The core of 'design thinking' and its application

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In the last few years, "Design Thinking" has gained popularity — it is now seen as an exciting new paradigm for dealing with problems in sectors as far a field as IT, Business, Education and Medicine. This potential success challenges the design research community to provide unambiguous answers to two key questions: "What is the core of Design Thinking?" and "What could it bring to practitioners and organisations in other fields?". We sketch a partial answer by considering the fundamental reasoning pattern behind design, and then looking at the core design practices of framing and frame creation. The paper ends with an exploration of the way in which these core design practices can be adopted for organisational problem solving and innovation.
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The term 'Design Thinking' has been part of the collective consciousness of design researchers since Rowe used it as the title of his 1987 book (Rowe, 1987). The first Design Thinking Research Symposium was an exploration of research into design and design methodology, viewed from a design thinking perspective (Cross, Dorst, & Roozenburg, 1992). Multiple models of design thinking have emerged since then, based on widely different ways of viewing design situations and using theories and models from design methodology, psychology, education, etc. Together, these streams of research create a rich and varied understanding of a very complex human reality. Nowadays, "Design Thinking" is identified as an exciting new paradigm for dealing with problems in many professions, most notably Information Technology (IT) (e.g Brooks, 2010) and Business (e.g. Martin, 2009). The eagerness to adopt and apply these design practices in other fields has created a sudden demand for clear and definite knowledge about design thinking (including a definition and a toolbox). That is quite problematic for a design research community that has been shy of oversimplifying its object of study, and cherishes multiple perspectives and rich pictures.

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There are many good reasons to be interested in design, and consequently different people have picked up on 'Design Thinking' in different ways. This paper addresses one particular strand of enquiry; the interest in 'Design Thinking' expressed by the business and management communities, who feel an urgent need to broaden their repertoire of strategies for addressing the complex and open-ended challenges faced by contemporary organisations (Stacey, Griffin, & Shaw, 2000). Studying the way designers work and adopting some designerly practices could be interesting to these organisations because designers have been dealing with open, complex problems for many years, and the designing disciplines have developed elaborate professional practices to do this. The challenge of dealing with these open, complex problems leads to a particular interest in the ways designers create 'frames', and the way design organisations deal with frames in their field of practice.

This paper starts out by using a model from formal logic to describe the key reasoning patterns in design. This provides a basis for understanding how design deals with open, complex problems. We will then explore which, out of a very broad and complex repertoire of design practices, could be most interesting for adoption in organisations that operate in other professional fields. The creation of frames is singled out, and the complex relationship between framing practices and organisational problem solving is investigated in more detail.

1 The challenge: abduction

To understand the complex and sometimes puzzling field of design practices we have to realize that they have been developed in response to a particular need. It would be impossible to really understand design or even to find commonality in the incredibly diverse array of design practices without first referring back to the core challenge of design.

To build up a conceptual framework that is fundamental enough to anchor the variety of approaches that designers take, and connect the many descriptions of design thinking that have arisen in design research, it may be strategic to temporarily suspend the generation of 'rich' descriptions of design and instead take a 'sparse' account as our starting point. Logic provides us with a group of core concepts that describes reasoning in design and other professions. A 'sparse' description derived from logic will help us to explore whether design is actually very different from other fields – and should provide us with some insight on the potential value of introducing elements of design practice into other fields. In this paper we will move from these spartan beginnings to 'richer' descriptions of design.

To get to the heart of design thinking we build on the way fundamentally different kinds of reasoning are described in formal logic, in particular the way Roozenburg has described the work of Peirce in the context of design (Roozenburg & Eekels, 1995). We will describe the basic reasoning patterns

that <mark>humans use in problem solving by comparing different 'settings' of the knowns and unknowns in the equation:</mark>

$$\underset{\text{(thing)}}{\text{WHAT}} \quad + \quad \underset{\text{(working principle)}}{\text{HOW}} \quad \overset{\text{leads to}}{\longrightarrow} \quad \underset{\text{(observed)}}{\text{RESULT}}$$

