Design Thinking and Design Doing: Describing a Process of People-Centred Innovation

Rama Gheerawo

Abstract This chapter outlines the benefits of Design Thinking as a creative framework for innovation that can be applied to projects and organisations across government, business and the public sector. It includes a short history of the Design Thinking approach to set context and define the concept. However, much of the ensuing discussion and evaluation of ideas and methods is based on recent publications, papers and journal articles to give a current view of academic and practitioner activities. At the heart of the approach is a people-centred focus, and the chapter discusses the role of Inclusive Design and design ethnography in underpinning Design Thinking. It outlines five principles: Involve People, Translate Design Thinking into Design Doing, Create Value and Capture Value, Follow the Arc of Design Thinking and Navigate Complexity. It aims to give an overarching view of Design Thinking, demonstrating the value that it can bring to diverse areas of research and application. Challenges and observations for progressing the approach are also noted.

Keywords Design thinking · Inclusive design · Empathy · Innovation People-centred

1 Design Thinking

Design Thinking (DT) has gained significance and importance in using the principles and practice of design to address issues, problems and challenges across a variety of sectors and situations—from healthcare to education, from urban to rural, from local to global. It has proven to be an effective method for harnessing the creative, innovative, and a people-centred approaches enshrined in the design process and applying them across organisations drawn from the private sector,

public sector, government and education. However, DT has had a wider impact and is not simply limited to these organisations, reaching beyond them to impact entrepreneurs, small and medium enterprises as well as social institutions. DT harnesses ideas that have been developed within the design disciplines but makes a unique contribution by presenting disparate concepts and notions in a way that is digestible and implementable to designers and non-designers alike. It has allowed the ideas and creative endeavours of design to be democratised, co-opted and applied to creatively solve critical problems and issues in an innovative, holistic and human-centred way.

The practice of DT predates its modern nomenclature, with some scholars arguing that its ideas and ideals resonate across the centuries and even reach back to the achievements of ancient civilisations. Human history is thought to be full of design thinkers, long before the term was defined and popularised. Leonardo Da Vinci, Isambard Kingdom Brunel and Richard Buckminster Fuller all used or created processes that resonate with a DT approach that modern practitioners would recognise, from a desire to better the human condition using a cross-disciplinary approach, to taking advantage of technological advances to invent and innovate in a way that tackles complex or challenging situations.

Numerous definitions of DT currently exist, with many new ideas being researched, discovered and articulated as the value has spread. However, a widely-accepted positioning was articulated by Tim Brown, Chief Executive Officer of IDEO, a global design and innovation company. Published in Harvard Business Review, this primarily denoted DT as a tool for business. The article described DT as a discipline that uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity [4]. It signified an aspiration to shift design from simply being viewed as an aesthetic endeavour to moving upstream in the innovation process and upstairs to the boardroom. Importantly, it put the value of a people-centred approach at the heart of the idea through consultation with users and consumers. The simple strapline of *Thinking like a designer can transform the way you develop products, services, processes—and even strategy*, represented a bold statement of intent, positioning the discipline of design within the 'cut and thrust' of the business environment.

There are several suggestions as to other modern origins of DT as a phrase or a concept, with Mootee [53] and Chae [9] suggesting Herbert Simon's 1969 book *The Sciences of the Artificial* as the initial point at which design was suggested as a way of thinking, highlighting the definition of design in this publication as 'the transformation of existing conditions into preferred ones'. The book proposes seven steps which still relate to current processes of DT as follows: Define, Research, Ideate, Prototype, Choose, Implement, and Learn. Szczepanska [66] talks about the Design Science movement that originated in the US in the 1960s where Buckminster Fuller created multidisciplinary design teams to address complex systemic challenges. He described this as "the effective application of the principles of science to the conscious design of our total environment in order to help make

the Earth's finite resources meet the needs of all humanity", a definition that parallels some of the aspirations within the field of DT today.

Peter Rowe's 1987 book titled *Design Thinking* is also notable, though its focus was on delineating a detailed account of the process of designing in architecture and urban planning rather than DT as it is known today. Kleinsmann et al. [42] cite another early use of the term from Bruce Archer in his 1979 article *Whatever became of Design Methodology*, stating that DT originated within the design research community. Archer helped found the Design Research Society in 1967 and established the Department of Design Research at London's Royal College of Art (RCA) where he tackled one of the urgent healthcare issues of the time—the standardisation of the hospital bed. He used the newly established principles of design research to effect widespread consultation, evidence gathering through direct observations, and extensive field trials using mock-ups and prototypes to create a successful design that was written into a British Standard and ultimately taken up by a commercial bed manufacturer [44]. Archer's philosophy shifted the focus of design from being an individual process that could be framed as ego-driven, to one that is more collaborative and observant, noting over 40 years ago that:

> You cannot ignore the nurturing of the material culture and still expect to enjoy its fruits. That is why I invented design research as a back-up to design practice. I don't think it is because I happen to be standing here instead of somewhere else that the world seems to be revolving around this point.

In today's context, DT has become a living, evolving idea that is being adopted by a range of individuals and organisations. It is also being defined and redefined and means different things to different people [39]. Importantly, at the centre of DT is the idea that everyone can access and activate the creative value of design. Cross [13] states that "everyone can—and does—design", noting that humans have had a long history of DT as evidenced by the artefacts and inventions of previous civilisations and the "continuing tradition of vernacular design and traditional craftwork".

Exact definitions of DT vary but there are some commonalities and convergences that emerging published literature and practitioners see developing within the theory and practice. As a starting point, Beverland et al. [2] describe the fol-lowing characteristics of a DT approach: 'abductive reasoning, iterative thinking, experimentation and human-centeredness', and these are often widely accepted as some distinct benefits of DT. Dorst [21] talks about DT as a 'real alternative to conventional problem-solving strategies', something which DT case studies attest to, whether drawn from industry, public sector or academia. The move to address systemic challenges through DT [47] or create organisational change by establishing a DT culture within an institution or company [6] are ideas that have gained visibility in the last decade.

The link between DT and innovation, whether described as an attitude, a process or a result, is also widely understood within the general understanding of the work. It has even been noted to *promise* innovation inspired by the way designers work [7], hinting that DT when used as a strategy, can actually guarantee results.

The people-centred aspect of DT is also prevalent, with the terms human-centred and user-centred used unilaterally within the field. Fraser [24] talks about 'deep human understanding' based on work at the Rotman School of Management. Curedale [14] notes that design has moved from being a marketing tool to answering human need. This people-centred aspect of DT is further discussed later on in this chapter.

In recent years, academic literature has focused on progressing the application of DT in different contexts and looking at the different aspects and influences. As DT becomes increasingly global, one area that would benefit from further investigation would be how different cultural influences affect DT practice and process. Small-scale pilot studies also indicate the need for further research in this space, with

Clemmensen et al. [11] noting that 'the core DT methods of induction, deduction …. are affected by the ongoing appearance and disappearance of cultural difference among design team members'. They viewed their study as a starting point for additional research in this area. This represents one of many areas of further study that will need to be conducted over the coming years including the important aspect of delineating and implementing tools for evaluation that capture the outcomes effects and performance of DT in a variety of contexts, sectors and situations. This will need to be done in a manner that is both qualitative and quantitative to ensure a true representation of DT value-adds as well as challenges. As Kimbell [41] simply notes, more research needs to be done into critical understanding and evaluation of DT.

1.1 Creating a Bridge Between Business and Design

DT has enabled design to enter the business sector with a sense of purpose and legitimacy. Design Councils across the globe urge businesses to work with design to ensure a heightened level of creativity and to ensure longevity through a better understanding of their customers and through value creation. Antonelli [1] goes even further, urging business people to become designers, not just aim to under-stand them better. Recent financial trauma across the globe has fuelled a need for alternative thinking, and a drive for business to think differently, and this is where DT, with its ability to create and co-create non-traditional and alternative outputs has gained traction.

DT can influence innovation management within a business context, replacing outdated ideas such as strategic planning powers strategic innovation. Applied DT is strategic innovation with management of the process being more about imagi-nation, creativity and mobilising as opposed to planning, reducing risk or control [53]. The limitations of current management and organising paradigms can be improved with the integrative practice of DT and the value-based approach that it affords [65]. Professional guidance on project management remains rooted in a mechanistic paradigm of control and cannot therefore address changes in envi-ronment or business needs [48]. They go on to delineate three areas that DT can help with in evolving management approaches: managing the explorative phase,

managing stakeholder involvement, and managing the project in relation to the strategizing process of the organisation. Together these make for an important addition to innovative outcomes that may be achieved by DT as they point to impact on process, management and strategy.

