

## DESIGN THINKING: AN APPROACH WITH VARIOUS PERCEPTIONS

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### ABSTRACT

Design Thinking has become increasingly popular across different disciplines. However, what it exactly entails is becoming more and more vague, leading to the term being used for many different approaches and applications. This paper presents an interview study with experts on the application and training of Design Thinking in academia and industry. We find a divide with some seeing Design Thinking as a mere toolbox of methods, while others see it as an umbrella term for the mindset that determines how designers think and act. Subjects unanimously attest the approach large potential to support certain types of businesses, when applied under the leadership of trained designers, but see a lot of danger for the approach to become meaningless if it keeps being advertised as an all-purpose problem-solving tool. The interviewees further share extensive experiences on specific success factors and pitfalls in applying Design Thinking in practice.

**Keywords:** Design Thinking, Design practice, Design methodology, Design methods, Problem-solving

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## 1 INTRODUCTION

Design Thinking (DT) has been gaining increasing attention across disciplines, stretching beyond design. It is acclaimed to be “an approach to innovation that is powerful, effective, and broadly accessible that can be integrated into all aspects of business and society” (Brown, 2009, p. 3), supported with evidence for pioneering, visionary business venturing on almost all levels of participation (Garbuio *et al.* 2018; Liedtka & Ogilvie, 2011; Lockwood, 2009; Verganti, 2009). As the industries desire to become more creative and improve their dynamic capabilities, and given the success stories from large organisations like Procter & Gamble, Kaiser Permanente and the Mayo Clinic (Martin 2009; Rae, 2008), it is hardly surprising that the application of DT in business is growing.

However, DT, because of its versatile nature and large array of possible applications, is not well defined (Schmiedgen *et al.*, 2015). More so, in design research, many different descriptions of DT have emerged (Dorst, 2011) and DT in its modern form has been criticised for being reductionist to the decades of fundamental design research that preceded it (Badke-Schaub *et al.*, 2010). Effectively, DT has become a somewhat ambiguous term used for a host of approaches including different methods, structures, and applications. “Even on a cursory inspection, just what Design Thinking is supposed to be is not well understood, either by the public or those who claim to practice it” (Kimbell, 2011, p. 286). Some researchers suggest that DT should be more of a mindset and inert to company culture, rather than a discrete approach or process to follow (Kolko, 2015). Ultimately, this variance blurs a clear definition and communication of DT for researchers and practitioners alike.

Naturally, interests in DT are different across disciplines. Once a more consolidated definition on DT is identified, companies can determine what is needed for successful innovation through DT. This will be equally beneficial for educational institutions as the DT curriculum could be further developed and solidified to improve innovative, human-centred practices. This paper describes an exploration of the DT definitions across disciplines and expertise. Section 2 discusses the background of DT as a term, method and approach. Sections 3 and 4 provide insights from semi-structured interviews with educators and practitioners with DT expertise. Success factors and pitfalls for DT application are highlighted. These insights are used in Section 5 to discuss the potentials DT can offer when applied appropriately.

## 2 BACKGROUND AND THEORETICAL FOUNDATION

DT has grown substantially in popularity over the last decade following a ‘reboot’ by Tim Brown (Brown, 2009). This modern form is very different from the traditional interpretation of DT in research, focusing on fundamental cognitive acts of designing, such as information search and generation, mental imagery, assessment and evaluation, structuring and learning (Goldschmidt and Badke-Schaub, 2010).

The focus on the thinking and acting in creating new solutions underlying DT has shifted in what some scholars refer to as the ‘new movement’ of DT. Industry has since started to interpret DT as more of a business and management approach to creating novel ideas and innovating product portfolios. DT is essentially perceived through the famous double-diamond process model of repeated divergent (or explorative) and convergent (selective or defining) thinking steps. Divergent phases cover the exploration of user needs and empathy building as well as solution generation, initial prototyping and testing, respectively. Convergent phases focus on sense-making, selecting and defining target outcomes for subsequent steps, the overall design aims or, eventually, the final design. There are usually frequent jumps and iterations between phases, however, as insights generated at any stage in the process may affect prior and subsequent stages. A key characteristic of this approach is its clear focus on user-centricity, repeatedly (or even continuously) involving target user groups and other relevant stakeholders from multiple disciplines along the entire process for input, feedback and co-creation. All involved steps and activities can be formally supported with a variety of methods and tools.