In *Deduction*, we know the 'what' (the 'players' in a situation we need to attend to), and we know 'how' they will operate together. This allows us to safely predict results. For instance, if we know that there are stars in the sky, and if we are aware of the natural laws that govern their movement, we can predict where a star will be at a certain point in time.

$$\text{WHAT} \quad + \quad \text{HOW} \quad \overset{\text{leads to}}{\longrightarrow} \quad \text{???}$$

Alternatively, in *Induction*, we know the 'what' in the situation (stars), and we can observe results (position changes across the sky). But we do not know the 'how', the laws that govern these movements. The proposing of 'working principles' that could explain the observed behaviour (aka hypotheses) is a creative act.

$$\text{WHAT} \quad + \quad \text{???} \quad \overset{\text{leads to}}{\longrightarrow} \quad \text{RESULT}$$

<mark>This form of reasoning is absolutely core to the 'context of discovery' in the sciences: this is the way hypotheses are formed.</mark> Within the sciences, these hypotheses are then subjected to critical experiments in an effort to falsify them. These rigorous tests are driven by deduction. <mark>Thus, in the sciences, inductive reasoning informs 'discovery', while deductive reasoning informs 'justification'. These two forms of analytical reasoning help us to predict and explain phenomena in the world.</mark>

<mark>But what if we want to create value for others, as in design</mark> and other productive professions? Then the equation changes subtly, in that the end now is not a statement of fact, but the attainment of a certain 'value'.

$$\underset{\text{(thing)}}{\text{WHAT}} \quad + \quad \underset{\text{(working principle)}}{\text{HOW}} \quad \overset{\text{leads to}}{\longrightarrow} \quad \underset{\text{(aspired)}}{\text{VALUE}}$$

The basic reasoning pattern in productive thinking is Abduction. Abduction comes in two forms — what they have in common is that the outcome of the process is conceived in terms of value. The first form, <mark>Abduction-1, is often associated with conventional problem solving.</mark> Here we know both the value we wish to create, and the 'how', a 'working principle' that will help achieve the value we aim for. What is missing is a 'what' (an object, a service, a system), that will give

definition to both the problem and the potential solution space within which an answer can be sought.

$$??? \quad + \quad \textbf{HOW} \quad \overset{\text{leads to}}{\longrightarrow} \quad \textbf{VALUE}$$

This is often what designers and engineers do − create a design that operates with a known working principle, and within a set scenario of value creation. This is a form of 'closed' problem solving that organisations in many fields do on a daily basis (see Dorst, 2006). The other form of productive reasoning, Abduction-2, is more complex because at the start of the problem solving process we ONLY know the end value we want to achieve. This 'open' form of reasoning is more closely associated with (conceptual) design.

$$\underset{\text{(thing)}}{???} \quad + \quad \underset{\text{(working principle)}}{???} \quad \overset{\text{leads to}}{\longrightarrow} \quad \underset{\text{(aspired)}}{\textbf{VALUE}}$$

So the challenge in Abduction-2 is to figure out 'what' to create, while there is no known or chosen 'working principle' that we can trust to lead to the aspired value. That means we have to create a 'working principle' and a 'thing' (object, service, system) in parallel. The need to establish the identity of two 'unknowns' in the equation, leads to design practices that are quite different from conventional problem solving (Abduction-1). As the challenge that is before the actor in Abduction-2 is most closely associated with design (Roozenburg & Eekels, 1995) and best represents the open, complex problems for which organisations are seeking new approaches, Adbuction-2 will be the focus of this paper.