A definitive move that strengthens the relationship between DT and business is the development of DT methods, tools, teaching curricula and practice at business schools, a notable example being the d.school at Stanford University founded in 2005 and recognised as one thought leader in human-centred design, and a leading teaching institute for design and experiential learning [15]. Drawing on different design capabilities and a focus on addressing complexity rather than ignoring it, the d.school outlines eight 'core abilities' [16]:

1. Navigate Ambiguity
2. Learn from Others (People and Contexts)
3. Synthesize Information
4. Experiment Rapidly
5. Move Between Concrete and Abstract
6. Build and Craft Intentionally
7. Communicate Deliberately
8. Design your Design Work.

As large business organisations adopt DT methods and begin to train staff in the theory and application of these ideas, a number of books have appeared that describe and capture best practice. A popular publication is *Design Thinking Pocket Guide* by Curedale [14], a DT practitioner and professor who presents a brief introduction to DT and a collection of methods and tools used in the process, from insight generation, synthesis, ideation and prototyping. The book champions DT as the reason for intelligent business change, defining DT as "a human-centred approach which is driven by creative and analytical thinking, customer empathy and iterative learning".

Curedale suggests that DT is most applicable when you have a poorly defined problem, a lack of information and a changing context or environment, something many business organisations face. The book presents a selection of methods and tools collected over a number of years from a range of disciplines such as the social sciences, business, engineering and design. These are commonly used throughout the DT process, and are outlined as:

1. Define intent
2. Through ethnographic research develop empathy for the point of view of the user
3. Synthesise the research
4. Frame insights
5. Explore Concepts
6. Synthesize the concepts generated
7. Prototype the favoured ideas

8. Test the prototypes with users
9. Incorporate changes
10. Iterate prototype and testing till a workable design is reached
11. Implement
12. Deliver Offering.

An empirical interview study of six large organisations by Carlgren et al. [7] lead to five themes that characterise DT. These are: User focus, Problem framing, Visualisation, Experimentation and Diversity. *User focus* is about 'deep empathy building' as well as understanding and involving people in the generation and making of ideas. *Problem framing* looks at 'widening, challenging and reframing' a problem statement instead of simply trying to solve it, and avoiding the trap of narrowing down to a solution too quickly. *Visualisation* aims to use 'visual representations' to show ideas in either two or three dimensions to gain consensus and share ideas rather than simply being about prototyping and delivering a solution. *Experimentation* refers to iteratively developing and testing ideas in ways that are convergent and divergent, working on multiple solutions to maximise the creative value of process and outcome. *Diversity* was seen as a cross-cutting theme applicable to ensuring a range of opinions and perspectives as well as a diversity of team members. This type of detailed study is essential in establishing an evidence-base of the benefits and challenges of DT practice within business organisations and can lead to more empirical measures of the value that it can bring. Understanding this within a business context can lead to insights applicable to other areas and sectors where DT is being implemented, particularly the public sector.

1.2 Developing Focus Beyond Business

Although DT has been articulated primarily with a business focus, the ideology and application has developed to accommodate and impact a more social context. It has been described as an iterative and co-creative approach that can support innovation in both the economy but also importantly within society [17]. This effectively reflects the three aspects of sustainability namely, environmental, economic and social [61]. All three have to be considered in order to create truly sustainable solutions and DT can be instrumental in achieving social, as well as economic sustainability.

DT builds on a number of different movements and practices that take a socially-focused attitude to design. In Scandinavia, Co-operative Design emerged as a powerful antidote to 'top-down' problem-solving, by involving everyone in decisions and processes that the designer facilitated [22]. Participatory Design has also risen in popularity and prominence, involving people as authors, instigators and designers of their own solutions, and ideas [63]. Far from devolving or diminishing the role of the designer, this is being seen as a powerful tool for engaging non-designers within the design process in a way that parallels the

ambitions of DT. People-centered design encourages attention to, and consideration of the individual as a central part of any creative process and terms such as 'co-design' [64] and 'co-creation' are now actively being used across education, business and government. Professional designers have also co-opted these terms with most understanding that engagement with their end users can provide innovation benefits across the design process.

A recent publication of significance in the field, *Design Thinking for the Greater Good* [46], explores and emphasises how DT has moved from a business focus and into the social space. It outlines how DT is being used by organisations as diverse as charitable foundations, social innovation start-ups, national governments, and elementary schools to solve difficult social challenges. This builds on the inherent business focus that influenced DT at its inception and helps to evolve the ideas. DT is presented in this book as the perfect tool to tackle increasingly complex problems such as:

- Stakeholders who cannot even agree on the problem, much less the solution;
- Employees who are reluctant to change behaviours and take risks, who are often rewarded for compliance rather than performance;
- Decision makers who have too much data, but little of the kind they need;
- Leaders who are more likely to have short tenures and whose every move is scrutinised by funders, politicians, bureaucrats and the media; and
- Users of their services such as students, patients, customers, citizens—whose expectations are sometimes rising as fast as resources to meet them are declining.

The publication argues that DT can tackle these issues as it is a unique problem-solving approach; one that is human-centered, possibility driven, option focused, and iterative. It has developed as a new democratized form of innovation, moving away from designers as experts and external stakeholders, to participatory design with strategic partnerships. As with other DT definitions, they emphasise the importance of reframing the problem as a key evolution from traditional approaches to innovation. "*The definition of a problem is a hypothesis to be tested, as are its solutions…breakthroughs come with the redefinition of the problem itself*". DT moves away from the traditional 'one big solution' approach, towards multiple solutions quickly tested because numerous answers are both possible and desirable. Whilst the defi-nitions of DT provide a useful background, the novelty of the publication is in how DT can advance from the business world to be applied to the social sector, where issues can be more challenging, and solving them can matter even more.

The idea of 'designing for' people, which gained prominence in the last century is now evolving towards 'designing with' people and subsequently incorporating processes around 'designing by' people [26]. DT reflects these movements helping organisations to understand and relate to their customers and users. This democratization of design practice enables a move towards more people-centered and equitable processes that are increasingly relevant today.

DT is being applied in progressively diverse areas and with typically high levels of success. A few instances are mentioned in this chapter, but the list is by no means exhaustive. Healthcare has seen an influx of DT approaches partially driven by the

rise of technology applications and 'health tech'. As economist Peter Drucker noted, healthcare institutions are amongst the most complex in human history, and DT is seen as a competent tool for addressing this type of complexity. Even in critical emerging areas such as e-pharmacy, DT has a role on defining and sup-porting the collection of software requirements [8], and Peterson et al. [59] found in their study that "DT processes used in the development and implementation of the mobile heath app were crucial to creating value for user".

Education has also benefitted from DT consideration. Hernández-Leo et al. [36] noted that when dealing with the complexities of designing learning experiences for students, DT supported the range of activities from "designing stimulating and engaging tasks, selecting and creating appropriate resources, and deciding how best to support students to successfully complete the tasks". Even at primary school level, DT education interventions lead to a "paradigm shift" [57] and that it would be beneficial to expose children to the values of design and DT. When looking at higher education, Leonard et al. [45] argue that DT can enable sustainable cur-riculum development "through processes of rapid reconnaissance, mapping the territory and emergent modelling", signalling the value that can result when addressing urgent, emerging issues.

DT can also work in areas such as public services, engineering and urban planning but has seen significant results when applied in technological contexts which often lack people-centred consideration [30]. Merging traditional HCI methods with DT can lead to a seamless co-existence of methodologies such as user-centered design and rapid prototyping [54]. Even in a focussed technology context such as data storage, DT can have an effect. During a process to apply DT to an innovative data storage service, the methods were felt to be vague, blurry and very broad [28], however, the collaborative and people-centered emphasis of the method was appreciated, even by the technical participants.

DT processes can be used to 'design' creative forms of research in scientific and clinical areas. They were co-opted to create a framework of methods to study cognitive biases that can appear within teams involved in strategic decision-making [43], though the actual DT tool did not have the expected influence on mitigating confirmation bias, signalling that more research needs to be done in translating DT approaches from a primarily creative arena into more technical, technological and scientific areas. Other fields of study could also benefit from a DT approach. Ideas around social entrepreneurship and social business are on the rise, but whilst DT has established itself in business practice, it has received scant attention in entrepreneurship pedagogy [38].

2 Principles of Design Thinking

There are numerous frameworks that aim to codify and summarise DT intention and activity that are delineated by academics and practitioners alike. This section outlines five principles drawn from the Helen Hamlyn Centre for Design (HHCD) at

the RCA. This design centre, lead by the author, has completed over 260 projects with organisations, corporations and communities at an international level. Much of the work is based on DT methodologies developed and applied in the field and tested by academics and practitioners alike. The HHCD's approach is inclusive and interdisciplinary and work is organised in three research spaces:

- Age & Diversity, focusing on design for a more inclusive society irrespective of a person's age or ability
- Healthcare, looking creating safer and better products and services in the hospital and home
- Social & Global using people-centred design methods to deliver research projects that have social and global impact for marginalised communities.

The five DT principles developed at HHCD and outlined on the following pages are: Involve People, Translate Design Thinking into Design Doing, Create Value and Capture Value, Follow the Arc of Design Thinking and Navigate Complexity.

