Chapter 11
Design Thinking as a Problem Solving Tool

Rouxelle de Villiers

Abstract   In chapter 10 we covered thirteen ideation tools. We dedicate this chapter to Design Thinking (DT), as a procedure to generate and test ideas, and even more importantly as a creative problem-solving methodology. DT is a human-centred process that will help designers, innovators, entrepreneurs and business executives to systematically solve complex problems, not only in product design and businesses processes, systems and other sticky organizational problems, but also in our communities and our everyday lives. Some leading global brands, such as Apple™, Google™ and Samsung™ have adopted the DT approach to complex problem-solving.

   As DT is a shift in our way of thinking and a collection of hands-on methods and tools, we devote this chapter to this highly useful, well-honed 5-stage process. The chapter first covers the history of and thinking modalities involved in DT, then examines how various design thinking schools and leading universities (e.g., Stanford, Harvard and MIT) apply the DT principles using models with three to eight stages. Finally this chapter covers the 5-stage DT iterative process we propose for business executives – those who lead multi-disciplinary teams of innovators, ideators, intrapreneurs and others in business problem-solving roles.

Keywords Design thinking · Empathize · Human-centred approach · Prototype · Story-telling

Learning Objectives
On completion of this chapter, the readers will be able to:

- Understand the iterative nature of DT as well as its hands-on methods of thinking and doing.
- Apply a range of the thinking strategies and tools encompassed by the DT process.

R. de Villiers (✉)
Auckland University of Technology, Auckland, New Zealand
e-mail: rdevill@aut.ac.nz

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- Consciously break old habits of thinking and use a set of tools to find novel and appropriate alternatives to problems or design challenges.
- Differentiate between convergent and divergent thinking tools to aid intentional innovation processes within organizations.

11.1 Background

The concept and practices of design thinking [1, 2] (DT) are closely linked to the analysis of design thinkers' (DTers) processes, as described by Herbert Simon [3] and Donald Schön [4]. Donald Schön's book *The Reflective Practitioner* [4] is seen as the main catalyst for DT's adoption by various consultancies and agencies. The many articles and books written by principals from these design consultancies (e.g., IDEO) led to further popularization and expansion of DT in the management domain [5–7], and resulted in popularization to its "fad" status of today. In today's management toolkit, DT is offered as alternative to linear, analytical, and quantitative approaches to solving business and innovation problems [8].

Traditionally, design and the way designers think was linked to physical objects (e.g. [1, 2]). More recently, according to Prof David Keller of Stanford Business school, DT is being viewed a strategic weapon to solve really difficult problems in innovation. DT provides design thinkers (DTers) a set of thinking tools, and a 5-stage process to help divergent thinkers to consider content, capabilities, context and social needs to refine problems; consider a range of possible solutions; prototype likely solutions; fail fast; reiterate the process and innovate for viable, practicable solutions. Tim Brown, CEO of IDEO™, reports that "designers have a unique way of looking at things, and we call it 'design thinking'… [which] can be used to tackle a whole range of creative and business problems…design new strategy, open new markets, build new products, new services to meet new needs, …new ways of doing business and new ways to apply technology." [9] Global brands, including Adobe™ Apple™, Bank of America™, General Electric™, Google™, Hewlett Packard™, McDonalds™, Philips ™, Red Cross™, and Samsung™, have adopted the design thinking approach, and design thinking is being taught at leading universities around the world, including Stanford design school, Harvard, and MIT.

What is design thinking, and why is it so popular and effective? A study by Lotta Hassi and Miko Laakso [10], based on a management discourse on DT, describes DT as consisting of three dimensions: mentality, thinking styles, and practices. We discuss these three dimensions in the next sections.

11.2 Mentality

A comprehensive study [11] of the mindsets of DTers found 40 characteristics described in the literature. Researchers Marco Paparo, Cleo Dosi and Matteo Vignoli [11] describe eight clusters that capture the mentality of design-thinkers (DTers):

experimental, explorative and learning oriented; open-mindedness; willingness to integrate diversity; action - and visualization-oriented; holistic and integrative thinking; tolerant of ambiguity; risk embracing; and consciously creative. Tim Brown of IDEO™ views curiosity and finding fulfilment (even joy) in solving problems, as essential traits in creative leaders and effective innovators. Brown [6] and various other DT authors [12–14] underscore innovators' willingness to tolerate ambiguity, work within fluid and fast-changing contexts and processes, and generally accept failure en route to new solutions. All eight clusters [11] and the full set of 40 characteristics (p.371) extracted from prior literature are set out in Table 11.1 below. We add a ninth cluster from the work of Haasi and Laakso [10], namely visionary/future-oriented. A short definition of each mentality appears next to the title of each cluster, then a short extract from the prior literature, relevant to each cluster, and a short list of relevant studies is presented in the last column.

