Design thinking and sustainability

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Introduction

Media coverage of the impact of ‘design thinking’ – also described as ‘human-centred design’ or ‘service design’, among other terms – on business and society seems to be on the increase, with much of the discussion focusing on its application to innovation practice.

Simultaneously, the need for business and public services to integrate socially and environmentally sustainable practices is becoming more urgent and important to address pressing issues such as climate change, resource scarcity, environmental degradation and growing social challenges and perceived deterioration of community.

This paper briefly explores the impacts of design on business before providing a working definition and overview of the key themes of design thinking. It then outlines commonly recognised environmentally-focused sustainable design principles and considers how design thinking could be applied in support of these.

Although a (non-exhaustive) review of specific examples of design thinking applied to environmentally sustainable objectives was undertaken in preparation of this paper, such examples are relatively few. As such, while specific examples are touched upon, the primary focus of the paper is on the potential application of design thinking in this context.

Acknowledgements

I would like to acknowledge the generosity of Penny Hagen, Duncan Underwood & Dave Gravina from Digital Eskimo, Suze Ingram, Natalie Rowland, and Rachel Botsman, who provided support through inspiration, conversation, experience and pointers to examples and resources before and during the preparation of this paper.

The expanding scope of design

Within the design and business communities there is growing momentum behind the idea that design can move "beyond fashion, graphics, products, services into education, transportation, economics and politics." (Nussbaum 2007) Publications including The Guardian (2010) newspaper, Fast Company (Cannell 2009; Dziersk 2005; Tischler 2009) and BusinessWeek (2006) have highlighted the impact that design methods, incorporating ethnographic research, collaborative problem solving and iterative project management, are having in the business world.

As Nussbaum (2007) notes:

> Over the past decade, design has evolved to become an articulated, formalized method of solving problems that can be widely used in business—and in civil society. Design's focus on observing consumer/patient/student—human behavior, it's [sic] emphasis on iteration and speed, its ability to construct, not destruct, its search for new options and opportunities, its ability to connect to powerful emotions, its optimism, made converts out of tough CEOs.

This broadened conception of design is referred to using a variety of labels including 'design thinking', 'service design' (Campbell 2009; Engine Service Design 2010; Guardian 2010; Kimbell 2009; livelwork 2010a), 'experience design', 'user-' or 'human-centered design' (IDEO 2009; Sato 2009), 'integrative thinking' (Sato 2009), 'transformative design' (Campbell 2009) and 'social innovation' (Guardian 2010; Manzini 2006). This latter term is often used to more broadly describe the application of innovative responses to social challenges, such as in the context of public service programme delivery, but it is increasingly used to describe the application of design methods in such a context. The variation 'design thinking', while not a perfect descriptor, is primarily used herein for simplicity.

Discussion about design thinking is most commonly framed as a method to achieve innovation outcomes, and by extension competitive advantage, through the design of products and services that better meet the needs of, and are therefore more successful in, the market. The appeal of an increased role of design is apparent in the commentary surrounding the success of companies such as Apple Inc., Procter & Gamble and GE, whose integrative approach to design is often highlighted as a key element of their success (for example, see Patnaik 2009; Walters 2009; Wong 2009).

Some commentators have suggested that an understanding of design thinking will become a core competency for future C-level managers (see, for example, BusinessWeek 2006). Supporting this perspective is IBM's recent executive survey which found that company leaders believe that "more than rigor, management discipline, integrity or even vision – successfully navigating an increasing complex world will require creativity." (IBM 2010)

Reflective of design's shift to the boardroom is the appointment of Mike Parker as CEO of sports apparel brand Nike. Parker's design background with the company no doubt influenced his singling out of design as a critical component to Nike's strategy moving forward (Robischon 2010). Junginger (2005) and Heapy (2010) further propose applying design thinking to the design of an organisation itself, not just the products and services it delivers.

In addition to private sector interest, an increasing number of examples of design thinking within the public sector are emerging, especially in the UK (for example, Design of the time 2007; Engine Service Design 2010; Guardian 2010; IDEO 2010; livelwork 2010a; Participle 2010; thinkpublic 2010). In this context, a design thinking approach has been shown to benefit projects as varied as

energy efficiency programs (Design of the time 2007) to neighbourhood policing (livelwork 2010a) to family support (Participle 2010).