2 The response: design reasoning

There are many ways to respond to the challenge presented by Abduction-2: for example, students and other novice designers can be seen to almost randomly generate proposals for both the 'how' and the 'what', and then seek to find a matching pair that does lead to the aspired value. But experienced designers tend to have much more deliberate (and efficient) strategies to tackle the complex creative challenge of coming up with both a 'thing' and its 'working principle' that are linked to the attainment of a specific value. These strategies involve the development or adoption of a 'frame'. In terms of our logical framework, a 'frame' is the general implication that by applying a certain working principle we will create a specific value.

$$\underbrace{\textbf{WHAT} \quad + \quad \textbf{HOW} \quad \overset{\text{leads to}}{\longrightarrow} \quad \textbf{VALUE}}_{\textbf{FRAME}}$$

'Framing' is a term commonly used within design literature (since (Schön, 1983)) for the creation of a (novel) standpoint from which a problematic situation can be tackled (for an example of 'framing' see Section 4 of this paper). Although frames are often paraphrased by a simple metaphor, they are in fact very complex sets of statements that include the specific perception of a problem situation, the (implicit) adoption of certain concepts to describe the situation, a 'working principle' that underpins a solution and the key thesis: IF we look at the problem situation from this viewpoint, and adopt the working principle associated with that position, THEN we will create the value we are striving for.

Performing the complex creative feat of the parallel creation of a thing (object, service, system) and its way of working is the core challenge of design reasoning. This double creative step requires designers to come up with proposals for the 'what' and 'how', and test them in conjunction. The most logical way to approach this complex problem situation is to work backwards, as it were, starting from the only 'known' in the equation, the value that needs to be created, and then adopt or develop up a frame. This initial framing activity is actually a form of induction, reasoning back from consequences. Once a credible, promising or at least possibly interesting frame is proposed, the designer can move to Abduction-1, designing a 'thing' (object, system, service) that will allow the equation to be completed. Only completed equations can be tested on their merit. The next step then is a reasoning forward, using deduction to see if the 'thing' and 'working principle' combined actually perform well enough to create the value. Until this test, the frame-as-proposed is just that: a possible way forward, that cannot be accepted as 'definitive' until the whole equation has been filled in by the creation of the design, and that design has been shown to lead to the aspired value.

This comparison establishes the designing professions as reasoning in ways fundamentally different from the reasoning in fields predominantly based on analysis (deduction, induction) and problem solving (Abduction-1, see also (Dorst, 1997, 2006)). But the distinction is not very clear-cut, as we have seen that design is not one way of thinking: it is a mix of different kinds of thinking, building as it does on induction and problem solving. It also inherently contains quite a bit of strict analytical reasoning, as rigorous deduction is needed to check if design solutions will work.

3 The breadth of design practice

As a response to the challenge of working in problem situations that require this second, 'open' kind of abduction, designers have developed and professionalised specific ways of working. This is an important point: although many of the activities that designers do are quite universal, and thus it would be inappropriate to claim these as exclusive to design or 'Design Thinking', some of these activities have been professionalised in the design disciplines in

ways that could be valuable for other fields. The value then is not so much to be found in a general adoption of something as amorphous as 'Design Thinking', but it lies in the application of these specific professional design practices.

To quickly get a sense of the broad repertoire of design practices, we can turn to the overview given in Lawson and Dorst (2009), based on three different categorisations; distinguishing between *kinds of design activities*, *levels of design expertise* and *layers of design practice*. Starting with the kinds of design activities, Lawson and Dorst distinguish five general groups: 'Formulating', 'Representing', 'Moving', 'Evaluating' and 'Managing'. The second distinction is between seven 'levels of design expertise': 'Naïve', 'Novice', 'Advanced Beginner', 'Competent', 'Expert', 'Master' and 'Visionary'. These roughly correspond with seven different ways of operating in design practice, namely choice based, convention based, situation based, strategy based, experience based, creating new schemata and the redefinition of the field. These seven approaches each come with their own practices. A third and, in the light of this paper, very significant distinction is made between three layers of design practice: 'project', 'process' and what we will here call the layer of the 'field' (after Bourdieu et al. (1999)). The rationale behind this categorisation is that design is not just an activity within projects, but that experienced designers develop up their own processes that work across projects within a firm or professional practice. The third layer, 'field' then is the organisational, intellectual and physical environment in which a type of design practice can take shape (hence the term, as Bourdieu sets out the 'playing field' of a social group). The reality of the concept of the 'field' for professional designers can be illustrated by this interview quote from Ken Yeang. He is an eminent architect, describing his work on creating the 'field' in his big internationally operating architectural firm:

