep empathy towards new problem situations. Confirmation bias indicates the tendency to seek only that information which affirms one's own ideas. It also has been pointed out that the tendency to collect favourable evidence and hide the inconvenient evidence affects the success of analogy reasoning (Gavetti & Rivkin, 2005).

This is close to the argument of double loop learning in Argyris and Schön (1978). Single-loop learning is a learning behaviour that modifies actions within a range of basic assumptions when the result of an action does not match the expected one. Double-loop learning, on the other hand, is a learning behaviour that modifies not only the behaviour, but also basic values (Argyris & Schön, 1978).

It is also close to the argument of the 'technical rationality' model criticised by Schön (Schön, 1983). The technical rationality model emphasises on the rationality of technical knowledge generated by a specific professional occupation. Schön (1983) criticised that, in highly specialised groups, while standardised knowledge constructed by hierarchising its expertise and learning had been emphasised on, the knowledge of the 'defining problem' had been ignored. He also argued that hierarchising cultivated the wrong attitude which tries to solve a problem by applying standardised knowledge to a situation (Schön, 1983).

In any case, this creative loop being generated from a designer's practical intelligence supported by the embodied disposition (or attitude), greatly influenced design thinking.

Conclusion

This study explored the theoretical foundation of design thinking, especially from the perspective of the 'practical intelligence' linked to the designer's thinking, acting, and attitude. The literature review shaped the discussion about the designing and designerly thinking. In design practice, the designers apply two types of knowledge: designerly ways of knowing and working principle. By using these two types of knowledge, the designers can deal with complex problems.

On the thinking front, the combination of a working principle and a value is applied, forming a hypothesis from abduction reasoning and the examination of that through deduction would be performed. In addition to the above discussion, we introduced another perspective on practical intelligence by including the discussion of disposition, habitus and design attitude.

Finally, we proposed an integrated model that explains a designer's entire practical intelligence model, connecting design thinking and attitude.

Thus, this study provides a framework to understand a designer's practice, better. However, it is not clear how each element of design attitude (e.g. 'ambiguity tolerance', 'engaging deep empathy', 'connecting multiple perspective') influences their thinking process in entirety or in parts.

In addition, there is a need to clarify the relationship between design thinking and other elements (e.g. 'embracing the power of the five senses', 'engagement with aesthetics').

John Dewey, an early twentieth century philosopher and educator once stated, that if one chooses either of the two namely, 'having the right attitude to reasoning' and 'knowing the way of reasoning', one should choose the former. However, Dewey also emphasised that good thinking people usually possess a balance between attitude and knowledge. In our future work, we will be focusing on how the designers acquire and update these two factors.

Acknowledgement

This work was supported by the Japan Society for the Promotion of Science [grant number 18K01803] and [grant number 19H01536] .

References

- Adams,R., Daly,S., Mann, L. & Dall'Alba,G. 2011. Being a Professional: Three Lenses into Design Thinking, Acting, and Being. *Design Studies*, 32, 588-607.
- Anderson, J. R. 1983. *The architecture of cognition*. Harvard University Press.
- Amatullo,M. 2015. *Design Attitude and Social Innovation:Empirical Studies on the Return of Design*. Doctoral Dissertation. Weatherhead School of Management, Case Western Reserve University.
- Argyris, C. & Schon , D. (1978). *Organizational Learning: A theory of action perspective*. Addison Wesley.
- Banaji, M. R., Roediger III, H., Nairne, J., Neath, I., & Surprenant, A. 2001. Implicit attitudes can be measured. In H. L. Roediger III, J. Nairne, I. Neath, & A. Surprenant (Eds.). *The nature of remembering: Essays in honor of Robert G. Crowder*: 117-150. American Psychological Association.
- Boland, J., Richard J. 2011. On Managing as Designing. In R. Cooper, S. Junginger, & T. Lockwood (Eds.), *The Handbook of Design Management*: 532-537. Berg.
- Boland, J., Richard J, & Collopy, F. 2004. *Managing as designing*. Standford University Press.
- Bourdieu, P. 1979. *La Distinction: Critique Sociale du jugement*. Éditions de Minuit.
- Brown, T. 2008. Design Thinking. *Harvard Business Review*, 86(6), 84-92.