11.3   Thinking Styles

This dimension relates to issues such as cognitive styles, methods of thinking, and ways of processing information. Various proponents of DT stress the human-centred approach, thinking by doing, visualizing, and the combination of divergent and convergent approaches. Authors are consistent in emphasizing empathy towards current and future users (customers and other stakeholders) [5, 8, 14, 16, 37, 39, 40]. Innovation and management authors even label DT as synonymous with "customer-, user- or human-centred design" [41], with Porcini [42] labelling this customer-centredness as "being in love" [42]. The use of observational and ethnographic methods [5, 8, 32, 39, 43] is seen as a key means to achieve a deep and emphatic understanding of the customer. Beyond empathizing and understanding, collaborative design with customers [5, 12] is suggested as a viable approach. Proponents of DT see knowledge creation as an iterative, systematic process [44] where reflection-in-action [30] aids information gathering and knowledge advancement. The development cycles are systematic and rapid [8, 10, 14, 43].

DT practitioners use prototyping continuously [14, 20, 24, 36], starting "from day one" [5]. DTers explore what could be [20] by thinking: "What if… something completely new, could be, that would be lovely if it existed but doesn't now?" [39]. According to Lotta Hassi and Miko Laakso ([10], p. 7) "[p]rototypes are seen to facilitate thinking and knowledge creation by means of idea formulation and demonstration [40], to make concepts concrete [44], and to help the exploration of numerous possible solutions [20, 24]. In essence, prototypes can be seen as a tool for stimulating thinking and exploring ideas, not merely as representations of the products" [12]. Also, the prototyping stages are action-orientated. An action orientation or 'bias toward action' means "choosing action-oriented behavior over discussion and conceptual or analytical behavior. It is a preference to get out into the real world and engage users, do prototyping and test ideas as a manner of getting a team unstuck or inspire new thinking." ([11], p. 372). Further, Tim Brown, CEO

Table 11.1 Design thinking mindset characteristics

DT mindset characteristics			
Cluster	Definition	Characteristics	Literature
Experimental, explorative and learning oriented	An experimentation mindset is defined as "a bias towards testing and trying things out in an iterative way, and moving between divergent and convergent ways of thinking." ([15], p.47).	Learning oriented; unconstrained thinking; experimental intelligence; inquisitive and open to new perspectives; intellectual curiosity; playful and humorous; critical questioning - "beginner's mind"	[15–18]
Open-mindedness and diversity	"Open-mindedness entails being open to new ideas, new people and new ways of doing things, including … have a clear mission to create economic and human value for stakeholders" ([29], p.71). "Having an open mind means also to make errors and accept comments/ opinions on our own work. Only in this way it is possible reach high results" [19].	Open to diversity; willing to integrate diversity; embracing diversity; open to differences of personality and background; democratic spirit; open-mindedness; non-judgemental	20–22, 29]
Ambiguity, tolerance and risk embracing	Ambiguity is "the timely absence of information needed to understand a situation or identify its possible future states. Ambiguity is therefore a lack of information beyond risk or uncertainty which requires an awareness of all possible outcomes." ([23]: p.977).	Tolerance of ambiguity; open to the unexpected; embracing risk; comfortable with complexity and ambiguity	[15, 24, 25]
Empathy and user-centeredness	"The ability to 'put yourself in someone else's shoes' is essential if you want to understand the desires, hopes and problem of the users" ([11]: p. 372). "In designing something, we create value with people and for other people" ([29]: p.72). Empathy is the tool able to recreate abstractly a given situation and how individuals perceive it. [26]	User-centredness; empathy; human-centredness; social; co-develop value with user	[26–28]

Table 11.1 (continued)

DT mindset characteristics			
Cluster	Definition	Characteristics	Literature
Action-oriented visualization-driven	An action bias means "choosing action-oriented behaviour over discussion and conceptual or analytical behaviour. It is a preference to get out into the real world and engage users, do prototyping and test ideas as a manner of getting a team unstuck or inspire new thinking." ([18]: p. 10)	Biased toward action; thinking through doing; prototyping visualization-oriented; desire to make a difference; optimistic and energetic	[15, 18, 28–31]
Radical collaboration	DT is fundamentally a social process and "only works in teams. Collaboration is essential for innovative outcomes" ([26]: p.7).	Eager to share; collaboratively geared; team collaboration; knowledge sharing; team working; active communication; visualization for collaboration	[16, 25, 31]
Holistic & Integrative thinking; problem framing	DTers see and understand the connections, the interactions and the dynamics of complex context. A holistic approach enables the capacity to simultaneously manage user's needs, problem's context, social and cultural aspects in which the solution will be used [12, 25] as cited in [11], p. 373). Identifying, framing, and reframing the problem to be solved are seen as equally important as solving the problem or finding an appropriate solution [12], looking beyond the immediate boundaries of the problem to ensure the right question is being addressed [36].	Mindful of process; holistic view; integrative thinking; problem exploration; problem framing	[12, 15, 17, 18, 31, 32]
Consciously creative	"Creativity" describes the individual's ability to develop ideas or products judged by others as new and adequate [33]. Creative people have to be unafraid to take the first step and unafraid of losing control of the process [34].	Conscious divergent thinking, connecting diverse domain and disciplines; consciously using thinking tools	[15, 18, 33, 34, 35]

(continued)

Table 11.1 (continued)

DT mindset characteristics			
Cluster	Definition	Characteristics	Literature
Visionary; future-oriented	Oriented towards what can be; what is possible, rather than what is. Vision versus status quo and intuition and foresight as driving forces; anticipate and visualize new scenarios. This future orientation is long-term, and the forces guiding the vision-driven process include intuition ([38, 42], and hypotheses about the future [38]).	Visionary; solution-oriented; positive, projective; intuitive	[36–38, 40]

of IDEO™, sees visualization as DT practitioners' main sensemaking device, using various ideation and communication tools to visualize ideas and concepts [8, 36, 43]. Symbols, models, mock-ups, and tech-based interfaces provide ways to express intangible concepts, models and ideas to aid common understanding [45], and allow for active engagement with shared ideas, revealing inter-dependencies, interactions and relationships that are not achievable with purely verbal presentations [44].