The modern DT approach after Brown represents a generic, iterative problem exploration and solution finding process to create solutions for a particular user group or set of stakeholders. As such, it is unspecific to the context or aim it is applied in and for, respectively. Brown (2009) effectively stresses that the DT approach, in its new form, is applicable equally to products, spaces, system or dealing with abstract problems and services. DT is thus given the claim of almost limitless applicability to generate innovative concepts (Gericke & Maier, 2011) stretching into transitioning businesses, management and even societies (Garbuio *et al.*, 2018). There are very famous examples of how DT has helped transition large, established organisations to become more innovative (as discussed above), making

DT a plug-and-play solution to boost innovation anywhere (Carlgren *et al.*, 2016). This perception is fostered also by design and management consultancies like IDEO. They claim that DT is not just for designers, but also an inherent requirement for business and management leaders that seek to outperform in competitive settings: “design is now too important to be left to designers” (Brown 2009, p.37). The thought leadership of consultancies in this field has a strong impact on the popularity of DT, calling it a ‘useful myth’ even (Norman, 2010). This is based on the fact that its concrete meaning is hard to grasp nowadays, but the term alone enjoys popularity and opens up pathways for designerly ways of thinking to enter executive levels of organisations. In this research, we studied the different views of experts on modern DT approaches. This is a first step towards consolidating the different views, but also to explore what success factors and pitfalls are for its application.

### 3 STUDY DESIGN

The purpose of the presented exploratory study is to explore the various viewpoints on DT by a selected group of seven experts in design research and education, through semi-structured interviews.

#### 3.1 Participants selection

All participants were carefully selected from experts teaching and practicing DT, in an educational context with advanced students on Master and PhD level; five participants also have a long-standing track record of applying DT working in/with industry. With one exception, all participants have more than 5 years of experience with DT (max. 25 years). Their applications include the traditional as well as alternative versions of the modern interpretation of DT. The one person with less experience by years, still has acquired extensive expertise working with large organisations seeking to implement DT in their ranks. Educational backgrounds include design engineering, product design, psychology and business administration. Six of the participants are faculty academic staff in design and innovation who hold PhD degrees; the last participant holds a post-graduate degree.

#### 3.2 Research questions

The study is guided by the following overarching research questions:

- How do the experts describe the DT approach; what are commonalities and differences?
- What are the essential elements and practices that are perceived as DT characteristics?
- What are the success factors and pitfalls in applying DT?

#### 3.3 Data collection and analysis

The semi-structured interviews were conducted over a period of four weeks. The interviews were either carried out in person or through online channels. The interviews lasted between 34 and 55 minutes, with an average of 44 minutes. Audio was recorded and transcribed. The interview procedure followed a questionnaire based on the overarching research questions. Qualitative data was inductively coded and analysed following the Grounded Theory approach (Strauss & Corbin, 1994).

## 4 RESULTS

### 4.1 Defining Design Thinking

In the interviews, participants were asked to define DT in their own words. Often, this reflected their background, education and their DT-focused current research. Across all interviews, a key difference was found regarding whether the interviewee had a business-focus or a product/service design focus in applying DT. Business-focused participants emphasised the tools and methods to create novel strategies and/or business models.

Participant #1: “I make a difference between [Design Thinking and] strategic design, because for me, [...] Design Thinking is a set of tools that you can use, for [developing and] executing your innovation strategies. I think the difference that I make, is that it is really about [it being] a set of tools and methods”.

Conversely, a design-focused participant highlighted the DT mindset as inherent to the work and approaches used by designers. Interestingly, approaches and methods considered part of DT were mentioned multiple times as something that designers would have acquired during their education, without it necessarily being called DT.