2.1 Involve People

Human-centeredness and empathy are widely accepted components of DT as noted by several researchers and practitioners [2, 46, 53, 56], sometimes framed as meeting customer latent needs [62] or an empathic look at users or consumers [31]. The discipline of design, which DT draws its processes from, is also changing, becoming less about making people want things, and more about answering human need [14]. DT can enhance co-creation and facilitate respectful, creative interaction, thereby ensuring that both a project output and the process are people-centred, and providing benefit for the recipients of a product, service or system as well as the creators.

Empathy is fundamental to DT and can range from an observational stance to complete immersion. Immersive techniques draw on some radical sociological experiments. In 1979, aged twenty-six, designer Patricia Moore dressed up as different eighty-year old women and travelled across the US to document society's treatment of older people firsthand [52]. Nearly two decades earlier, John Howard Griffin, a journalist living in Dallas darkened his face using medication to immerse himself in African American communities and experience the difficulties they encountered in some Southern US states at that time [33]. Although these types of approaches were viewed negatively by designers and social scientists at the time, they are now seen as positive and pioneering in creating empathy within the research process.

However, whilst they change the perspective of the designer or researcher by moving them closer to that of the user, recent methods in DT look to empower participants themselves, giving them visibility and a platform for self-expression. It is not enough to simply advocate on behalf of another person, as the ideal is to

empower and enable people in order to bring higher level of authenticity and a directness of the 'lived experience' into the ethnographic process.

Methods that involve people are at the core of DT. At the HHCD, 'design ethnography' is used to empower and involve people. This term is being increasingly used to cover the description of a process by which designers conduct research with people using tools and methods drawn from social science [10]. As designers typically have to operate in much shorter timescales than traditional social science, many of the ethnographic methods employed by them have come to be known as 'rapid ethnography' [58]. As a result, designers often evolve existing tools, some of which address the opposing time demands of design and ethnography [37]. The process of design ethnography has been embedded in the HHCD's work over the last 26 years.

Practitioners within research, DT and ethnography, should avoid relationships that promote them as 'so-called' experts, and participants in a project as 'non-experts'. People are often termed 'users' or 'consumers', but this can reduce their contribution to that of a 'research subject' simply responding to questions set by the designer, and following the lines of inquiry as dictated by the process. This removes the human perspective that can so often lead to hidden insight, innovation and design opportunities. Participants should be seen as human beings with a context, lifestyle, attitudes and desires. The terms 'user' or 'consumer' can remove the human perspective which runs the risk of missing deeper connections with an individual. Users just use, consumers only consume, but people live, and the aim of DT is to capture different dimensions of a person's life.

There is a tendency to objectify the people that designers choose to work with, seeing them as 'test subjects' rather than human beings with a context, lifestyle and desires that go beyond their physical representation and as a person with needs, aspirations and ambitions. Design thinkers should shift towards an attitude of peer-to-peer exchange, treating a person as a valued contributor and partner. Only then can contributions go beyond a viewpoint of assumption (Fig. 1).

People are typically seen within the context of their lives, whether at home, at work, in the city, the hospital or whilst travelling. Every person has a context that informs and surrounds them, and a richer ethnographic picture can be formed when people are seen against the background of their connections, their family or even just the architecture of their surroundings. Nothing can replace this type of direct contact [68]. This is especially important when a design thinker aims to empathise with a person who can be radically different from them.

Interaction between a person and their space can also be significantly informa-tive allowing the designer to access contextual issues rather than simply studying the individual, and opening up a wider channel of inquiry. Context also becomes important when dealing with different types of exclusion such as cultural or emotional, or looking at multi-faceted or less tangible issues. The relationship between designers and users of their designs can be historically described as one of producer-consumer, or expert and non-expert. However, co-creative and collabo-rative viewpoints have begun to engender a more equitable stance in these rela-tionships, moving from a perspective that is empirically objective to one that is

Fig. 1 When researching issues of safety and security with migrant workers in the Middle East, it took days before trust could be built with the project researchers. Dressing in the same clothes was part of a suite of activities to gain trust and build acceptance

more connected. This can result in a heightened level of inventiveness as design thinkers are challenged to seek new, novel or non-conventional solutions. An empathic stance is essential for designers developing their own ethnographic practice in this area [50] (Fig. 2).

Fig. 2 HHCD researchers conduct conversations and interviews with a project participant in their home to gain contextual insights and ensure that they are on an equal footing

2.2 Translate Design Thinking into Design Doing

Some critique of DT exists around actioning frameworks and translating the 'thinking' into 'practice. Although insights have real value, they need to be implemented in order to bring maximum benefit and impact. The traditional processes of design have to be evolved to support the delivery of DT and one prominent approach is called Inclusive Design (ID). This was defined in 2000 by the UK Government as products, services and environments that include the needs of the widest number of consumers [18]. This consumer focus marked it as a business strategy, bringing ideas of people-centred design and a social attitude into the corporate innovation space.

Since 2000, ID has developed in a number of different directions whilst maintaining relevance to the private sector. It has been characterised as a practice, methodology, philosophy and technique, but a key achievement is that it is internationally recognised and used by governments, industry, designers, policymakers, and social and creative organisations. The idea was articulated in a paper delivered at the International Ergonomics Association's 12th Triennial Congress [12] and is the primary focus of the HHCD at the RCA.

ID is very close in its ideology to two other people-centred design practices, namely Universal Design (UD) and Design for All (DfA). All three began by focusing on issues of accessibility, the needs of older people or those with disabilities, but a variety of different cultural, historical and political factors have affected the exact manner in which these ideals have been interpreted, developed and expressed [67].

ID has progressed to meet a wider range of emerging social challenges that go beyond a focus on age or ability. Today, the people-centred design tools enshrined in ID can be used to address other instances of exclusion such as by gender, socio-economic circumstance, geography, race or locality, amongst many others. Whilst ID has traditionally focused on product design or the built environment, emerging design disciplines such as digital design, service design or experience design are becoming increasingly prominent and more relevant to the innovation landscape today. There is a shift from historical approaches, to defining new the-ories, practices and experiences within the teaching, research and practice of design. A notion within ID is that design should sit within a multi-disciplinary context, often forming the platform discipline for other departments or sectors to engage with. Within commercial development processes, design has real value when added into the 'mix', and DT is key in enabling this.

At the HHCD, designers draw down from research techniques including co-creation approaches, expert consultation, interviews, observation 'in situ', test-ing with prototypes, research kits and more design-specific practices such as cul-tural probes [27]. If the designer cannot be present to conduct face-to-face research with participants, methods such as diaries or video logging are also used to record material in absentia [60]. Designers are encouraged to derive their own methods and build on existing ones so ensure appropriate engagement throughout the process.

Sometimes design ethnography methods are developed at the HHCD to suit shorter-term, DT-focused applications. *Creative Bridging* has been extensively used in work redesigning the London taxi. This uses a combination of words, user quotes and images associated with modern London to inspire creative designs for the vehicle exterior. *Design Provocation* is another example where props, visuals or sketch ideas are shown to people to stimulate feedback and provoke discussion [23]. This originated in a technology project conducted at the HHCD in 2006 that asked older people to discuss digital technology, something they were unfamiliar with and even fearful of. Creating a set of 'mocked-up' ideas around managing health or money, such as digital medicine bottles and piggy banks, allowed them to step over their apprehension and take ownership of the ideas, even drawing over and modifying them (Fig. 3).

The search is for creative insights rather than a detailed understanding of every aspect of a person's life. The aim is to achieve a diversity of needs, points of view and life positions. It is essential to look at new practice as well as evaluating limitations from existing approaches. Creative speculation within design where the designer as the key protagonist is often at odds with the move to engage users. Facilitating peer-to-peer exchange and community engagement demand deeply different thinking from traditional people-centred methods.

The co-creative stance of ID can raise some questions, such as whether users can be equal partners with designers when they are typically placed in a less powerful position. Or can they be seen as co-inventors with rights to the Intellectual Property within a business context? This all points to the idea that in DT, the practitioner is

Fig. 3 A Design Provocation consisting on an image of a piggy bank with a USB tail that reads out bank information when a credit card was inserted into the slot on its back. This was used to prompt response from older people

ethically bound and responsible for the people they work with, something that needs careful consideration when applied in practice. In summary, ID can be considered as a delivery tool for DT, taking it from the realm of insight, framing and thinking, and into the realm of practice, development and delivery,

2.3 Create Value and Capture Value

DT can create value in a number of different ways. It can enable organisations to go beyond the limits of their imagination and overcome innovation barriers [5]. Figure 4 shows a research activity conducted with eight older people as part of a workshop held at the HHCD looking at attitudes to technology and health for a large Japanese company. Initial responses to questionnaires were of limited value, but employing a visual research method allowed researchers to access people's inventiveness. It asked participants to describe what an imaginary fourth hand on a watch would measure about their health and well-being. As well as functional ideas such as steps, heart rate or calories, this inspired aspirational responses such as happiness of family members, proximity of authority figures, or level of stress in the people around them. These ideas enabled a deeper level of communication and insight into what was important and of value to the workshop attendees.