Additional practices of DTers that are valuable in working with diverse solutions and finding numerous alternatives are collaboration, team brainstorming and idea elaboration. Involving a wide range of stakeholders is seen as a key approach to refining the problem; finding a wide range of diverse (possible) solutions, and considering multiple domains and multiple stakeholders. Interdisciplinary teams are most typically employed throughout the design process, and teams may vary over the different stages of the DT process [5, 6, 8, 14, 16, 36, 41]. This concept links closely to the view of holistic thinking. Here DTers pursue 360-degree understanding of all issues [14], including the fact that the end-users' context, social and environmental factors are inherently linked to both the problem(s) and the solution(s).

A key challenge for a design team is to ensure that the problem is clearly defined and the working DT team has a common understanding of the context, capabilities, people and likely hurdles involved in the ideal solution. According to Nicholas Dew, DTers rely on their ability to think up new ways of looking at the problem [13]. This ability, referred to as "reflective reframing" of the problem or situation, includes questioning the way the problem is represented right from the outset [12].

Lastly, but at least of equal importance, are the dual issues of abductive and integrative thinking. Integrative thinking is seen as the cognitive ability to hold to opposing ideas in harmonious balance and to consider competing constraints, plaiting them into a solution that brings creative resolution to a third alternative model – containing elements of each idea or constraint, but superior to both [5, 20, 38]. This integration also refers to the ability to consider and create balance between the technical, business, and human dimensions [5, 14, 16]. DT pursues balancing (i) human-centredness with company-centricity throughout the cycle [44], (ii) exploitation with exploration, and (iii) analytical thinking with intuitive thinking [42, 44]. Abductive thinking goes beyond what is known (facts, theories, models,

design elements, products, machines, technology) to the exploration of what could be [20, 46]. Abductive thinking[1] challenges the known, the norms and current thinking, driven forward by the urge to create something new and find new opportunities [20, 38, 40, 47]. Tim Brown sees DTers understanding that there is no single answer to a problem, as a fundamental aspect of DT.

11.4 Practices

The "practices dimension" encompasses elements that are closely related to concrete activities, tangible approaches, ways of working, and using particular tools and processes of collaboration and integrative communication. Some of the elements included in the practices dimension include: human-centred approaches to problems; thinking whilst doing; synergy through collaborative work styles within multi-disciplinary teams; visualizing; tangibilizing (prototyping) solutions; and a strong emphasis on a combination of divergent and convergent approaches to generate multiple solutions to prototype, test and refine. DT practitioners emphasize DT thinking as inherently human-centred in approach, by "putting people first" [5, 42, 45], with 'people' being all stakeholders, and specifically the people with the problem that needs a solution. A key feature of the practices and processes in DT is the exploration of numerous problem statements and numerous possible solutions [20, 24]. Lotta Hassi and Miko Laakso [10] underscore the iterative and highly tangible approach favoured by DTers. The iterative development cycles of DT are characterized as rapid, systematic and continuous [8, 14, 36, 43, 44], with regular prototyping, testing and re-designing. This iterative process and visualization through prototypes facilitates idea formulation, aids in knowledge sharing, and facilitates discussion [37] by creating a means of demonstration [40], and helping to tangibilize[2] concepts [41, 44].

11.5 DT Process

Tim Brown, CEO of IDEO™, argues that DT in its most basic form is fundamentally "an exploratory process" that follows a non-linear, iterative design process with three basic phases: inspiration, ideation and implementation, to convert problems into opportunities ([6, 48], p. 17). The Stanford design school (commonly known as the Stanford d.school, established in the early 2000s by David Kelly) depicts the DT process in five stages: empathize, define, ideate, prototype and test (see Fig. 11.1) (https://dschool.stanford.edu). Some of the tools that are useful to

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[1]Abductive reasoning is a form of logical inference formulated from inconclusive or incomplete information, relying on inference or intuition, and is directly aided and assisted by personal experience.

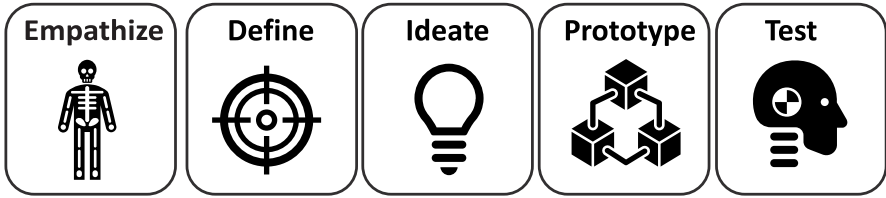[2]Tangibilize – make it tangible or concrete; an equivalent term is 'concretize'.