Participant #6: “In one sentence it would be: The way how designers have learned to think and act during their education. You can use that in several ways, especially to be able to improve innovation. It is mainly about elements such as creativity, visual thinking, providing insights, holistic thinking and centralise user”

In addition to DT being inherent to designers’ working, another participant described it as an entity across methods and mindset alike.

Participant #6: “I know that some people describe it as a set of methods, some as an overall approach and some as an overall mindset. For me it is actually a combination of them all. It is an integration between overall mindsets, focused on human centeredness and prototyping combined with a set of methodologies that you can use in a process [for the development of product solutions] with different phases.”

Human-centeredness, methods, methodology, mindset, and other terms were frequently used to describe DT and are considered at the core. These are further elaborated in the following sections.

## 4.2 Characteristics of Design Thinking

### 4.2.1 Diversity of characteristics and their context-dependency

A broad spectrum of characteristics were mentioned by the participants as essential to DT, several of which were recurring across interviews. Table 1 summarises these characteristics as they were articulated in the interviews.

Participant #4: “I have done some research on DT definitions and there are some people who claim that human centeredness is the core aspect of DT, some claim that it is a combination between human centeredness, prototyping and something else, but there are also people who explain elements of DT on micro level.”

Participants often referred to uniqueness of DT when it was also applicable to other methodologies. The uniqueness was sometimes related to a combination of several elements, due to the fact that some participants claim that stand alone elements are not representing DT.

Participant #6: “I think that all four elements that I mentioned are important, because they all have their goal in a project. Focussing on the user is evident and you should definitely do that, but it is not always enough to implement Design Thinking in the whole company. You should place the user in the centre, but you should also be able to communicate this to all the stakeholders and cope with ambiguity, which is often done with visualisations.”

Participant #4: “Other disciplines have no idea what human centeredness is, using the user’s perspective as the key of DT might be the most unique.”

Some participants talked about one or more general elements, which were defined in two different ways. First it could be an element that is not unique or which is used in other methodologies as well. A specific example is an element is ‘framing-reframing’ which two participants advocated strongly.

Participant #1: “Problem framing fits both Design Thinking and design, but it is still part of the Design Thinking approach.”

Participant #2: “When I was doing research in social sciences, I was already aware of the framing-reframing theory. I thought that there was not a big difference between what had been written in design and social sciences about it. It is part of what designers do, but it is not that different from others. That is why I think that it is not a uniqueness of DT. Also framing-reframing comes close to rhetoric and for example people who are working with the police can do the same.”

None of the elements is used all the time and it seems hard to rank the different elements on importance. One of the participants mentioned that the elements are dependent on the context of the users and the kind of project they are working on. Then, elements of DT are re-interpreted in a different manner, but may address the same/closely related entities/actions. Yet, across their experiences individuals were able to give a subjective ranking according to what they think the element’s importance is to DT as a whole (even if not 100% the same in every case), this is reflected in the order from top to bottom in Table 1.

Participant #6: “Many factors of Design Thinking are dependent on the context which the applicants of Design Thinking work in, the company they work for, their job title, their organisation structure and the innovation they are working on. [...] An example can be a businessman, he is never talking about a user.

He talks about the market and doing market research. That is a different way of looking at [the same] element and using specific tools<sup>1</sup>.”

Table 1. Characteristic DT elements ranked by importance from the top by each participant

Participant 1	Participant 2	Participant 3	Participant 4	Participant 5	Participant 6	Participant 7
Human Centeredness	Co-evolution	Consideration about method use	Human Centeredness	Human Centeredness	Holistic	Problem understanding
Multi-disciplinary	Abduction	Analysis	Generative Sensing	Prototyping	Bias towards creation / Creativity	Iterating
Future Oriented	Visualisation	Reflection	Prototyping	Problem Framing	Visual Language	Testing
Problem Framing	Experimentation	Human Centeredness	Abduction	Collaboration	Orchestrating Ambiguity	Visual language
Flexibility	Framing - Reframing		Coping with uncertainty	Visualisation	Human Centeredness	
Visualisation	Human Centeredness			Experimentation		