> …*I'm trying to develop a new form of architecture. We have this climatically responsive tropical skyscraper agenda and each project we try to see whether we can push an idea a little bit further…I give every new member of staff the practice manual to read when they join. They can see not just past designs but study the principles upon which they are based. We work these out over time, over many projects…. I do competitions more as an academic exercise. I treat competitions as research projects….it motivates the office — gets them excited - lets the mind develop new thoughts and themes. I put all the drawings together an publish a book… 'it's research, it develops ideas.'* (Lawson & Dorst, 2009, p. 63)

The repertoire of frames that the design firm regularly works with are a key element of the 'field' that holds their professional design practice together. In Lawson's book, top designers report different strategies to manage the 'field' and to adopt, maintain, develop and express the frames of the organisation.

This is an interesting area of organisation-level design practices that could be relevant for adoption in other professional arenas (Dorst, 2009, p. 64).

4 A core design practice: frame creation

We have seen that the creation and use of frames is inherently linked to Abduction-2. Framing is the one step in the Abduction-2 process that is particular to design practice: the processes in Induction, Abduction-1 and Deduction are part of the conventional problem solving repertoire of many organisations. Thus in our aspiration in this paper to concentrate on the core, special thing that design practices could bring to organisations that are struggling with open, complex problem situations, it is a natural choice to concentrate on framing.

The process of design reasoning as it was described in Section 2 looks quite complex, and if spelled out in its logical principles it is. However, framing can be a simple, routine, lightning-quick process within design practice. If the problem situation is familiar, and the designer has dealt with such matters before, a frame will be an integral part of the way the designer is 'reading' the situation, and will come to mind straight away. The more elaborate multi-step process described in Section 2 only comes into play when the problem situation presents a real paradox to the designer. The word 'paradox' is used here in the sense of a complex statement that consists of two or more conflicting statements — true or valid in their own right, but they cannot be combined. The core paradox is the real opposition of views, standpoints or requirements that requires a renewed framing of the problematic situation. In her writings on ethics in engineering, Caroline Whitbeck flags the way designers deal with paradoxes as a key element of design practice (Whitbeck, 1998).

> … The initial assumption (within moral philosophy) that a conflict is irresolvable is misguided, because it defeats any attempt to do what design engineers often do so well, namely, to satisfy potentially conflicting considerations simultaneously (Whitbeck, 1998, p. 56).

Framing in response to paradoxes in the problem situation is a key and rather special element of design's problem solving practices. As we are interested in the transfer of core design practices into other problem arenas, we need to now focus on understanding the capacity of design practitioners to create new frames. The rough description of design reasoning in Section 2 only describes how frames are used, but not where frames originate.

Experienced designers can be seen to engage with a novel problem situation by searching for the central paradox, asking themselves what it is that makes the problem so hard to solve. They only start working toward a solution once the nature of the core paradox has been established to their satisfaction. In a study that observed the subsequent process in detail, it was found that the best expert

designers do not address the core paradox head-on, but tend to focus on issues around it. They search the broader problem context for clues. New frames with which to tackle the central paradox then arise (or emerge) from this engagement with the broader problem context (Dorst, 1997). A very deliberate strategy for frame creation has recently been proposed by Hekkert and van Dijk (2011) — here we will describe the broader principle of frame creation itself.

In creating new frames, what expert designers are engaging in is a subtle process of analysis that has much in common with phenomenological methods of analysis, through which a complex situation is read in terms of 'themes' (Van Manen, 1990, p. 89). In phenomenological method, a 'theme' is the experience of focus, of meaning. Themes are essentially a sense-making tool, a form of capturing the underlying phenomenon one seeks to understand. They are not clearly positioned in either the problem space or the solution space; their status is unclear until it is determined (retrospectively, after the frame is proposed) where they belong. Distilling themes from a complex situation is described as a process of insightful invention, discovery and disclosure. In design practice we see that 'themes' which could (from a problem solving perspective) be judged peripheral to the central paradox, become the triggers for the creation of new frames that allow the central paradox to be approached in a new and interesting way.