Fig. 11.1 The five stages of the DT procedures

Table 11.2 Models of design-thinking process in practice

Stage	IDEO	Continuum	Stanford Design School	Rotman Business School	Darden Business School
Stage I – Data gathering about user needs	Discovery and interpretation	Discover deep insights	Empathize and define	Empathy	What is?
Stage II - idea generation	Ideation	Create	Ideation	Ideation	What if?
Stage III - Testing	Experimentation and evolution	Make it real: prototype, test, and deploy	Prototype and test	Prototyping and experimentation	What wows? What works?

Adapted from Liedtka [28], p. 928)
IDEO.com. 2014. Available at http://designthinkingforeducators.com/.Continuum.com. 2014. Available at http://continuuminnovation.com/whatwedo/. Stanford Design School. 2014. Available at http://dschool.stanford.edu/use-our-methods/; University of Toronto Rotman School DesignWorks. 2014. Available at http://www.rotman.utoronto.ca/FacultyAndResearch/EducationCentres/DesignWorks/About.aspx; University of Virginia's Darden Business School Design at Darden. 2014. Available at http://batten.squarespace.com/

activate the team during each of the stages appear in the table next to each stage (see Table 11.2). It is important to note that the phases are not linear, but iterative (you can come back to an earlier or go to a later phase at any time). According to Tim Brown [6], the phases may be entered and left at random intervals and are best perceived as a system of overlapping spaces rather than as sequential, orderly steps.

There are many variants of the DT process in use today and being taught by various business schools. They vary from three to eight modes of thinking, or stages. However, all variants embody the same principles originally described by Nobel Prize laureate Herbert Simon in *The Sciences of the Artificial* in 1979. The various DT processes are summarized in Table 11.1, adapted from a study by Jeanne Liedtka [28].

In the next few paragraphs, we discuss each of five phases, provide some examples to aid in application, and present some ideas on how to implement DT to its full potential as a trans-disciplinary, collaborative complex-problem-solving process.

DT tackles complex problems in five iterative stages:

Empathizing: Understanding the human needs involved.
Defining: Re-framing and defining the problem in human-centric ways.
Ideating: Creating many ideas in ideation sessions.
Prototyping: Adopting a hands-on approach in prototyping.
Testing: Developing a prototype/solution to the problem.

Phase I: Empathy

> Empathy is at the heart of design. Without the understanding of what others see, feel, and experience, design is a pointless task. —Tim Brown, CEO of the innovation and design firm, IDEO.

Design thinkers (DTers) need to understand the context within which the problem they need to solve exists. One of the main distinguishing features of DT is its human-centredness. This means that an important aspect in the DT process is pursuing and building a deep understanding of the needs and desires of all the stakeholders; in particular the end users of the proposed solutions. DTers take deliberate and conscious action to understand the feelings, values, norms, pressures, and experiences of the end users and other key stakeholders. Tim Brown ([49], p.1) describes various actions including interviews, shadowing customers and users on their experience journey, seeking experience to understand the problem (e.g. using the product yourself) and non-judgemental engagement in an "effort to see the world through the eyes of others, understand the world through their experiences, and feel the world through their emotions." Some of the tools used to gain higher levels of understanding of the entire problem and how it affects users include reading customer complaints, and engaging in interviews, observations and immersive experiences. Immersive experiences are aimed at developing empathy by physically and psychologically experiencing the context of users; e.g., mystery shopping and shadowing. Shadowing is a user-observation experience, where DTers follow users for a day to experience every moment through their lens, get to understand their moments of joy and frustration and how the problem affects their service/product/problem experiences. For some projects, interviewing or observing experts may be useful in problem framing or solution finding. For example, to understand why certain customers are frustrated with flight onboarding processes, it might be useful to research how both the frequent flyer and the first-time traveller go through the booking-in process. Designers are likely to notice both the good and the bad, and consider ideas to reduce the bad and increase the good components of the experience. Dave Gray [50], the founder of XPLANE (goo.gl/EKnM3U), a consultancy company, developed The Empathy Map as a business tool to help organizations to understand their customers' experiences and expectations. A copy of the empathy map is displayed in Fig. 11.2. On completing an empathy investigation, DTers use the insights gained to refine the original problem statement to guide further phases in solving the problem(s).
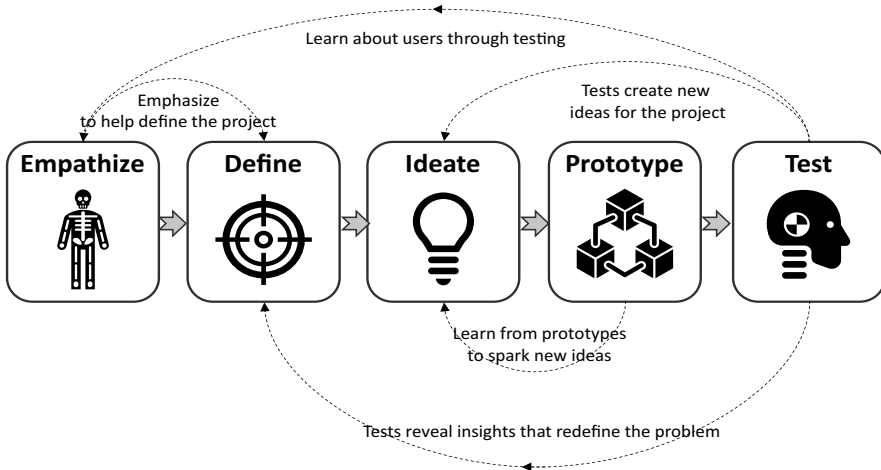
Fig. 11.2 Design thinking (DT): a non-linear, iterative process