Defining "design thinking"

As outlined above, a wide range of interpretations can be invoked by the term 'design thinking'. This is in part due to the term being used both in reference to the application of specific design techniques as well as to the broader principles that such methods embody.

It is important, therefore, to provide at least a cursory definition to ground the term's use in the remainder of this paper. To this end, the following key themes are proposed as constituting design thinking in practice:

- **Human-centred:** Places people at the centre of the design process, rather than tackling design challenges from internal/organisational or technical frames
- **Research-based:** Qualitative, ethnographic and observational research techniques applied in the aid of responding to design challenges
- **Broader contextual view:** Expanding the design 'question' to a wider frame of reference, to examine the system and context in which design challenges exist
- **Collaborative & multi-disciplinary:** Exploratory, and at times playful, approaches to problem-solving, including co-design methods specifically designed to encourage participation from a broad array of stakeholders and multi-disciplinary design teams
- **Iterative delivery & prototyping:** Use of iterative project management approaches and prototyping, incorporating rapid feedback loops from end-users, to evaluate and evolve ideas and prospective designs

As Sato (2009) quips "The good news is that design thinking is systematic; the bad news is that it is not formulaic," pointing to the way in which designers mix and match methods and techniques drawn from these themes to suit the specific needs of the design challenge at hand.

Human-centred

Taking the perspective of the end-users of a product or service is one of the central tenets of design thinking. Design thinking is informed by human/user centered design, which has grown out of a usability-oriented, functional approach that began in the workplace, now taking "into account many dimensions of the user's experience, including emotional needs and motivations." (Fabricant n.d.)

Kumar (2009) links a human-centred approach to innovation, noting that in order to "create innovations that have a good fit with users", the designer's focus needs to shift "from products that people use, to what those people do – their behaviors, activities, needs, and motivations." (Kumar & Whitney 2007, cited in Kumar 2009, p. 92)

This does not mean that organisational goals are ignored, however. As Sato (2009, p. 48) points out: "Design thinking is a heuristic that balances customer, business and technology needs to ensure the results benefit both customers and company." IDEO (2009, p. 5) also highlight three complimentary lenses of 'desirability' (people's wants and needs), 'feasibility' and 'viability' that combine in successful human-centred design projects, reflecting a balance of end-user and organisational goals.

Design thinking approaches support the designer in developing empathy for the people that will ultimately be impacted by the service or product being designed. Dan Pink, interviewed in The Guardian (2010, p. 2), singles out empathy as a critical component of successful design. Empathy

is also noted by IDEO (2009, p. 20), Rowland (cited in Hagen, Robertson & Gravina 2007, p. 12), Suri & Howard (2006, p. 250) and Visser, Stappers & Lugt (2005) as an attribute of the qualitative research approaches common to design thinking projects.

Research-based

Putting people at the centre of the design process suggests that a deep understanding of users – their behaviours, motivators and barriers – is required. For this reason, qualitative research is considered an essential component of design thinking within much of the literature.

IDEO (2009, p. 20) provide a summary of how such research fits within the design process:

> Qualitative research methods enable the design team to develop deep empathy for people they are designing for, to question assumptions, and to inspire new solutions. At the early stages of the process, research is generative – used to inspire imagination and inform intuition about new opportunities and ideas. In later phases, these methods can be evaluative–used to learn quickly about people's response to ideas and proposed solutions.

While many methods of research are available – see IDEO's method cards (IDEO 2002) for some examples – observational techniques inspired by, or derived from, the anthropology and ethnographic research disciplines are considered especially effective tools to make sense of the complexity of people and culture (BusinessWeek 2006; Guardian 2010; Weber 2009). In contrast to articulated research techniques, such as focus groups or surveys, observational techniques aim to place the researcher in the participant's natural setting and context, reducing the reliance on the participant's conscious analysis of their own behaviour (Weber 2009, p. 15).

Mobile technologies also provide opportunities for new and interesting research methods of 'contextual inquiry' such as the mobile diaries, which provide "rich and deep insights into people's daily rhythms, thoughts and experiences" and allow participants to include other members of their social groups into the research process (Hagen, Robertson & Gravina 2007). Such methods extend the reach of the researcher into previously inaccessible contexts. Fabricant (n.d.) echoes this expanding role for technology in research, suggesting that social media technologies allow research methods to "play a more transformative role", something that Hagen & MacFarlane (2008) also explore when considering 'seeding' in the context of design and research for, and using, social media tools.