Although new frame creation is an important element in professional design practice, it often looks to be a largely informal activity. Designers refer to 'getting close' to the situation, they talk about the importance of the 'richness' of the problem area, and they do stress the merit of getting 'first-hand experience' of the problem situation. While this sounds vague and their behaviour may look quite hit-and-miss, we would argue that they are exploring the broader problem situation, gathering clues that can lead to the emergence of themes. These themes inform the development of a frame that articulates a response to the central paradox of the problem situation. This is a deliberate strategy, not a random process. There is some 'method to their madness', after all.

An example of theme exploration and frame creation in a complex problem situation might help to illustrate this practice.

> *The problem situation centres on entrenched and seemingly intractable issues associated with an entertainment quarter in a metropolis. This particular area with its bars and clubs attracts about 30,000 young people on a good night. The issues include drunkenness, fights, petty theft, drugs dealing and, later in the night, sporadic violence. Over the years, the local government has been using 'strong arm tactics', increasing the police presence and putting in CCTV camera's. Clubs have been required to hire security personnel. All this visible extra security has made for a grim public environment, and the problems have persisted.*

*Designers from the Designing Out Crime centre (see (*Lulham, Camacho Duarte, Dorst, & Kaldor, 2012*)) quickly realized that the issues presented to them were framed by the local council as law-and-order problems, needing law-and-order solutions. The designers took a broader approach and studied the behavior of the revelers in detail. Key themes that emerged were that the people concerned are overwhelmingly young people (non-criminals) wanting to have a good time (=the value to be achieved), and that they were becoming increasingly bored and frustrated as the night progressed. Paradoxically, they were not getting a good experience at all — a problem exacerbated by the security measures in place. The designers framed what were originally presented as crime issues differently by studying these themes and proposing a simple analogy: that this problem could be approached AS IF they were dealing with organising a good-sized music festival. This analogy immediately allows further exploration: WHAT would one do IF one were to organise a music festival? This metaphor triggers new scenarios for action, as well-run music festivals provide for needs that have not been taken care of in this public space. Just to name a few, out of about 20 design directions that were sparked by this single frame:*

- *Transportation. When organising a music festival one would make sure that people would be able to get there, and also leave again when they want to. In this entertainment quarter, the peak time of young people coming into the area is about 1AM, and the last train leaves at 1.20AM… Getting a taxi takes about 2 h, later in the night. So once you are in the area you cannot leave without difficulty until the trains start running again at six in the morning. That leads to boredom, frustration and aggression. Apart from putting in more trains, the designers proposed as a fall-back position a system of temporary signage on the pavement, helping the party-goers to get to a different train station (a 20 min walk) that has trains running throughout the night.*
- *Crowd control. In organising a music festival, one would also create chill-out spaces and continuous attractions, to make sure that people's experience does not completely depend on what happens on a single big stage. As it happens, this entertainment quarter has a few big clubs that form the main attractions. Youngsters that have visited a club and go back out on the street might find that the queue for the next one is too long, and so wander on the streets with nothing to do. The designers proposed that this problem can be minimized by providing a smartphone app, allowing them to check the waiting time for the next club before leaving the one they are in. It was also suggested that some of the laneways around the central street be opened up as rest areas, with water fountains and a more relaxed 'lounge' atmosphere.*
- *Safety and wayfinding. In organising a music festival, one would plan for staff to be around to help people and keep an eye on safety. Over the years, the clubs have hired more and more sinister-looking security personnel and bouncers. The designers proposed a system of very visible young 'guides' in*

bright T-shirts, who would help people find their way through the area and also would be approachable when help is needed.

This example shows how a hitherto paradoxical and open, complex problem situation can be approached in an original manner. The designers created a frame, based on the themes that emerged from their investigations. Through this process, the designers moved away from the frame in which the problem was originally expressed and the limitations in the 'working mechanisms' that were implied in that frame.