Phase II: Define

The Define Phase, according to the Interaction Design Foundation (as cited in Lee, [51], p. 94), involves "creatively piecing the puzzle together to form whole ideas, organizing, interpreting, and making sense of the data we have gathered to create a problem statement". Once DTers have collected the various perspectives, studied and interpreted the needs of the users, and analysed the brief or initial problem thoroughly, five outputs can be developed and visually captured, among them a mutually acceptable problem statement. The problem statement defines a common purpose and a challenge to the DT team to find a desirable solution. David Lee [51] suggests a further two methods to synthesize teams' learning: Story-share and Capture, and Structuring Insights. The Design Academy (Amsterdam) suggest developing three to five key personas that are likely to be key role players in using and adopting the problem solution. We discuss each one of these tools briefly below. (Please note that these are not sequential stages, but tools that can be used throughout the DT process. They are listed here to help you gain a firm grasp on the problem and beneficiaries' needs, desires and motivational drivers.)

II.i   Story-Share and Capture

The story-share tool developed by the d.school (Kelly and Brown at IDEO™), helps the participating team members to unpack the insights gained from their interviews, observations and primary research. Team members write concepts or important realizations on sticky notes (ONLY ONE per note). Each sticky note comprises a short title describing an observed activity, action, behaviour and response by the observed stakeholders. Many sticky notes are placed on accessible, visible boards and participating teams create clusters of themes or patterns emerging from the stories. Prominent ideas or recurring themes are discussed to share and synthesize valuable insights. The main benefits are that the entire team compares and contrasts

findings, so that these discussions help to generate new insights and act as catalysts for new solutions.

II.ii   Structuring Insights

Once the findings and realizations are visually clustered and displayed, participating DTers turn the findings into insights. The insights, as defined by Matt Cooper-Wright at IDEO™, are realizations that help the team to better respond to the problem or design challenge. Insights normally include the finding and the cause of the finding (the symptom and the causes). An example provided by David Lee ([51], p. 96) states a finding as: F1: Businesses are doing well and remain in this area for years. I1: Business are doing well and remain in the area, because of easy access via bus routes and the highway (cause of behaviour). Cooper-Wright, design lead at IDEO (as cited in Lee, [51], p.97) suggests asking germane questions to determine the quality of the insights: "Do the insights inspire the DT team to start designing for problem solution? Do you have a story that can explain your insight and response? Does the insight have the potential to affect the design? Is the insight relevant to the contact of the design challenge?"

II.iii   Problem Statement

A clear, well-defined problem statement helps the DT team to work towards a common solution. Defining the problem well is essential to solving the problem effectively and appropriately. Einstein believed that the quality of the solution is directly proportional to the ability to identify the right problem to solve. Einstein is quoted [52] to have said: "If I had an hour to solve a problem I'd spend 55 minutes thinking about the problem and five minutes thinking about solutions." Although most sticky and complex problems will demand more than 5 min of thinking about solutions, the principle of the matter is clearly illustrated by the quote: make sure the problem is the "right one" before embarking on a solution-finding mission. The first (and possibly most essential) part of the problem definition is identifying the user(s). (see the Persona section for more detail). The problem statement takes the original brief or identified concern/issue and turns it into fairly loosely defined problems.

II.iv   How Might We (HMW)

Authors Lee ([51], p. 97) and Andersen ([52], p 1.) suggest that a problem statement can be redefined as a "How might we…". This particular wording helps to unite the team in their collaborative effort to solve a common problem and ignites the ideation and prototyping phases. The Design School at Stanford suggest that HMW questions "turn perspective into actionable provocations" (https://dschool.stanford.edu/resources/how-might-we-questions). When the insight is that "Licking someone's ice cream cone is more tender than a hug", some of the suggested HMW questions (based on earlier user observations/identified needs) are: (I) HMW make an "I'm sorry" ice cream cone experience? Or (II) HMW design an ice cream cone that says goodbye? Or an HMW question that challenges assumptions, for example: (III) HMW share an ice cream without a cone or cup? The HMW question needs to be broad enough to inspire and be the catalyst for a wide range of solutions, but narrow enough to provide some helpful boundaries for the team.