These techniques provide opportunities to dislodge hidden assumptions and uncover the influence of biases and heuristics that may remain unarticulated using traditional methods of research (BusinessWeek 2006; Gabrielli & Zoels 2003; Hagen, Robertson & Gravina 2007; Kumar 2009; Sato 2009; Visser, Stappers & Lugt 2005; Weber 2009). Suri & Howard (2006, p. 246) suggest that businesses "value this technique as offering more texture, sophistication, and depth than most traditional consumer research methods provide."

In other words, while traditional methods are useful at exposing the explicit knowledge of research participants, contextually-focused observational methods help illuminate tacit knowledge (Visser, Stappers & Lugt 2005). Visser, Stappers & Lugt (2005, p. 4) map various research methods in relation to the levels of knowledge accessed:

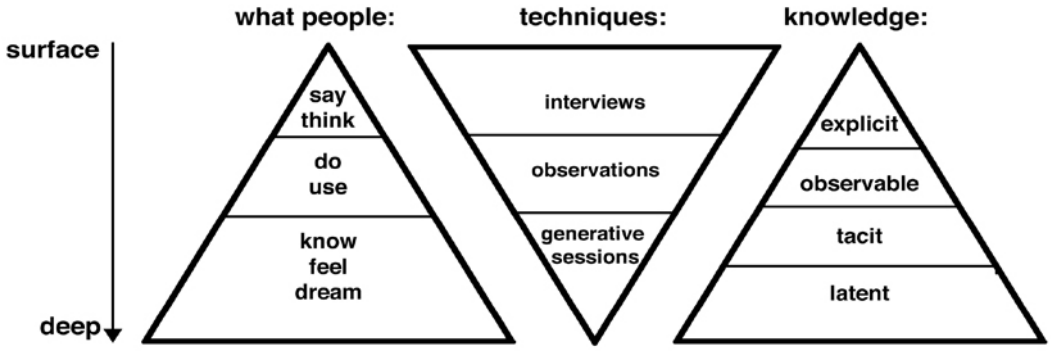

Figure 1: Visser, Stappers & Lugt illustrate the different levels of knowledge about experience are accessed by different techniques.

A slightly different perspective is presented by Weber (2009, pp. 20–21), who plots techniques across a continuum from articulated to unarticulated (which broadly map to "explicit" and "tacit" in Visser, Stappers and Lugt's description):

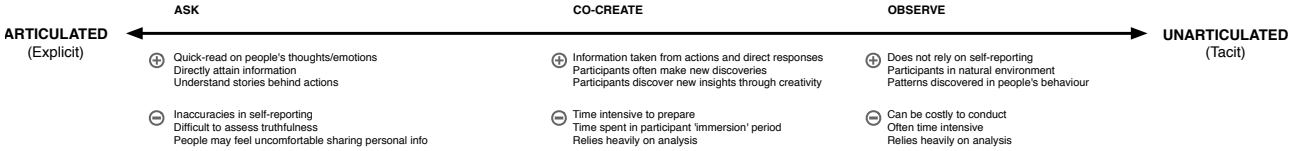

Figure 2: Adapted from Weber's map of articulated vs. unarticulated research methods, including pros and cons of each approach. Note that hybrid methods, such as mobile diaries, which combine self-reporting with technology-assisted observation, are not represented.

Another key aspect of design-oriented research activities is that they are targeted at solving specific business or design problems. That is, it is not merely an academic understanding of people and culture that is sought, but instead the aim is to understand a person's activities and product or service use within the context of their social and cultural world (Sato 2009, p. 41). While the data generated by such research are key to informing the design process, the value of observation comes from the "quality of interpretation and synthesis applied to the observations, the freshness of insights surfaced, and the effectiveness in influencing how companies respond." (Suri & Howard 2006, p. 246)

Broader contextual view

Sanders & Simons (2009, p. 2) cite Eero Saarinen who "reminds us to Always design a thing by considering its next larger context — a chair in a room, a room in a house, a house in an environment, an environment in a city plan". Understanding this broader context is often highlighted as a key component of innovation practice (for one example, see Kumar 2009, p. 93)

Kumar (2009, p. 93) outlines five contexts to be considered as part of a design-led innovation process:

1. **Physical:** How do people experience their physical interaction with things?
2. **Cognitive:** How do people associate meanings to things they interact with?
3. **Social:** How do they behave in teams or in social settings?
4. **Cultural:** How do people experience shared norms, habits, and values?
5. **Emotional:** How do people experience their feelings and thoughts?