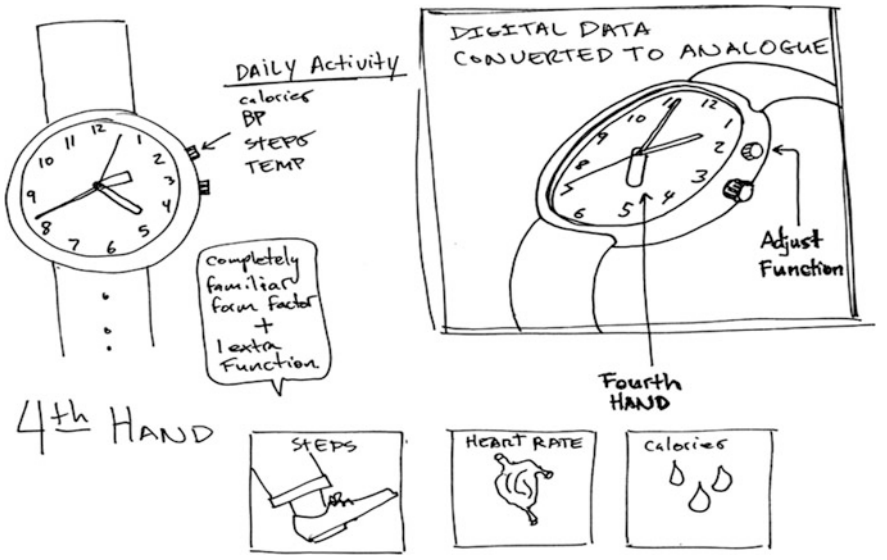

Fig. 4 A DT imagination exercise asking participants to imagine what the fourth hand on a watch would tell them about their health

DT creates value in different instances. It quantifies convergent and divergent ways of approaching problem-solving allowing for a balance of focused methods of assessment with more open-ended exploration [14]. Understanding people's mental models [40] is extremely important and DT can reveal people's actions, as well as uncovering the reasons, motivations and mental perspectives behind them. It is also a tool for business development and social enterprise as discussed earlier in this chapter, contributing to project management and innovation [48]. However, alongside the accepted understanding that DT creates value is the need to look at how it captures value, and can help create new types of evidence-base that support the quantitative, data-driven or numerical information that typically forms the fundament of strategic, organisational decisions.

At the HHCD, a novel way of presenting the people-centred insights that typify DT methods was developed, called an Insight Bank [29]. This was a response to the challenge around how to represent the voice of the user alongside the noise of all the other project considerations [56] and ensure that user experience is valued within decision-making. The Insight Bank is a digital platform that brings user quotes, videos, insights and inspiration together in an easy-access repository that can openly exist online or securely sit behind a firewall on a company intranet. It enables marketers, engineers, designers and technologists within the company to access and hear rich and textured insights from the people who participated in the research, and presents new opportunities for the design ideas. Organisations who have worked with the HHCD on Insight Banks note that they embody a solid, qualitative evidence-base for business decisions, design inspiration as well as research reflection for every employee (Fig. 5).

Another example of a way in which DT can create and capture value is by utilising the visual capability of design. Visualisation can be a powerful tool for expression and communication, particularly when less tangible ideas are discussed or more imaginative directions have to be articulated and researched. One project the HHCD worked on as part of a large European consortium spanning four countries, looked at domestic energy use, bringing aspects of DT into a technologically-driven area of study [3]. Early research indicated that the team needed to understand how people viewed energy, used energy and related to it before any realistic and relevant interventions could be created. Energy's invisi-bility was a defining characteristic, and one that could help define a person's perspective on their own energy use.

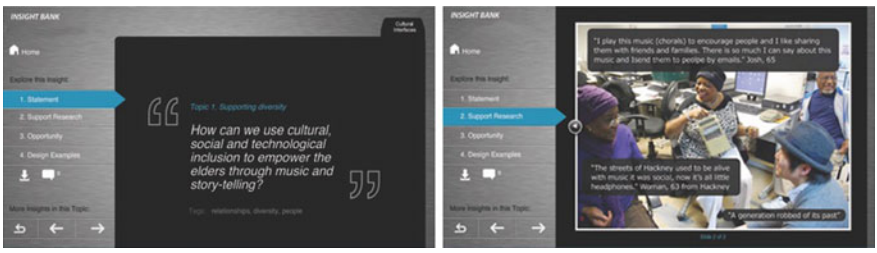

Fig. 5 An example of an Insight Bank

‘Keeping energy use visible’ was central to the thinking behind home energy monitors [35]—but one that has often been addressed in design through leaping straight to technology-driven interface designs [25] without exploring the issue further in terms of the meanings, social and ecological factors of everyday lived experience [49]. To investigate how people might represent energy’s invisibility using their own ideas and sharing their perspectives, a DT method was developed based on the activity of drawing. This mode of visual research is one that social scientists would typically denote as a ‘participatory visual method’ [34]. People were asked to respond, through drawing or writing on paper, to the question: what does energy look like? As Gray et al. [32] states, ‘[w]ords become more challenging to visualise as they become less literal’, and energy, as a form of dynamism, power, force or activity, might be considered ‘an idea that isn’t anchored to an object in reality’.

This enabled an exploration of people’s mental models and perceptions of energy, and of the infrastructures connected to it. This study was conducted with visitors to the Life Examined exhibition at the Royal College of Art in September 2013 and replicated with students participating in the UK ArtScience Prize at the Silk Mill, Derby in April 2014. A final workshop took place with visitors to the V&A’s Digital Design Weekend in September 2014. In each instance, the partici-pants spent the time they needed creating their drawing. Some were informally interviewed about the drawings produced, the subject matter, the materials and the act of drawing. Asking people to draw the invisible offered a very human-centred means of investigating energy and uncovering people’s thoughts. Very few draw-ings contained words or numbers, most representing metaphorical representations of energy drawn from nature, patterns or colour (Fig. 6).

This was in stark contrast to how energy companies communicate to their customers, typically using numerical dialogue, citing Kilowatt Hours as a unit of usage, something very few people could visualise or relate to. This discrepancy highlighted an opportunity to design better ways for energy organisations to understand and engage with their user, potentially affecting more positive and deep-rooted behaviour-change. There is a history of participatory drawing research being used before to explore people’s understandings of abstract concepts [55], and building on established design techniques such as this can bring value to DT practice. Visualisation is discussed in detail here but design research contains a plethora of techniques that can be co-opted, from ‘low contact’ methods such as questionnaires, through ‘medium contact’ techniques such as interviewing and contextual observation, to ‘high contact’ ones such as workshops, shadowing and long-term community engagements [23].

Defining the potential value creation that can stem from DT is an ongoing concern and needs further attention. At the HHCD, efforts to visualise a framework have been undertaken (see Fig. 7), lead by Prof. Jeremy Myerson, a noted figure within DT. This is based on conducting and delivering a number of DT projects completed with organisations across a variety of sectors. This helps the framework to be generally applicable to almost any DT endeavour. The diagram splits a circle into quadrants based on two axes. The horizontal axis denotes a shift between ‘now’

Fig. 6 A representation of energy resulting from a visual research method

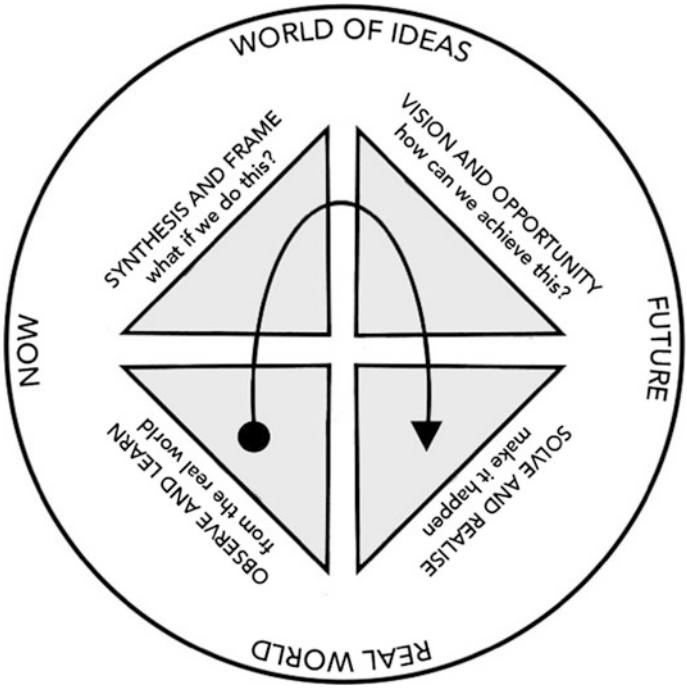

Fig. 7 DT manages a shift of focus between 'now' and the 'future', and the 'world of ideas' and the 'real world'

and the 'future' looking at DT activities that take place today and those that are more speculative and future-facing. The vertical axis attenuates between the 'real world' and the 'world of ideas'. A special characteristic of DT is that it is able to seamlessly move across these axes balancing the real with the speculative and allowing space for creative imagination alongside operational necessities. DT produces a managed approach to enable more intangible but equally important factors alongside established forms of organisational decision-making. Simply put, DT lifts the creative value of any project.