#### 4.2.2 Mindsets

Mindsets lie at the centre of DT. These are individual beliefs and tendencies that orient action. For example, the empathetic mindset, which values user engagement throughout the design process and emphasises development of empathetic, contextualised understanding of users, is a key DT mindset (Carlgren *et al.*, 2016). Schweitzer (2016) describe this mindset as: desire and determination to make a difference – positivity, hope, and creating change, often marked by resilience, determination, and optimism. DT borrowing inherent skills of designers, and the mentioned reinterpretation in different context, the interviews then focused on the question if DT required specific mindsets for it to be applied successfully. All the participants confirmed this, frequently mentioning things like being empathic, motivated, open-minded and curious as vital to applying DT successfully and effectively. Equally, pragmatism in terms of what can be realistically achieved was mentioned. This allows companies to see how concepts generated by DT can be feasible within their means.

Participant #2: “You need a balance between a form of pragmatism on one hand and on the other hand some kind of optimism to the world. The idea that everything is doable. Being completely pragmatic is going nowhere unless you believe that it makes the world a bit better. So you need a compromise between pragmatism and optimism.”

#### 4.2.3 Other requirements

Interviewees highlighted additional requirements going beyond including DT related elements (tools, methods, etc.) and having the right mindset. Such additional prerequisites include the right environment for the applicants of DT to work in, a seamless collaboration between people in applying DT and sharing the relevant technical expertise, organisational structures to support this, prior knowledge of the approach and trust in its potential, the ability to zoom in and out to prevent fixation, and also experience with what the user is doing. This pertains to personal insight to facilitate empathy and allowing Design Thinkers more easily to take the user perspective.

Participant #1: “I think that it also depends on the physical environment. Design Thinking is a lot about collaboration. Sharing ideas, being creative. You feel it when you enter specific companies and I think it is because of the way it is organised.”

Participant #3: “Knowledge about specific disciplines is needed. For example, when I have to design a printing machine, I have to have knowledge about the movement of the different elements in mechanics. And I have to know how the electric components influence the mechanical components. So we can call that domain specific knowledge; without [such] knowledge good design is not possible.”

<sup>1</sup> Ultimately, the market is constituted by users, and their needs and wants drive their purchase behaviour. This then, by extension, drives product/service design and inherent user focus.



Participant #4: “You need to be able to zoom in and out on system level and detail level. If fixation occurs you need to be able to break out of it.”

Whilst many of these elements have been similarly highlighted by scholars as prerequisite of (radical) innovation outside the context of DT (compare Carlgren *et al.*, 2016), multiple participants stressed one more element as absolutely essential in the interviews. This is the attitude shown by people in dealing with design problems, i.e. ill-defined problems.

### 4.3 Best practices in applying Design Thinking

#### 4.3.1 Practices, methods and tools that support successful application of Design Thinking

A large part of the interviews focused on the methods and tools that constitute or support the successful application of DT as an approach. Table 2 summarises the practices, methods and tools mentioned by the interviewees. These were described specifically as beneficial to achieve (a) good user-insight during the process, (b) empathise with the target user/market segment, and (c) allow thinking beyond the premises of incremental innovation and thus opening up to more radical change. Interestingly, one participant did not name practices or tools to be specific for the success of DT. In her justification for this, she expressed doubts if there are any tools that are truly *unique* to DT. Another participant emphasised that it is crucial to know when to use a specific tool/method, as there is no generally applicable action plan for executing DT. One needs to find out for each particular project how to structure the DT approach. This also pertains to what expertise has to be brought in at a given point in time. According to this participant, it is the task of the DT facilitator to make a decision if/when to add more/remove people to the process depending on the expertise needed at a given point in time. This element of *experience*, rather than a formalised rule, in knowing when to apply what or when to add a particular expertise was stressed by two more participants.