- Brown, T. 2009. *Change by Design. How Design Thinking Transforms Organizations and Inspires Innovation*. HarperCollins.
- Buchanan, R. 1992. Wicked Problems in Design Thinking. *Design Issues*, 8 (2), 5-21.
- Christiaans, H.& Dorst, K. 1992. *An Empirical study into Design Thinking*. Delft University Press.
- Cross, N. 1997. Descriptive Models of Creative Design: Application to an Example. *Design Studies*, 18 (4), 439.
- Cross, N. 2006. *Designerly Ways of Knowing*. Springer Verlag.
- Cross, N. 2011. *Design Thinking*. Berg.
- Carlgren,L., Rauth,I. & Elmquist,M. 2016. Framing Design Thinking: The Concept in Idea and Enactment. *Creativity and Innovation Management*, 25(1), 38-57.
- Darke, J. 1979. The primary generator and the design process. *Design Studies*, 1(1), 36-44.
- Dorst, K. 2006. Design problems and design paradoxes. *Design Issues*, 22(3): 4-17.
- Dorst, K. 2010. The Nature of Design Thinking. *DTRS8 Interpreting Design Thinking: Design Thinking Research Symposium Proceedings*, 131-139.
- Dorst, K. 2011. The core of 'design thinking' and its application. *Design Studies*, 32(6), 521-532.
- Dorst, K. & Cross,N. 2001. Creativity in the Design Process: Co-evolution of Problem-Solution. *Design Studies*, 22 (5), 425-437.
- Duncan, R. G. & Hmelo-Silver, C. 2009. Editorial: learning progressions: aligning curriculum, instruction, and assessment. *Journal of Research in Science Teaching*, 46(6), 606-609.
- Dunne, D. & Martin, R. 2006. Design Thinking and How it will Change Management Education. *Academy of Management Learning & Education*, 5, 512–523.
- Ericsson, K.A. (Ed.). 1996. *The road to excellence: The acquisition of expert performance in the arts and science, sports, and games*. Lawrence Erlbaum Associate.
- Ericsson, K. A. 2001. Attaining excellence through deliberate practice: insights from the study of expert performance. In M. Ferrari (Ed.). *The pursuit of excellence in education*:21-55. Erlbaum.
- Gavetti, G. & Rivkin, W. 2005. How Strategists really think: Tapping the Power of Analogy, *Harvard Business Review*, 83,54-63.
- Hatchuel, A. 2001. Towards Design Theory and Expandable Rationality: The unfinished programme of Herbert Simon, *Journal of Management and Governance*, 5(3-4), 260-273.
- Johansson-Skölberg,U., Woodilla, L. and Çetinkaya,M. 2013. Design Thinking: Past, Present and Possible Futures. *Creativity and Innovation Management*, 22(2), 121-146.
- Kolko, J. 2010. Abductive Thinking and Sensemaking: The Drivers of Design Synthesis. *Design Issues*, 26(1), 15-28.
- Kolko, J. 2011. *Exposing The Magic of Design: A Practitioner's Guide to the Methods and Theory of Synthesis*. Oxford University Press.
- Kimbell,L. 2011. Rethinking Design Thinking: Part I. *Design and Culture*, 3(3), 285-306.
- Lawson, B. 1979. Cognitive strategies in architectural design. *Ergonomics*, 22, 59-68.
- Lawson, B. 2004. Schemata, gambits and precedent: Some factors in design expertise. *Design Studies*, 25(5), 443-457.
- Lawson, B. 2006. *How Designers Think: The Design Process Demystified (4th ed.)*. Elsevier/ Architectural Press.
- Lawson, B. & Dorst, K. 2009. *Design Expertise*. Routledge.
- Liedtka, J., & Ogilvie, T. 2011. *Designing for Growth: A Design Thinking Tool Kit for Managers*. Columbia University Press.

- McDonnell, J. 2011. Impositions of order: A comparison between design and fine art practices. *Design Studies* 32, 557-572.
- Martin, R. 2007. *The Opposable Mind: How Successful Leaders Win through Integrative Thinking*. Harvard Business School Press.
- Martin, R. 2009. *The Design of Business: Why Design Thinking is the Next Competitive Advantage*. Harvard Business School Press.
- Maher, M.L & Poon, J. 1996. Modeling Design Exploration as Co-evolution. *Microcomputers in Civil Engineering* 11(3), 195-209.
- Michlewski, K. 2008. Uncovering Design Attitude: Inside the Culture of Designers, *Organization Studies*, 29, 373-392.
- Michlewski, K. 2015. *Design Attitude*. Gower Publishing Limited.
- O'Reilly, C. A., & Tushman, M. L. 2013. Organizational ambidexterity: Past, present, and future. *The Academy of Management Perspectives*, 27(4), 324-338.
- Peirce, C. S. 1970. *Collected Papers of Charles Sanders Peirce: I-VI*, Hartshorne, C. and Weiss, P. (Eds.) The Belknap Press.
- Ryle, G.1984. *The Concept of Mind*. University of Chicago Press.
- Rittle, H. 1972. Son of Rittelthink. *Design Method Group 5th anniversary report*.
- Rozenburg, N.F.M. & Eekels J. 1995. *Product Design: Fundamentals and Methods*. Wiley.
- Rowe, P. 1987. *Design thinking*. MIT Press.
- Schön, D.A. 1983. *The Reflective practitioner: How Professionals think in action*. Basic Books.
- Schön, D.A. 1984. Problems, Frames and Perspectives on Designing, *Design Studies* 5(3), 132-136.
- Simon, H.A. 1973. The structure of ill-structured problems. In Cross, N. (Ed.) *Developments in design methodology* :145-166, John Wiley & Sons.
- Simon, H.A. 1969. *The Science of Artificial*. MIT Press.
- Stenberg, R.J. & Wagner, R.K. 1992. Tacit Knowledge: An Unspoken Key to Managerial Success. *Creativity and Innovation Management*, 1, 5-13.