The four quadrants that result from the framework described in Fig. 7. lend themselves to the following DT activities that follow a pathway as shown:

(1) Now-Real World: this is about observing and learning from what is currently happening. Activities are about understanding context and people's behaviours in existing situations and gathering insights that can be evaluated and process. This takes place in the present moment and builds up a real picture of any given situation.
(2) Now-World of Ideas: synthesising and framing the insights that were gathered in the previous stage is the main activity here. Asking questions such as 'what if we do this' talks to the speculative characteristic of this. This is a transformational process that moves a project into more imaginative and unknown spaces.
(3) Future-World of Ideas: here, the focus is on articulating a vision and defining opportunities. Design briefs are typically formulated and answered at this point and a number of creative avenues are delineated and explored. It is important to nourish every idea at this stage as often the most creative ideas come from unfettered ideation.
(4) Future-Real World: The final stage is about solving, realising and delivering ideas back in the real world, making sure that they are relevant to the people who will most benefit from them, and that they are market-appropriate. Activities such as prototyping, evaluation and work-shopping often take place at this point.

There are numerous ways to prescribe and describe the value that DT creates and captures. Definitions vary and outcomes can be radically different. As DT grows in application and interest, these type of frameworks become increasing useful in defining the specific contribution DT makes and allowing the theory and practice to be evaluated and discussed by academics and practitioners alike. This enables DT to mature in a useful and sustainable manner, and for its benefits and affordances to be communicated to organisations and individuals interested in taking up the approach. This is invaluable in growing DT into a mainstream practice.

2.4 Follow the Arc of Design Thinking

Co-creation and co-design are regularly presented as signifiers of DT, but design needs to build bridges with other disciplines linking to areas such as social science, anthropology, technology, science, business, policy, the third sector and

government. DT can be a powerful way to interact and by embracing other disciplines, the role of the individual designer is impacted, moving from maker to facilitator, from creator to listener, and from instigator to partner. An attitude of DT or 'design enquiry' can ably contribute to other disciplines and demonstrably bring benefits into the co-operative space.

DT needs to take an interdisciplinary approach to design [13], not just looking at different types of design such as product design or graphic design, but across a range of sectors and disciplines. DT is a creative activity that can be appreciated by anyone and done by everyone, but tools, methods, process and structures need to be described that democratise the approach and make it accessible to everyone. The idea of a creative project involving a series of specialist disciplines in a linear way with each sector contributing specific knowledge at a particular point in a process, is something that the world is moving away from. DT presents a more collaborative stance, with diverse individuals working together to equitably contribute ideas in a way that is more involved and less regimented. Although this allows for a heightened sense of creative freedom and more relevant outcomes, frameworks and structures need to be formed that describe the DT process both operationally and empirically.

At the HHCD, researchers have collaborated with Pat Whitney at the Illinois Institute of Technology to develop a way of describing DT that combines the convergent and divergent nature of the UK Design Council's Double Diamond process, typically used by professional creatives, with the innovation stance of DT. The resultant idea, named the Arc of Design Thinking (see Fig. 8), can be co-opted onto any project and has been used within business, government and the third sector by teams of non-creatives including policy makers, civil servants and accountants. Over 40 workshops conducted by the HHCD have used this system to enable rapid

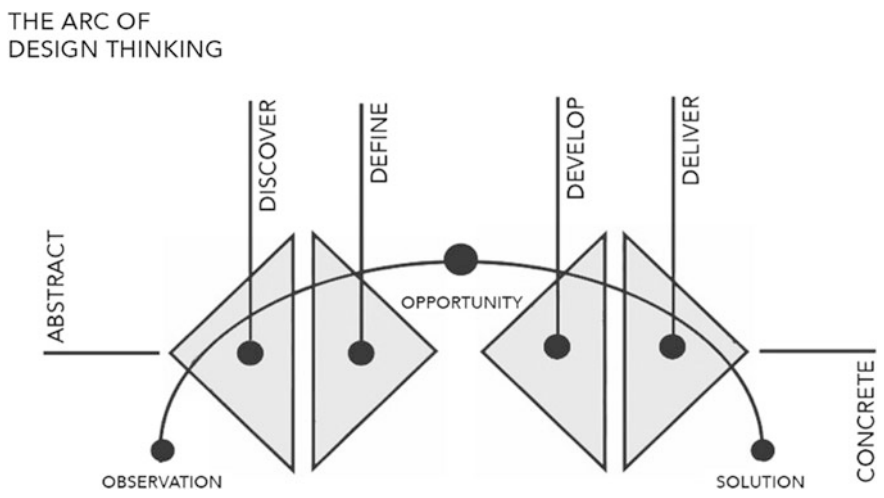

Fig. 8 The Arc of Design Thinking positioned over the UK Design Council's Double Diamond Process

innovation, with participants using DT to address challenging societal issues such as ageing, emergency healthcare or economic division within a city.

An important aspect is that DT is a platform to support creative endeavour and enable teams of disparate individuals to raise the group level of innovation. Of note, is the value that non-experts bring to the process. On a number of occasions, it has been observed that enabling non-experts to engage with an issue and have creative input into the solution, has produced some of the more innovative ideas. Sometimes, expertise has even been seen as a barrier, as nominated experts replay historical perspectives when defining problems, articulating their personal contexts and denying more inventive, non-traditional outputs. The Arc of Design Thinking allows for individual representation across the process, with all levels of expertise valued at different stages. Importantly it brings the voice of the user back into the foreground. As Eikhaug et al. [23] states "people are experts in their own lives" and DT can give users, experts and contributors the tools to not only understand and assess their situation, but also impact and instigate change.

The four stages of the double-diamond process is defined by the Design Council [19, 20] in the UK as follows. Each stage is convergent or divergent depending on whether it is about 'blue-sky thinking' or focusing ideas. Typical activities in each phase are:

(1) Discover phase (divergent): exploration of brief and hypothesis, contextual research and definition of project participants or communities. Looking at the world in a novel way and gathering insights
(2) Define phase (convergent): designing and conducting design ethnography. People-centred briefs defined from the research insights. Curating and implementing the possibilities identified in the Discover phase
(3) Develop phase (divergent): development of a number of ideas through co-creation and design ideation processes. This process of trial and error helps to improve and refine ideas
(4) Deliver phase (convergent): selection of ideas to take forward and delivering outputs in the form of prototypes, services ideas or guidance. The resulting project is finalised, produced and launched.

This process is widely accepted globally as a platform for innovation. The Arc of Design Thinking sits across the four phases with three touchpoints: observation, opportunity and solution. As per Fig. 8 the bottom half and top half of the diagram are spread into two halves denoting 'concrete' and 'abstract' activities.

Observation is an activity that takes place in the 'concrete' world where real challenges and issues can be researched and investigated. Although observation primarily focuses on 'seeing', a number of methods can be deployed including contextual visits, desk research, workshops and interviews. The aim is to create a focused picture of the issue and empathise with the people involved. It is paramount to get this part of the process correctly orientated to ensure that the initial project framing is correct and that the right questions are being answered.

Opportunity is about articulating the scope and focus of the project and recognising the right potential direction to investigate. This is an 'abstract' activity as it

involves assimilating the insights gathered in the Discover and Define phases, mapping potential opportunities and then selecting one, often as the project brief or design brief. *Solution* is a touchpoint that brings the project back into a landing phase. It signals the endpoint of the DT process, finishing up in the 'concrete' space with the delivery of a concept, prototype or final design.

The Arc of Design Thinking is a framework that describes how DT can lift a project from remaining in the 'concrete' phases into an 'abstract' space, heightening the possibility for creativity and innovation. Many organisations make the mistake of remaining in an operational space that is more risk-averse, but ultimately less transformational. DT allows for a more imaginative approach within a framework of 'managed risk'. The Arc of Design Thinking describes this pathway presenting the creative possibilities that it affords in a way that designers and non-designers can find approachable. Organisations that have worked with the HHCD state that it takes a level of trust and resilience to stay the course, but the outcomes are typically more valuable, inventive and ultimately applicable.