Participant #4: “I think you need a feeling for context and the situation you are in. I created the learning history tool myself, that replaces context mapping. It is not that I do not like the tool, but it is not useful in every situation.”

Participant #2: “Many people worked on tools and methods to gather insights about the consumer, but not that many tools will be applied to define opportunities. Think about personas and journey mapping, which are developed to create insights, but are also applied in service design to prototype.”

Tables 1 and 2 shows the differences in perspective between definition, element and practice. Certain elements that are found in the previous sections are according to a participant tools instead of an element. Visualisation is an element that is mentioned three times in the interviews as an element, but can also be seen as task to execute or tool, e.g. as means to communicate ideas to others or idea through form variance. Others cannot find tools for specific elements, because they have the feeling that you only need a mindset to apply the element.

Participant #5: “Collaboration is more like an overall mindset. You need to involve different people at different times with different expertise.”

Table 2. Interviewees’ perspectives on practices that make DT application successful

Participant	Element (Practice)
1	Human centeredness (user-research), multidisciplinary, future oriented (vision, roadmap), problem framing, flexibility, visualisation
2	Co-evolution (domain expertise), abduction, visualisation, experimentation (qualitative processes), framing-reframing, human centeredness (personas, journey mapping)
3	Consideration about method use, analysis, reflection, human centeredness
4	Human centeredness (co-create with people, invite to play, customer journey mapping, qualitative interviews, context mapping, learning history), generative sensing, prototyping, abduction, coping with uncertainty
5	Human centeredness (personas, context mapping focus group), prototyping (mock-ups), problem framing (point of view), collaboration (more an overall mindset for this), visualisation (is a tool itself, synthesizing, business model canvas, customer journey mapping, persona definition, storyboard), experimentation (early prototyping)
6	Holistic, bias towards creation / creativity, visual language (prototyping, visuals, schemes), orchestrating ambiguity
7	Problem understanding, iterating, testing, visual language (process sketch, computer sketch)

### 4.3.2 Benefits Design Thinking can create for organisations

Participants unanimously agreed that DT can offer a lot of benefits for companies. They all shared both what exactly they experienced in industry to create benefit for the organisations and how this can be measured. They also strongly advocated the notion of human centeredness as the one quintessential driver of benefit DT offered for companies through creating a much deeper understanding of their customers.

Participant #4: “For example, human centeredness, they can satisfy their clients better than before. Understanding their needs better shows that Design Thinking works [well for them].”

Participants also highlighted the concept of flexibility. This pertains both to the processes being applied and also to not pre-determine what the final outcome is expected to be. In turn, DT applicants were said to enjoy a larger freedom and flexibility in what they do and pour their efforts into, which creates room for creativity and innovation. One interviewee also suggested that this flexibility, inadvertently, makes people reflect on their progress more consciously, which is a positive effect, although progress may not always be achieved as quickly as with more traditional, less flexible approaches. Another participant suggested that learning effects, employee satisfaction and employee innovativeness can be increased, though it is hard to quantify this in any way.

Participant #2: “I have always related the power of [Design Thinking] to flexibility, being flexible with your goals and resources.”

Subsequently, the benefit of early prototyping and visualising was highlighted as ‘good practice’ to facilitate design outcomes.

Participant #1: “[In my experience], many companies prototype quite late, but the good companies start early making quick and dirty sketches, even [as early as] part of their [initial] strategy meetings.”

Finally, two interviewees stated that, ultimately, market success determines if DT has led to better/ (more) suitable outcomes.

Participant #5: “I think the success factor is actually that eventually there is a market for whatever you have designed.”

It was admitted though that measuring a direct correlation between the use of DT and market success is very difficult. Yet, the relevant participants argued that DT offers a higher likelihood of creating a substantial market opportunity, given its focus on the prospect user and their needs and desires, which then – by design – (should) make the created solutions appealing to the target user group.