5 Frame creation and organisational change

As stated in the introduction, interest in 'Design Thinking' has been sparked by organisations having trouble dealing with open, complex problem situations. This is where the way design practice deals with themes and frames in the context of open, abductive reasoning could be particularly useful. For organisations, these really serious and potentially paradoxical problematic situations arise when their conventional problem solving fails, when the equation (*'what' plus 'how' leads to 'value'*) that an organisation has been operating under somehow doesn't work any more. In these situations, it can be very hard to fathom what's wrong: should the 'what' be changed, the 'how' could be wrong, the 'frame' that drives the implication could be faulty or maybe the organisation is misreading the values in the world?

There are several different ways of enlisting designerly practices for dealing with this problematic situation. (1) Organisations often initially react in a way that requires the least effort and fewest resources: they set out in a conventional problem solving manner (Abduction-1) to create a new 'something' that will save the day while keeping the 'how', 'frame' and 'value' constant. We have seen in the example above that this is often the nature of the problem situation as it is first presented to a designer, implicitly framed by the client organisation (see also Paton and Dorst, this issue). Often, the problem-as-presented first needs to be 'deconstructed' (Hekkert & van Dijk, 2011) before it can become amenable to solution. We then progress to (2): if the Abduction-1 approach of creating a new 'what' doesn't help, the organisation may need to go into Abduction-2 mode, that also requires them to create a new 'how'. The organisation might do this simply by applying one of the other frames that it already has in its repertoire, in its 'field'. (3) Alternatively the organisation might hire an external consultant that uses his/her experience to bring a new frame to the problematic situation. That frame could be added on to the practice of the organisation for this particular project, quite superficially, or it might become more important than that and enter the 'field' of the organisation, as an integral part of the organisations' own problem solving capability. (4) We have seen that a new frame can also be developed from scratch through exploring themes in the broader problem situation. When this happens within the organisation itself, the new frame (and all the knowledge gained in the theme

investigation) could become part of that organisation's 'field'. (5) Ideally, this would result in the designerly ability to investigate themes and create new frames that can be embedded in the organisation. If this crucial step is made, the organisation will be able to better deal with its open, complex challenges in the future. This is the most potent possibility for organisations that adopt the core design practice of frame creation.

6 Conclusion

We set out to investigate how design practices could be enlisted to help organisations deal with the new open, complex problems they are facing in the modern world. This paper has concentrated on frame creation as a core practice that is particular to the designing disciplines, and explored how that design practice could interface with an organisation. We have seen that design practices can relate to the practice of an organisation on at least five different levels: as the design practices that address problems within an existing frame (Abduction-1); as design practices that involve framing (Abduction-2), where the frame originates from the existing company practice; as the adoption of a new frame that has been brought or developed by an outsider; and as the creation of a new frame through the investigation of themes, in a deeper transformation of the organisations' own practices. This last level is where design-based practices and organisational innovation are most intimately linked. This is where design practices and the knowledge that has been built up over almost 50 years of design research can directly relate to processes that have been described in terms of 'entrepreneuring' (Steyaert, 2007) and 'effectuation' (Sarasvathy, 2008) in management literature.

Often, in popular literature, many disparate, vaguely creative activities are combined under the label of 'Design Thinking'. We hope to have shown in this analysis that the design professions stand for quite specific and deliberate ways of reasoning, and that design practices can interface with organisations on different levels, requiring the application of different kinds, levels and layers of design practice (see Section 3) each requiring specific designerly abilities. Confusion about these application levels seems to be partly to blame for the general confusion about both the nature and the merit of 'Design Thinking'. This confusion has now reached a crisis point, with eminent design researchers rallying against using the term 'Design Thinking' at all, vocally pronouncing its 'death'. In this paper we have tried to demonstrate that specific elements of design practice, like the way professional designers create frames out of the investigation of themes in the broader problem situation, could really benefit organisations and practitioners in other fields. In order to realise the true value that 'Design Thinking' can have for these practitioners and organisations, we need to articulate these practices with subtlety, clarity and in much more detail than has been achieved in this brief paper. They are the key contribution that design practitioners and design researchers could bring to a professional world that really needs them.

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