"Zooming out for context" is highlighted by Suri & Howard (2006, p. 247) as a key element for achieving more "meaningful" design outcomes by creating a stronger foundation for insight gathering, interpretation and synthesis. Cultural forces can also have a significant impact on the

acceptance and/or use of a product or service (Suri & Howard 2006, p. 248), reinforcing the benefits of taking a broader contextual view. Avoiding assumptions about users or a product is another benefit of this approach (Visser, Stappers & Lugt 2005, p. 3).

IDEO (2009, p. 22) also notes that qualitative research can be ”powerful for analyzing and mapping the relational dynamics between people, places, objects and institutions,” hinting at research’s role in acquiring this broader perspective.

Collaborative & multi-disciplinary

Collaborative approaches and the multi-disciplinary nature of design thinking are also key themes of design thinking. This applies not only to the makeup of design teams themselves, but also to the employment of activities specifically geared towards the inclusion of end-users and other relevant stakeholders within the design process.

Multi-disciplinary teams

IDEO list “multi-disciplinary teams” among their best practices in human-centred design, noting that structuring design teams in such a manner creates “a better chance of coming up with unexpected solutions when these people approach problems from different points of view.” (IDEO 2009, p. 11)

Kumar (2009, p. 94) and Sato (2009, p. 48) see such teams as a key component of successful innovation practice. When such teams are engaged in a user-centred design approach, they are capable of conceiving “more powerful innovations than through more conventional approaches that tend to be biased to benefit the company.” (Sato 2009, p. 48)

Fullerton (2009, p. 9) reports that the assembly of teams comprising of representatives from different agencies or departments in service design and co-design activities “formed much of the foundation for successful service delivery and allowed for the development of a cohesive, connected set of support services.” This, along with Suri & Howard’s (2006, p. 248) observations of the benefits of opening up teams and Heapy’s (2010) experience with SILK, suggests additional, more subtle, benefits to including a wide variety of stakeholders in the design process – benefits that go beyond idea generation and solution design – including improved communications and breaking down of internal organisational barriers.

Co-design

The idea of including users in the design process is commonly referred to as ‘co-design’, an approach that philosophically positions users as experts in their own context (Rijn & Stappers 2008, p. 2). Sanders & Simons (2009, p. 1) define:

> co-creation as any act of collective creativity that is experienced jointly by two or more people. How is co-creation different from collaboration? It is a special case of collaboration where the intent is to create something that is not known in advance. The concept of co-design is directly related to co-creation. By co-design we refer to collective creativity as it is applied across the whole span of a design process.

Suri & Howard (2006, p. 248) position consumers as “creative participants rather than passive recipients”; Pilloton & Kuruvilla (2009, p. 48) express this simply as designing “*with*, not *for*.” This perspective is grounded in the “belief that all people are creative and seek outlets for creativity in their lives” and that co-creation “satisfies the need for creative activity while addressing the need for social interaction.” (Sanders & Simons 2009, p. 1)

Nussbaum (2007) suggests that co-design approaches are to an extent demand driven, as “People want to participate in the design of their lives. They insist on being part of the conversation about their lives.” He further highlights the impact that this shift is having on the design process and the role of the designer within it.

Co-design methods range from participation in brainstorming sessions to the creation of “tangible artefacts” (Rijn & Stappers 2008, p. 1) and prototypes, and can occur throughout different stages of the design process, as outlined by Sanders & Simons (2009, p. 3):

- **pre-design:** where innovation and opportunity development take place
- **design research and/or discovery:** where research and translation to design occur
- **design:** where exploration, design, and development take place
- **marketing, sales and/or distribution:** where implementation, roll-out and sales occur
- **after sales:** where product use and service experience take place

Co-creation can also occur in a variety of contexts (adapted from Sanders & Simons 2009, p. 1):

- within communities
- inside companies and organizations
- between companies and their business partners
- between companies and the people they serve (customers, consumers, users/end-users etc.)