### 4.4 Pitfalls of Design Thinking

The potential pitfalls mentioned by the participants for not being successful in DT application can be discerned in two categories: (1) what DT is *missing*, and (2) situations in which DT simply is not a suitable approach. Although both these two components were explored in the interview, most participants focused on the latter. Participants widely agreed that the hype around the DT approach creates problems. Some described it as ‘naivety’, because users tend to have the idea that it ‘can do *anything*’, due to the commercialisation by design consultancies. They emphasised DT being valued for its speed in application, ease of use and general applicability, although most applications were superficial. One of the respondents even described it as ‘corporate entertainment’, referring to a lack of time that would be needed to thoroughly understand the process.

Participant #5: “Many non-designers think they can learn it in one or two days and start using all these methods, but the methods themselves require a lot of practice.”

Besides the criticism of DT being sold as ‘a simple cure for innovativeness’, one participant argued that it has always been inherent to design activities. And, in fact, it is something that one would expect designers to be doing anyway, every day.

Participant #3: “You can skip the term, because it’s same as if I expect that designers who go to work are healthy. I expect healthy also in the sense of, if they have the flu, they stay at home.”

DT is agreed to be a good fit with young and progressive companies, e.g. design consultancies, but has strong limitations in established corporate environments. This is due to the difficulty people experience in changing their way of working and their mindset in traditional organisational structure and culture.

Still, most interviewees think all companies *can* benefit from DT, but not in all situations. It is seen as not suitable in situations when a company is under significant time pressure, when there is not much flexibility as to what the outcome *should* be or when the company is mainly interested in incremental, rather than radical innovations.

Participant #1: “It depends on the type of portfolio they have. You have to have a coherent portfolio. And your portfolio [should be] balanced between radical and incremental innovation. So you cannot be radical all the time or looking for the great solution all the time.”

For some companies it is easier to adopt DT than others. Progressiveness and design orientation are imperative. The number of designers in a company is also an influencing factor, since having designers in the team adds to the skillset the team can draw upon in applying DT and having had exposure to designers’ ways of working increases confidence in the benefit this can bring.

Participant #5: “In the end for any company that doesn’t have designers and doesn’t deal that much with uncertainty, those are the most challenging for Design Thinking.”

Finally, DT was described to be not suitable for a highly competitive corporate culture (as this can impede team work), emergency cases, i.e. failing companies, finally, start-ups in middle of their growth.

## 5 DISCUSSION AND CONCLUSION

The diversity of DT process definitions in literature is heavily reflected in the interviewee’s perceptions. Some of the participants described it as a toolbox of methods and tools that - if used right - will lead to more human-centeredness and creativity in teams or organisations. Others focused on ‘how a designer would do it’, implying DT as an umbrella term for the acts typically carried out by designers as part of their typical work/approach in addressing a design task or to solve a problem.

### 5.1 Design Thinking as a practical toolkit

DT is seen as a practical innovation approach in managerial contexts that can be taught to everybody (Liedtka and Ogilvie, 2011). This is most in line with the modern interpretation of DT as advocated by others (Brown, 2009; McKilligan *et al.*, 2017) and others. The content of the toolbox, however, can vary significantly (see Table 2). Interviewees stressed the importance of experience in using the encompassed methods and tools and/or having facilitation from design experts during the process and or professional tutoring/training by them. This very much aligns with the mentioned pitfalls, suggesting that DT requires more than the right tools and methods, but presupposes a significant level of knowledge gained by experience. One participant was adamant in saying that the only way to master DT is by year-long experience. Thus, proper use of DT is ascribed to significant tacit knowledge (Reber, 1989) that is hard to transfer to another person by means of making it explicit, writing or verbalising it. This would provide additional explanations as to the origin of the ambiguousness which comes with the methodology, i.e. if ‘proper’ use of DT comes with long-term experience, than what a person considers *proper* DT is inevitably flavoured by the specific cases and application that this person has encountered prior.