If everyone is thinking alike, then somebody isn't thinking. —George S. Patton

II.v   Persona

According to the Interaction Design Foundation [53] (https://www.interaction-design.org/literature/article/5-stages-in-the-design-thinking-process),   "Personas are fictional characters, which you create based upon your research in order to represent the different user types that might use your service, product, site, or brand in a similar way. Creating personas will help you to understand your users' needs, experiences, behaviours and goals. Creating personas can help you step out of yourself. It can help you to recognize that different people have different needs and expectations, and it can also help you to identify with the user you're designing for. Personas make the design task at hand less complex, they guide your ideation processes, and they can help you to achieve the goal of creating a good user experience for your target user group." Personas provide meaningful archetypes, which you can use to assess your design development against. Constructing personas will help you ask the right questions and answer those questions in line with the users you are designing for. For example, "How would Peter, Joe, and Jessica experience, react, and behave in relation to feature X or change Y within the given context?" and "What do Peter, Joe, and Jessica think, feel, do and say?" and "What are their underlying needs we are trying to fulfil?"

Persona [54] data sheets also provide insight into the way different users make decisions about the design challenge (problem/issue), which pain points they face that are relevant to the problem/issue, and what phases of the service journey are most relevant to the problem, and therefore also the solution. Various templates are available from a diverse range of providers. (Search for them using Google Images). In their article, *Personas– A Simple Introduction* Rikke Friis Dam and Teo Yu Siang [54] explain that the process of creating personas helps creative genii to understand user needs, behaviours, experiences and goals.

The purpose of working with personas is to be able to develop solutions, products and services based upon the needs and goals of your users. So, be sure to collect real data and describe personas in such a way as to express enough understanding and empathy to understand the users [53] (See Chapter 12 on storyboards and online sources [55]).

Phase III: Ideate

Once designers have analysed the observations of the Empathy and Define stages of the DT process, and produced a human-centred problem statement, the team can start identifying possible solutions and concentrating their efforts on idea generation. There are many ideation, divergent and lateral thinking techniques [56–60], such as analogical thinking, brainstorming, Braindumping, BrainWriting, BrainSketching, metaphorical thinking, ideation heuristics such as Random Word Technique (RWT), SCAMPER, Worst Possible Ideas [56], CUPPCO and many more (see tools in Chapters 3, 4, 7 and 10). These enable the DT process to generate as large a range of alternative problem solutions as possible, right from the beginning of the Ideation phase. Towards the end of the process, prototyping and other

techniques should be used to investigate the suitability and efficacy of the ideas and to find ways to circumvent barriers to execution and application. On a cognitive level, ideation means going wide and deep "…in terms of concepts and outcomes. Ideation provides both the fuel and also the source material for building prototypes and getting innovative solutions into the hands of your users." [61]

IV. Prototype (Also phase V of the DT process)

> By taking the time to prototype our ideas, we avoid costly mistakes such as becoming too complex too early and sticking with a weak idea for too long. Tim Brown, CEO of IDEO [61]

Many of the proponents of DT recommend some form of prototyping as an effective way to gain insights into a problem/solution and test the practicability of a solution. "This method involves producing an early, inexpensive, and scaled down version of the product in order to reveal any problems with the current design" [61]. Because consumers and users may find it hard to visualize a new solution, a prototype might help DTers to investigate how a sample of users think and feel about the suggested solution. Prototyping can be used during any stage of the DT process, but is often part of the Define Phase, shared with the DT team itself in order to be examined, improved, accepted or rejected (ACT = accepted, changed, trashed), mostly based on a sample of users' experiences. Providing the prototype for testing and further discussion provides the team with additional insights about how real users might behave (think/feel/respond) when interacting with the proposed solution.

Phase V: Test

> If the user is having a problem, it's our problem. (Steve Jobs, founder of Apple Computers)

After identifying suitable solutions during the prototyping phase (IV above), DTers or assigned adjudicators and evaluators rigorously test the Pareto prototype. The Pareto prototype is a label for prototyping products or inventions that are 80% ready, but all problems or concerns are clearly not yet 100% ironed out). As mentioned earlier, the DT process is iterative and results generated during this test phase are likely to be used to redefine the problem, improve understanding of the way stakeholders perceive and use the new solution, or improve designers' empathy towards the context, in terms of how users think or feel and how they behave, once the solution is available to them. The main desired outcome for this phase is to arrive at an even deeper understanding of the product (designed output) and to rule out possible future problems with the suggested solution(s). Feedback from users and other stakeholders is obviously of great importance to ensure that any unforeseen factors and limitations are cleared up, before launching into production or implementation of the suggested solution. Ditte Mortensen [62] suggests DTers need to use qualitative and quantitative consumer research to test the relevance, desirability, and return on investment (ROI) of proposed designs. Quantitative user research, such as surveys, scenario experiments, laboratory and field experiments, is used in pursuit of statistics, and to measure user behaviour and actions. Usability tests and interviews with future users are examples of qualitative research tools to investigate attitudes, intent, motivation and other emotional aspects. These exploratory user studies seek deep insight into and understanding of future users – both individuals and user groups (Fig. 11.3).
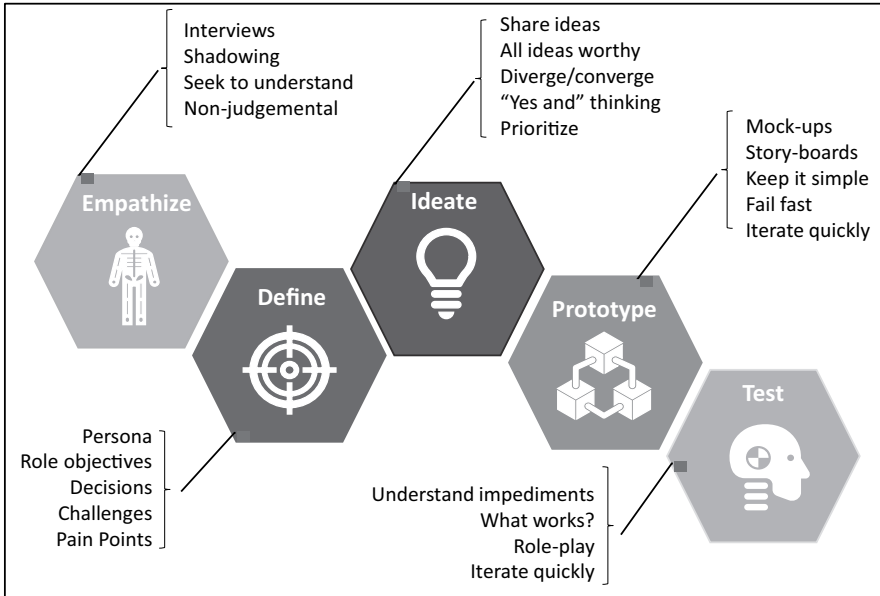
Interviews
Shadowing
Seek to understand
Non-judgemental