Implicit in these approaches is a belief that engaging end users in the design process will result in more effective designs that are better suited to the end-users needs, thus increasing the potential for adoption of the resulting solution (Kumar 2009, p. 91; Visser 2009, p. 11).

A secondary benefit is that involving end-users in the design of solutions creates a sense of ownership of the solution, which can contribute to the adoption and advocacy of the solution within the end-user group. Matthew Taylor, Chief Executive of the Royal Society for the encouragement of Arts, Manufactures and Commerce (quoted in Guardian 2010) notes that “There is something about service design which motivates people and mobilises them, because they have a sense of ownership.” Campbell (2009), Fullerton (2009), Hagen & MacFarlane (2008) and Rijn & Stappers (2008) also point to a sense of ownership as a benefit of co-design approaches.

Iterative delivery & prototyping

Traditional project management practices follow a linear pattern, placing design towards the beginning of the process where requirements and specifications are ‘passed along’ to the next process for implementation and delivery, at which point design ceases to play a role. Design thinking instead emphasises non-linear and iterative processes, where a project is broken down into smaller pieces, or iterations, where sub-components of the larger deliverable are prototyped, tested and refined (or refactored) over time.

In a design thinking context, an iterative approach typically builds in opportunities for testing of designs with end-users to verify and further inform future design decisions, with the intention of reducing risks, improving visibility of progress and ultimately crafting a solution that is better suited to its intended purpose. An incremental approach also helps “identify what it will take for your organization to deliver that idea.” (IDEO 2009, p. 85)

Wever, Kuijk & Boks (2008, p. 6) represent this diagrammatically:

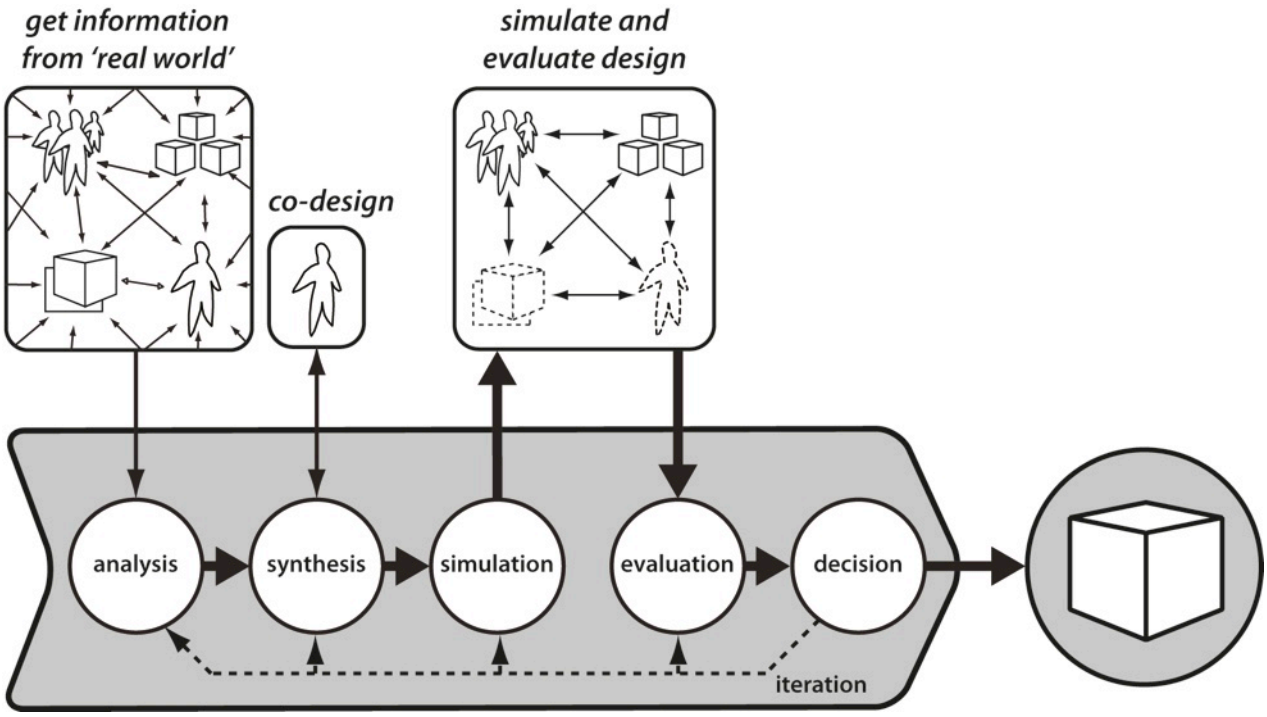

Figure 3: Wever, Kuijk & Boks representation of the iterative process incorporating user research, co-design and prototyping