DT is about achieving balance. Organisations cannot always function if they are in space of challenging themselves all the time as they need to attend to the everyday and balance the 'strategic' activities with operational needs, and incremental discovery with those that occasional periods of disruptive thinking. DT can help employees, colleagues and clients move between two spaces (see Fig. 9.): the first is

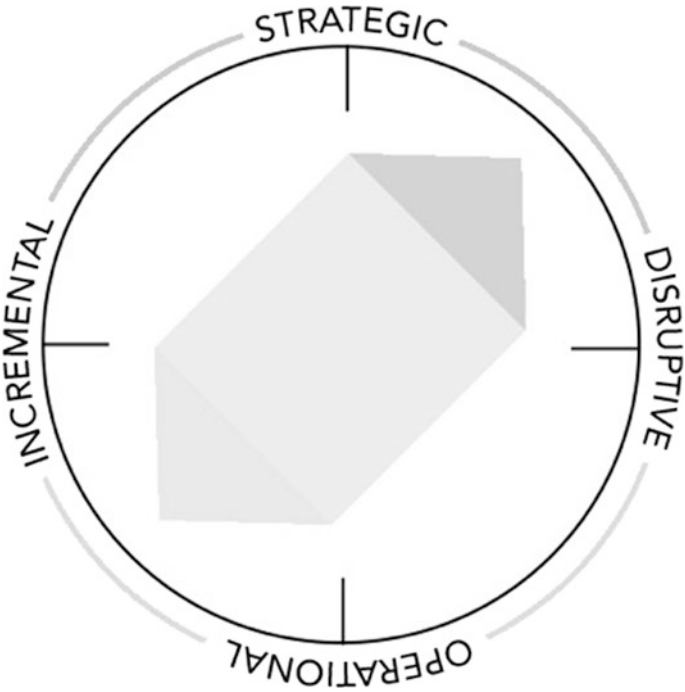

Fig. 9 Organisations need to move seamlessly between being operational-incremental and strategic-disruptive

operationally focused and incremental in terms of innovation, and the second takes a more strategic view that is disruptive in a creative manner. Working in a way that allows both areas to be covered can ensure longevity and create continuity whilst allowing new ideas to surface, be evaluated and then implemented. Innovation can be perceived as risky, however DT offers a secure way to mitigate this.

2.5 Navigate Complexity

DT can help to navigate complex challenges and guide both organisations and individuals through the complicated route towards real innovation. Liedtka et al. [46] state:

> We acknowledge two truths: first, it is often impossible to tell early in the life of an innovation just how big or small it will be; and, second, many small things can add up to something big.

Innovation can be unpredictable, often requiring deviation or even total departure from the 'known' towards the 'unknown'. DT can help to pilot projects, especially in the early stages or when addressing issues that involve systemic change. Too often, the impact of design is limited as it is not implemented at multiple levels whether it is a single project that directly addresses a particular place or community, or whether it is a larger scale endeavour that impacts organisational, cultural or governmental structures. DT is a scalable process that has a role in integrating and influencing these larger agendas whilst also creating positive impact at regional and local level and at smaller scales. DT can step beyond the intricacies that exist and directly enable a project team to get to the root cause of an issue, often creating permanent rather than temporary change.

DT, with its empathic and people-centred stance can be inclusive, especially when looking at different user and consumer groups and there are many groups that can benefit from truly inclusive consideration including diversity across sexuality, race, personal economy, cultural stigma, age and ability. It can help step beyond obvious examples of exclusion to those that are more less recognized and help overcome the ingrained hierarchy of exclusion that exists.

Historic frameworks can be less relevant in understanding current social contexts as they sometimes no longer describe the everyday needs and aspirations of people, institutions and organisations in a way that is accurate or occasionally even recognisable. For most of human history, older people have held the knowledge and wisdom in society, but technology has disrupted this age paradigm with younger age groups typically leading the way in terms of invention and innovation capital. Engaging younger technology entrepreneurs in an empathic and age-inclusive manner is one of many potential benefits that DT can offer. Through a diversity of user engagement, DT can help step beyond preconceived beliefs and traditional forms of deployment, helping to navigate a complex world that can feel like it is in a state of flux.

One of the biggest challenges in DT endeavours is the focus on individuals rather than communities and this presents an increasing layer of complexity and complication. Many projects deal with groups, such as neighbourhoods, families, localities or organisations. DT needs to account for this shift as the majority of methods focus on an expert-user engagement in a way that is primarily person-to-person. Methods need to be derived that account for group behaviour as community-centred design is becoming valued by business, government and the private sector in today's increasingly connected social context.

The rise of digital communities has only supported this. DT needs to evolve methods and hone research intentions to become a trusted part of group conversation. This also assures more sustained engagement allowing members of the community to create, participate and deliver ideas rather than expecting them to simply act as grateful recipients of DT expertise.

In 2013, the author ran a workshop with Sean Donahue from ArtCenter College of Design at the Include 2013 conference in Hong Kong titled "Design and Community". Five specific qualities for working with communities (as opposed to individuals) emerged: Time, Continuity, Ownership, Legacy and Trust. These are discussed below.

'Time' holds a different value for communities than for individuals. Design often works swiftly, but engaging a community for longer periods of time is essential in order to understand the range of relationships that can exist within a group, to see the cycles and rhythms of community interaction, and to identify boundaries and bridges between people. More time is needed to connect with a community than an individual. 'Continuity' looks at building consistent engagements which is important in establishing respectful relationships. Dedicated research teams where personnel remain the same are essential as is giving priority and commitment to existing community events rather than simply inflicting an external research agenda onto a group's activities.

'Ownership' of the process is a significant but often under-considered issue. Even in co-creation and participatory models, designers or researchers can visibly remain as the drivers of the project, with a leadership stance that can prevent true behaviours being revealed from participants. This also reduces the probability of acceptance within a group. Approaches that give collectives the opportunity to lead and direct their own engagements are needed, with designers refraining from being the sole author or facilitators. Working in community-owned spaces can help people feel more comfortable and empowered.

'Legacy' is about developing work that ensures longevity and sustainable outcomes. It is more important to give back to a community than the individual and this needs to be built into a research plan from the start. 'Trust' builds on the previous four values and has to be established at the start of an engagement. Asking a group of individuals to commit and dedicate to working with a designer on issues that can be personal or sensitive means that a strong connection needs to be built and renewed throughout the project with multiple points of contact in the community.

Part of this is about seeing the strengths rather than the deficiencies of a community. Design thinkers should not 'hero' their own research and discoveries, but rather see themselves as another contributor in the conversation. The Asset-Based Community Development Approach [51] supports this move away from traditional needs-orientated frameworks to capacity-focused alternatives. This creates a strong case for DT's potential to redress social inequalities and impact systems at a larger scale, becoming an operational conduit to implement social ideals.

3 Case Studies

3.1 Redesigning the Emergency Ambulance

A key hypothesis within DT is that there needs to be space for other disciplines to engage and even lead design projects as this can add to the socially creative process. A recent HHCD project redesigned the interior treatment spaces of emergency ambulances. This not only closely engaged clinicians and patients, but also co-opted a paramedic onto the design team on a daily basis for over a year. By making the people who deliver the service central to design development, and by giving them a position of authority and visibility in the process, a heightened level of relevance, insight and creativity was achieved.

The paramedic advised the development team on frontline issues and provided immediate feedback, sometimes halting a line of enquiry that was not fit for purpose. An example was the idea of a side-loading ambulance which was highly acclaimed in the design studio. However, the paramedic noted that in most major cities, there is not space next to the vehicle to load a patient due to narrow streets, parked cars and other obstacles. This type of direct engagement was invaluable in accelerating the results towards a realistic treatment space that improved clinical efficiency and enhanced the patient experience.

There were many problems with the design of existing ambulances. The interior was difficult to keep clean given the frequency of use and the resultant lack of opportunity to clean the vehicle. Ambulance crews also suffered from poorly thought-out ergonomics, badly laid out equipment and difficult-to-access storage spaces, all of which affected performance in critical, life-threatening situations.

In the redesigned interior, the stretcher is placed in the centre of the interior, allowing 360 degree access to the patient (see Fig. 10). Equipment and disposables for treating the patient are arranged into treatment packs allowing for easy access and a restocking process that can take place out of the vehicle (see Fig. 11). Patient information is displayed on an overhead touch screen that also integrates with hospital records to facilitate handover and built on the increasing pervasiveness of technology.[26] This multi-disciplinary process of ethnography helped to create and map key insights from ambulance users and then translate them into sketch designs and a full-scale test rig. This all had an impact on safety and security of the vehicle as well as the patients, paramedics and clinical staff who engaged with it.

Fig. 10 The new interior allows 360 degree access to the patient. Here a team of paramedics test out the co-designed interior

3.2 Using DT to Understand 'Hopes' and 'Fears' Around Driverless Vehicles

The development of driverless vehicle technology is often met with suspicion. The notion that humans will be made redundant or overly reliant on robotics already reflects a general unease with automated technology that exists. However, the idea that vehicles or machinery no longer need to be supervised by people because they are able to assess and adapt to situations on their own raises more ethical and security concerns. Cautionary sci-fi tales emphasise safety and security concerns.