Share ideas
All ideas worthy
Diverge/converge
"Yes and" thinking
Prioritize

Mock-ups
Story-boards
Keep it simple
Fail fast
Iterate quickly

Empathize

Ideate

Define

Prototype

Test

Persona
Role objectives
Decisions
Challenges
Pain Points

Understand impediments
What works?
Role-play
Iterate quickly

Fig. 11.3 Overview of the Standford d.school DT Process. (Adapted from https://dschool. Stanford.edu) [63]

It is clear that the five stages (illustrated in Fig. 11.4), use a variety of thinking (cognitive) and behaviour (conative) tools to uncover needs, reduce cognitive biases and generate a diverse range of solutions. DT uses a wide range of human resources in the form of collaborators [64] to define and refine problems and conduct human-centred need analysis focused on users; opportunity scouts and creative genii to idea proposed solutions; engineers, manufacturers, product developers and researchers to prototype the viable alternatives; experimenters or research testers to fine-tune and produce alternatives; and finally implementation teams to project-manage the adoption of the solution. An in-depth study by Jeanne Liedtka [65] considers DT as an end-to-end system for problem solving, delivering a bundle of tools, attitudes and approaches to novice and expert multi-disciplinary teams, which combines risk-reducing analytical and creative reasoning to produce solutions. Liedtka [65] considers the managerial roots of DT as it is practiced in highly innovative organizations (HIOs) and finds that many theories are echoed elsewhere in management theory and practice (see Table 11.3).
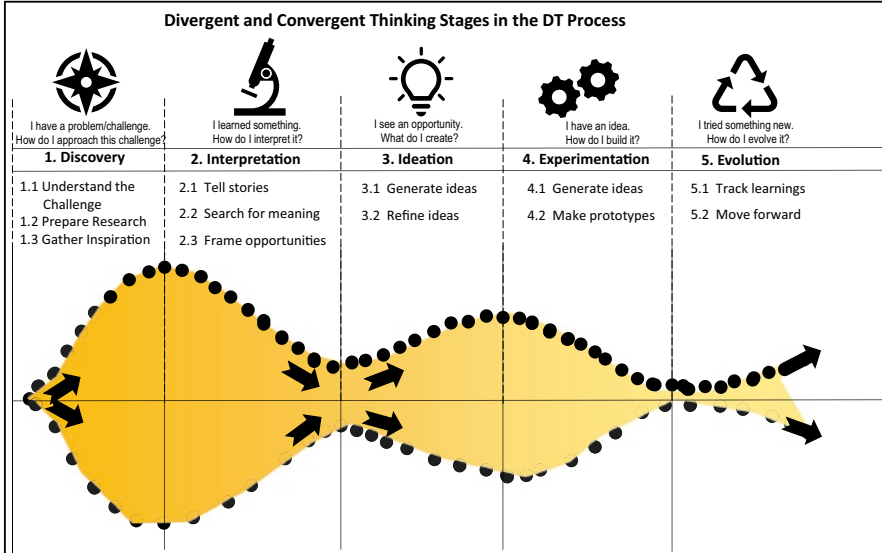
Fig. 11.4 Five stages in the DT Process, illustrating convergent and divergent processes (IDEO™)