### 5.2 A ‘Design Thinking’ mindset

A set of DT mindsets was promoted by the majority of participants. De Lille (2012) prominently describes the value of a designerly approach, from empathising, visualising, prototyping to other creative activities, as the core essence of design as a discipline/field of study. The right mindset lets designers see problems as opportunities to create new solutions, which is a different mindset from non-designers who tend to favour analysis and selection of ‘the best option’ out of a set (Boland and Collopy, 2004). This is not to say, non-designers cannot generate novel solutions, yet it stands to reason that their inherent skills will not be as developed in doing so. DT is then referring to the particular way designers deal with wicked problem, which is in the nature of design problems (Buchanan, 1992). Equally, cognitive capabilities that are considered the life-blood of design like analogising, (re)framing, abductive hypothesising, et cetera, are considered vital in the inherent mechanism of DT in its modern interpretation, but not explicitly discussed as part of the ‘toolbox’ by its advocates (Dorst, 2011). This provides explanations why almost all participants consider DT as not suitable for small-scale problems or incremental changes to existing solutions. Designers have the



biggest impact when working with problems that are wicked, vague and need considerable reformulation and exploration before they can be matched with a potential solution.

### 5.3 Help non-designers see a new world and foster innovation at the merging points

Ultimately, the expert interviews strongly support extant literature in highlighting the varied, disjointed nature of how DT is interpreted, which might make it even more ambiguous for its practitioners. Interestingly, there is a lot of agreement though as to success factors and pitfalls. Most striking is the unanimous perception that seeing DT as some kind of plug-and-play solution to solving any given problems and the related hype around it as a key issue. DT runs the danger of becoming obsolete when it is advertised and perceived to be able to do much more than it can deliver and then inevitably leads to significant disappointment with the people applying it. Eventually, this must reflect badly on design as a wider discipline, if – mainly commercial – advocates of DT advertise it as the core of design, and design also as being “too important to be left to designers” (Brown, 2009, p.37).

Participants also agree that it is imperative to have designers train others thoroughly in how to apply DT for it to provide significant benefit. This aligns clearly with the concept of mindset and skill inherent to design as incorporating DT as an approach. DT is not so much about methods and tool, these are only instances of much deeper, but often tacit, skills and knowledge.

This research originally set out to find a consensus in what DT is and its applications. It seems plausible that DT is both applicable as a toolbox and a mindset approach. Participants agree that its main benefit is for people who are non-designers to start thinking explicitly about the user in solving adequate problems and to generate creative solutions for them. This can generate very quick ‘wins’ as novel insights spark for entirely new ideas for non-designers. Ultimately, it is a push into a creativity mindset and perspective. Methods/tools like personas and user stories, or skills like visualisation and prototyping or methodologies like co-creation are seen as practical ways to instil designerly ways of working and thinking. On the verge of deep technical, business, scientific or other knowledge directed towards a novel perception and facilitated by designerly cues and approaches, novel ideas and combinations of disciplinary knowledge can manifest (Bason, 2010). As such, DT is a pertinent means to inspire and to facilitate transdisciplinarity leading to novel solutions at disciplinary intersections. To achieve this, and prevent DT from becoming meaningless, it is and remains vital for trained designers to be involved, to lead non-designers, know when to do what and add particular expertise to use.

### 5.4 Limitations and future research

A limitation to this research is the low number of participants, which prevents generalisability. Yet, it has to be highlighted that the interviewees can be considered true experts in their fields. The acquired data was extremely rich and in many ways and helps in building a deeper understanding of what are issues and strengths of DT. A second limitation is a potential experimenter bias, i.e. an unintentional influence on the answers given by the researcher conducting the interviews. Given the multi-faceted nature of the responses, and the missing consensus on DT that the researcher originally set out to find, such an influence can be considered minor, if present. The results of this study show a broad diversity within a small sample of researchers on what DT is, but, at the same time, reveal a strong consensus on what its strengths and pitfalls are. These will be focus of future research. By using a combination of qualitative and quantitative research methods, it becomes more feasible to research practices and perception on DT from a larger group of people.

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