GATEway (Greenwich Automated Transport Environment), a large research project funded by the UK government, was set up to try and understand how the technical, legal and societal challenges of autonomous vehicles might be tackled. The HHCD and the RCA's Intelligent Mobility Design Centre were tasked by the project consortia with using DT techniques to work with the general public and develop a better understanding of the attitudes towards this emerging future-focused technology. Involving people in conversations surrounding the development of these vehicles meant that user concerns could be taken into account when designing

Fig. 11 Treatment packs that can be replaced at the end of each shift reduce restocking time and complexity

new propositions. This extended to thinking about the kinds of services and infrastructure that will need to be put into place, a number of which were focused on critical areas of personal safety.

The project asked this key question: How does design help to increase the acceptance and adoption of driverless vehicles in urban environments? In order to improve public perception and engagement with the technology, the team led a series of DT workshops to explore the possibilities of what autonomous vehicles could be. As they would no longer need to take a traditional 'car form', ideas such as travelling coffee shops, moving cinemas, enclosed gardens and even mobile showers have been posited as potential vehicles. The workshops helped the team to understand people's hopes and fears about a driverless future, and led to significant insights into how the public might embrace the technology (Fig. 12).

The participant groups included 33 women and 74 men, 5 people between 18 and 24, 39 between 25 and 34, 29 between 35 and 44, 14 between 45 and 54, 10 between 55 and 64 and 7 over 65. Of these:

- 13 had additional needs including visually impairment, reduced hearing or mobility
- 6 classified themselves as cyclists
- 6 as pedestrians
- 9 mainly used buses
- 19 regularly drove a car
- 21 used a mix of various modes apart from a car
- 38 mainly travelled by rail.

Fig. 12 Workshop participants express their hopes and fears around driverless vehicles

Over the eight workshops, people shared over 700 'hopes' and a similar number of 'fears'. Most of the participants said they had a limited or average knowledge of driverless vehicles with only 6% saying that they had expertise. The results of the workshops found that those who are currently excluded from driving, including older people and those with additional needs, might be more attracted to the benefits of autonomous vehicles than other groups. The findings from these initial workshops presented both utopian and dystopian futures and DT was key in eliciting, mapping and understanding responses.

Major hopes centred on the freeing up of time, as cities become less congested and the time during journeys becomes more useful and valuable. Participants felt that driverless vehicles would create healthier and safer city environments leading to less stress, reduced pollution-related illness and more social and convivial streets and journeys. Security issues centred around safer streets, less drink-driving, travel-on-demand, quieter and cleaner vehicles and more accessible and affordable transportation. Some unintended insights focused on the vehicle's potential ability to self-diagnose so that it could take itself for a service before becoming unsafe, noisy or less secure.

Findings around fears and concerns included the impact on employment as 'robots' take over existing jobs and economic activities, fears around data privacy, the ethical judgement of autonomous but supposedly intelligent vehicles, the loss of independence that might come when driverless vehicles control how people use the street, the challenges of cybercrime and the impact that 'on-demand' vehicles will have on people's health as they find it easier and cheaper to get door to door transport rather than walking or cycling around town.

Fig. 13 A driverless vehicle could be a first respondent in an accident or support people with low vision

Quieter vehicles also might make the urban environment less safe for partially sighted or distracted pedestrians and the transition to single surface roadways could make it even harder for people with additional needs to navigate and cross streets. Security concerns included ethical dilemmas around responsibilities in case of an accident, increased potential for antisocial behaviour inside the vehicle, large corporations controlling the transport network based on profit and the increased ability to track travellers. Subtler concerns were also uncovered such as the dangers of being always connected, the dangers of vehicles starting to tout for business and a more disconnected and isolated travel environment where passengers cannot rely on the safety of a 'crowd'.

DT enabled a process to allow workshop participants to express their hopes and fears in a way that was descriptive, imaginative and even unexpected. It further enabled the translation of ideas into opportunities for innovation that challenged the purely functional or technical focus that typically surrounds driverless vehicles and created better social experiences and outcomes that are more relevant to the potential users (Fig. 13).

4 Conclusion

DT enables the practice of design in a number of ways. Firstly, it leads design out of the studio and into the boardroom by delineating the benefits of a creative approach and framing them in a way that business can access and utilise. Secondly, it evolves design practice, adding to the designer's toolbox and ensuring that people-centred,

empathy-driven approaches are prominent in mainstream design. Thirdly, it can positively change the perception of design and the role of the designer. Ghajargar et al. [28] found that the role of the designer is still viewed in a primarily aesthetic manner by those from a technical background whilst user experience specialists also found it challenging to accept that a designer has a role in studying user needs. Finally, and most importantly, DT democratises design, delineating inventive methods and activities that can be used by anyone and positively applied to almost any sector, company or corporation.

DT can face internally or externally within an organisation. When internal-facing, it can help with a range of issues from problem-framing to project management, ensuring that employees and colleagues from different backgrounds have equal voice. When applied externally it creates a deeper understanding of context, user behaviour and gives a platform for equality, partnerships and knowledge sharing. It can impact on process, management and strategy and cultivate an environment that encourages exploration and experimentation.

DT also provides an evidence-base that is based on people's attitudes and behaviours rather than simply relying on numbers or statistics. Working with smaller numbers of people to gain richer levels of insights signals a shift in relying on 'big data' to benefitting from 'deep data'. Rather than canvassing hundreds of participants and getting a little information from each of them, DT enables working with fewer people and spending more time to understand the details of their lives, their needs, aspirations and perspectives. Whilst providing real and relevant information to any project, this can also be more time-effective and cost-effective.

Future work and research is needed to map DT's application in a variety of sectors and spaces and there is a need for empirical research [39] to codify and assess its contributions. DT cannot be treated as a "wonder drug" [53] that can solve every issue or foster distinct improvement of all situations. Practitioners need to record challenges and failures as well as successes and discoveries, and the intersection of DT with new areas of application is paramount in evolving current practice.

The application of DT within security further stretches its reach in a way that is timely and appropriate. Security is a critical area of human concern where people's behaviours are often unexpected and variable. This is a complicated field of research and application, requiring a view that spans the holistic through to the specific. DT can help assess risk, design research and articulate concepts that span a range of emerging technologies, global situations and political concerns. It can support endeavours as it is well-placed to understand human needs and perspec-tives, work creatively with scientific precision and deliver multi-perspective understanding and clarity in one of the most complex and critical fields of study.

Acknowledgements Academic colleagues at the Helen Hamlyn Centre for Design at the Royal College of Art have been invaluable in producing this chapter, primarily Prof. Jeremy Myerson who articulated the Arc of Design Thinking. Dr. Chris McGinley's research and ideas have contributed to the Inclusive Design approach and Dr. Jak Spencer supported efforts in assessing the primary research. External academics and practitioners include Sean Donahue from ArtCenter College of Design (USA) and Onny Eikhaug from the Norwegian Centre for Design and

Architecture, both of whom influenced and supported many of the ideas in this chapter through collaborative work with the author. Prof. Dale Harrow, Dan Phillips and the team at the Intelligent Mobility Design Centre at the RCA were partners on the GATEway project, supporting the creation of the case study.

References

1. Antonelli P (2013) Rotman on design. Rotman Magazine. University of Toronto Press, Canada
2. Beverland M, Wilner S, Micheli P (2015) Reconciling the tension between consistency and relevance: design thinking as a mechanism for brand ambidexterity. J Acad Mark Sci 43 (5):589–609
3. Bowden F, Lockton D, Gheerawo R, Brass C (2015) Drawing energy: exploring perceptions of the invisible. Royal College of Art, UK
4. Brown T (2008) Design thinking. Harvard Bus Rev 86(6):84–92
5. Buchanan R (1998) The study of design: doctoral education and research in a new field of enquiry. In: Doctoral Education in Design: Proceedings of the Ohio Conference, 8–11 Oct
6. Calabretta G, Montaña J, Iglesias O (2008) A cross-cultural assessment of leading values in design-orientated companies. Cross Cult Manage Int J 15(4):379–398
7. Carlgren L, Rauth I, Elmquist M (2016) Framing design thinking: the concept in idea and enactment. Creativity Innov Manage 25(1):38–57
8. Carroll N, Richardson I (2016) Aligning Healthcare innovation and software requirements through design thinking. In: Proceedings of the international workshop on software engineering in healthcare systems, SEHS '16, Texas, USA
9. Chae S (2017) Design thinking in action: changing the public service model. QLA Q 22 (3):15–19
10. Clarke AJ (ed) (2011) Design anthropology: object culture in the 21st century. SpringerWienNewYork, USA, New York
11. Clemmensen T, Ranjan A, Bødker M (2016) How cultural knowledge shapes design thinking —a situation specific analysis of availability, accessibility and applicability of cultural knowledge in inductive, deductive and abductive reasoning in two design debriefing sessions. In: Proceedings of DTRS 11: design thinking research symposium 2016, Copenhagen Business School, Denmark
12. Coleman R (1994) The case for inclusive design—an overview. In: Proceedings of the 12th Triennial Congress, International Ergonomics Association and the Human Factors Association of Canada
13. Cross N (2011) Design thinking. Bloomsbury Academic
14. Curedale R (2015) Design thinking: pocket guide. Design Community College Inc, USA
15. d.school (2017a) https://dschool.stanford.edu/fellows-in-residence/project-fellowship-history-approach. Accessed 19 Nov 2017
16. d.school (2017b) https://dschool.stanford.edu/about/. Accessed 19 Nov 2017
17. Davis J, Docherty CA, Dowling K (2016) Design thinking and innovation: synthesising concepts of knowledge co-creation in spaces of professional development. Des J 19(1):117–139
18. Department of Trade and Industry (2000) Foresight: making the future work for you. Department of Trade and Industry, UK
19. Design Council (2005) The double diamond process model. Design Council, UK. Available at: http://www.designcouncil.org.uk/designprocess
20. Design Council (2005) The double diamond process model, Design Council, London. https://www.designcouncil.org.uk/news-opinion/design-process-what-double-diamond. Accessed Jan 2018