Table 11.3 Common design-thinking tools

	Common design thinking tools
1	Visualization involves the use of imagery, either visual or narrative. In addition to traditional charts and graphs, it can take the form of storytelling and the use of metaphor and analogies, or capturing individual ideas on post-it notes and whiteboards so they can be shared and developed jointly.
2	Ethnography encompasses a variety of qualitative research methods that focus on developing a deep understanding of users by observing and interacting with them in their native habitat. Techniques here would include participant observation, interviewing, journey mapping, and job-to-be-done analysis.
3	Structured collaborative sense-making techniques like mind mapping facilitate team-based processes for drawing insights from ethnographic data and create a "common mind" across team members. Collaborative ideation like using brainstorming and concept development techniques, assists in generating hypotheses about potential opportunities. These tools leverage difference by encouraging a set of behaviours around withholding judgement, avoiding debates, and paying particular attention to the tensions difference creates in the process of seeking higher-order thinking and creating more innovative solutions.
4	Assumption surfacing focuses on identifying assumptions around value creation, execution, scalability, and defensibility that underlie the attractiveness of a new idea.
5	Prototyping techniques facilitate making abstract ideas tangible. These include approaches such as storyboarding, user scenarios, metaphor, experience journeys, and business concept illustrations. Prototypes aim to enhance the accuracy of feedback conversations by providing a mechanism to allow decision-makers to create more vivid manifestations of the future.
6	Co-creation incorporates techniques that engage users in generating, developing, and testing new ideas.
7	Field experiments are designed to test the key underlying and value-generating assumptions of a hypothesis in the field. Conducting these experiments involves field testing the identified assumptions using prototypes with external stakeholders, with attention to disconfirming data.

Adapted from Liedtka [28], p. 928

11.6   Conclusion

A well-established body of knowledge confirms the value and usefulness of DT as a methodology and set of tools for HIOs and managers in pursuit of creative solutions to a wide range of problems. Key benefits of this well-tested, human-centred problem-solving approach are that it decreases human thinking errors and biases such as confirmation bias and loss aversion (and a host of thinking errors discussed in Chapter 7), and increases diverse thinking tools, and enhances iterative and reflective habits. DT applies high-fidelity practices from psychology, management, marketing and innovation.

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Activity I: Cognitive Biases

Explain how the DT process will overcome any four of the nine cognitive biases listed below. (Answers can be found in the paper by Jeanne Liedka ([28], p. 930-931) (Table 11.4)

Table 11.4 The relationship between DT and cognitive bias theory

| DT relationship with cognitive bias theory		
Cognitive bias	Description/definition and source	How does DT address or reduce this cognitive bias or thinking flaw?
Projection bias	Projecting the past into the future	
Egocentric empathy gap	Projecting own preferences onto others	
Hot/cold gap	Overemphasis on particular elements of the problem or solution	
Focusing illusion	The current state of affairs colours one's assessment of the future state	
Say/do gap	Inability to accurately describe one's own preferences	
Planning fallacy	Overconfidence and unfounded overoptimism about possibilities	
Hypothesis confirmation	Looking only for confirmation of the hypotheses (not contradictory evidence)	
Endowment effect	Decision-makers resist loss and attach more value to what they already have than to new avenues/ways of doing.	
Availability bias	Preference for what can be easily obtained, with regard to resources and solutions	
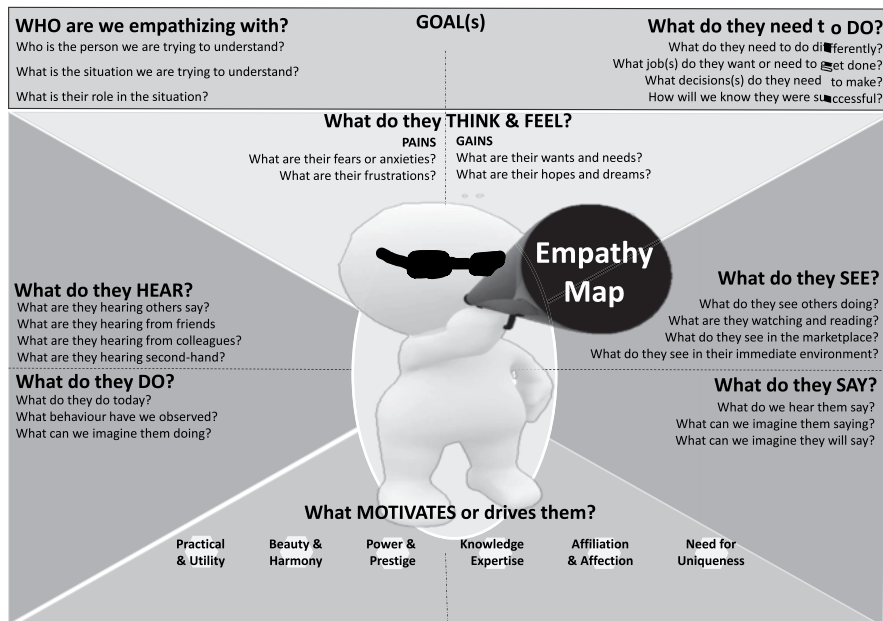
Fig. 11.5 Empathy map to facilitate persuasive idea sharing

Activity II: Empathy Map

Use the empathy map provided in Fig. 11.5 to consider a project or idea you need to "sell" to an antagonist. Try to "wear their/his/her shoes" for a day. Consider their pain points and the gains they might desire. Place yourself entirely in their shoes as you complete this map below. (You might like to copy a bigger version and consider a few rival positions or "enemies of the idea"). How does understanding their motivational drivers and their goals change the way you think about the way you might persuade them to buy into your idea?

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