21. Dorst K (2015) Frame innovation: create new thinking by design. MIT Press, Cambridge, Massachusetts
22. Ehn P, Kyng M (1987) The collective resource approach to systems design. Computers and democracy—A Scandinavian challenge. Aldershot, UK, pp 17–58
23. Eikhaug O, Gheerawo R (eds) (2010) Innovating with people: the business of inclusive design. Norwegian Design Council, Norway
24. Fraser H (2012) Design works: how to tackle your toughest innovation challenges through business design. University of Toronto Press, Canada
25. Froehlich JE, Findlater L, Landay JA (2010) The design of eco-feedback technology. In: Proceedings of CHI 2010, USA
26. Fulton-Suri J (2007) Design for people? Design with people? Design by people? Who is designing now? In: Proceedings of include 2007: designing with people conference, London
27. Gaver B, Dunne T, Pacenti E (2009) Cultural probes. In: Interactions, February + March issue
28. Ghajargar M, Mangano G, De Marco A, Giannantionio R (2017) Design thinking applied to data storage innovation: a case study. Des J 20(1):S3776–S3788
29. Gheerawo R, McGinley C, Gorzanelli C (2014) Inventory: 7 years|7 projects. Royal College of Art, UK
30. Gheerawo R, Lee Y (2009) Enabling people—creating inclusive human-computer interactions. In: Proceedings of the 5th international conference on universal access in human-computer interaction—Addressing diversity, UAHCI 2009, held as part of HCI International 2009, USA
31. Gothelf J (2017) Lean vs. Agile vs. Design thinking: what you really need to know to build high-performing digital product teams. Gothelf Corp, USA
32. Gray D, Brown S, Macanfuno J (2010) Gamestorming: a playbook for innovators, rulebreakers, and changemakers. O'Reilly, USA
33. Griffin JH (1962) Black like me. Signet
34. Gubrium A, Harper K (2013) Participatory visual and digital methods. Left Coast Press, USA
35. Hargreaves T, Nye M, Burgess J (2013) Keeping energy visible? Exploring how householders interact with feedback from smart energy monitors in the longer term. Energy Policy 52:126–134
36. Hernández-Leo D, Agostinho S, Beardsley M, Bennett S, Lockyer L (2017) Helping teachers to think about their design problem: a pilot study to stimulate design thinking. Paper presented at: 9th annual international conference on education and new learning technologies. EDULEARN17, Barcelona
37. Hunt J (2011) Prototyping the social: temporality and speculative futures at the intersection of design and culture. In: Clarke AJ (ed) Design anthropology: object culture in the 21st century. SpringerWienNewYork, USA
38. Huq A, Gilbert D (2017) All the world's a stage: transforming entrepreneurship education through design thinking. Educ Training 59(2):155–170
39. Johansson-Sköldberg U, Woodilla J, Centikaya M (2013) Design thinking: past, present and possible futures. Creativity Innov Manage 22(2):121–146
40. Johnson-Laird PN (1983) Mental models. Harvard University Press, USA
41. Kimbell L (2011) Rethinking design thinking. Des Cult 3(3):285–305
42. Kleinsmann M, Valkenburg R, Sluijs J (2017) Capturing the value of design thinking in different innovation practices. Int J Des 11(2):25–40
43. Kotina E, Koria M, Prendeville S (2017) Using design thinking to improve strategic decisions during collaborative sensemaking. In: Design management academy conference, Hong Kong
44. Lawrence G (2001) Hospital beds by design: a socio-historical account of the 'King's Fund Bed', 1960–1975. Ph.D. Thesis, London University
45. Leonard SN, Fitzgerald RN, Riordan G (2015) Using developmental evaluation as a design thinking tool for curriculum innovation in professional higher education. High Educ Res Dev Routledge. https://doi.org/10.1080/07249360.2015.1087386

46. Liedtka J, Salzman R, Azer D (2017) Design thinking for the greater good. Columbia University Press, USA
47. Luchs M (2016) A brief introduction to design thinking. In: Luchs M, Swan K, Griffin A (eds) Design thinking: new product development essentials from PDMA. Wiley, Hoboken
48. Mahmoud-Jouni SB, Midler C, Silberzahn P (2016) Contributions of design thinking to project management in and innovation context. Proj Manage J 47(2):144–156
49. Mazé R, Redström J (2008) Switch! Energy ecologies in everyday life. Int J Des 2(3):55–70
50. McGinley C (2012) Supporting people-centered design through information and empathy. Doctoral thesis, Brunel University, London
51. McKnight JL, Kretzmann J (1990) Mapping community capacity. Center for Urban Affairs and Policy Research, Northwestern University
52. Moore P (1985) Disguised. Word Books, Texas
53. Mootee I (2013) Design thinking for strategic innovation: what they can't teach you at business or design school. Wiley, USA
54. Mubin O, Novoa M, Al Mahmud A (2016) Towards the successful integration of design thinking in industrial design education. In: Proceedings from international conferences ITS, ICEduTech and STE
55. Nemeroff CJ (1995) Magical thinking about illness virulence: conceptions of germs from "safe" versus "dangerous" others. Health Psychol 14(2):147–151
56. Newton K, Riggs MJ (2016) Everybody's talking but who is listening? hearing the user's voice above the noise, with content strategy and design thinking. In: VALA2016: Libraries, technology and the future, VALA, Australia
57. Noel L, Liu TL (2016). Using design thinking to create a new education paradigm for elementary level children for higher student engagement and success. In: Proceedings of DRS 2016, design research society 50th anniversary conference. Brighton, UK
58. Norman DA (1999) Rapid ethnography. In: Aldersey-Williams H, Bound J, Coleman R (eds) The methods lab. Royal College of Art, UK
59. Peterson M, Hempler NF (2017) Development and testing of a mobile application to support diabetes self-management for people with newly diagnosed type 2 diabetes: a design thinking case study. BMC Med Inform Decis Mak 17:91
60. Pink S (2005) Dirty laundry. Everyday practice: sensory engagement and the constitution of identity. Soc Anthropol 13(3):275–290
61. Porritt J (2006) Capitalism as if the world mattered. Earthscan, London
62. Roberts JP, Fisher TR, Trowbridge MJ, Bent C (2016) A design thinking framework for healthcare management and innovation. Healthcare 4:11–14. https://www.sciencedirect.com/science/article/pii/S221307641500113X.Accessed Jan 2018
63. Sanders EBN, Dandavate U (1999) Design for experience: new tools. In: Overbeeke CJ, Hekkert P (eds) Proceedings of the first international conference on design and emotion, The Netherlands: TU Delft
64. Sanders EBN, Stappers PJ (2014) Editorial. CoDesign Int J CoCreation Des Arts 10(1)
65. Sewchurran K, Philipp F, Baets W, McDonogh J (2016) Could more thoughtful practice of complexity, design thinking and values-based organising address some of the limitations of current management and organising paradigms? Complex Leadersh Manage 3(3):169–181
66. Szczepanska J (2017) Design thinking origin story plus some of the people who made it all happen. https://medium.com/@szczpanks/design-thinking-where-it-came-from-and-the-type-of-people-who-made-it-all-happen-dc3a05411e53. Accessed Jan 2018
67. Vavik T, Gheerawo R (2009) The challenges in universal design. In: Vavik T (ed) Inclusive buildings, products & services: challenges in universal design. Tapir Academic Press, Norway
68. Warbuton N (2003) Everyday inclusive design. In: Clarkson J, Coleman R, Keates S, Lebbon C (eds) Inclusive design—design for the whole population. Springer-Verlag, UK