While this particular representation does not reflect the cyclical nature of iterative development particularly well, it does indicate the opportunities for user input within iterations. The Scrum project methodology (Wikipedia 2010), developed for the management of software programming projects, is a popular iterative development framework that can be applied in other contexts, including design thinking-oriented projects.

Iterative delivery is especially useful when designing for systems where "The design process is ongoing, not complete at the point of (system) delivery," as Hagen, Robertson & Gravina (2007, p. 3) note in the context of design for online social systems. The design of 'real life' services arguably constitutes such a system, where delivered components support ongoing relationships and interactions beyond the point of delivery.

Prototyping

Gravina (2010) aptly describes prototyping as "thinking with your hands" and prototypes often form part of an iterative delivery approach. Prototypes are quickly created examples of components of a deliverable (product, service or system) that serve to communicate ideas and/or test concepts. Prototypes primarily relate to the "simulate and evaluate design" process outlined in Figure 3 above, and may also be an output of co-design activities.

Harrelson (2010) outlines three principles for effective prototypes:

- **Fast:** allowing for rapid iteration (and feedback)
- **Disposable:** enough to express the idea to be communicated, and no more
- **Focused:** selecting the most important things to test – such as significant "unknowns" or complex elements

Prototypes may be rendered in varying levels of 'fidelity' – low-fidelity prototypes are 'rough and ready' examples that are quickly produced with little concern for end-use durability – their purpose

is primarily to examine concepts and ideas; high-fidelity prototypes may range from functional, early test units of a product to being close to finished products, where production processes are being tested, for example.

While more commonly associated with product development, Gravina (2010) suggests that “you can prototype anything, you can prototype government policy, you can prototype a transport system.” As an example of larger scale prototyping efforts, Apple Inc. are reported to prototype entire retail store designs (Useem 2007).

Moving towards sustainability through design

The importance of sustainability considerations for business is well documented. The impacts of legislation relating to materials use such as Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), Restriction of Hazardous Substances Directive (RoHS) in the EU, 'takeback' provisions in various jurisdictions – including Waste Electrical and Electronic Equipment Directive (WEEE), also in the EU – have had a visible effect on product development, especially in the consumer electronics sector. Emissions trading and carbon taxes have also featured heavily in the business press.

In addition to such legislative pressures, brand/reputation management and risk mitigation, consumer demand and loyalty, and employee satisfaction are often cited as key drivers for businesses adopting more sustainable practices.

White & Stewart (2008, pp. 6–7) highlight five drivers of sustainable design practice in business:
1. More regulation
2. Global product recalls
3. Innovations by competitors and in supply chains
4. Demand for product transparency
5. Product boycotts and media campaigns

They go on to note that "The diverse set of risks and opportunities that now confront companies make consideration of environmental and social impacts in design more than a nice thing to do. Increasingly, it is becoming a matter of remaining relevant and viable in domestic and global economies." (White & Stewart 2008, p. 5)

Competitive advantage is of key concern to business, and Hawken, Lovins & Lovins (1999, p. xiii) counsel: "There is now sufficient evidence of change to suggest that if your corporation or institution is not paying attention to this [sustainability] revolution, it will lose competitive advantage." More recently, White & Stewart (2008), Werbach (2009), and Umair Haque's regular contributions to Harvard Business Review (Haque 2010), among others, reflect this perspective.

Despite this growing awareness, there is seemingly a long way to go before the activities of businesses are sustainable. As Stuart Walker (2002, p. 6) points out "The characteristics of our production systems, our economic systems, and our consumption patterns are, in very many ways, often physically, ethically and spiritually unsustainable."

This raises the question: given the increased influence of design on business outlined earlier, what role could design have in introducing sustainability to business practice? Throughout their book, *Natural Capitalism*, Hawken, Lovins & Lovins (1999) stress the importance of design in reference to everything from eco-efficiency to systems design, a sentiment echoed in McDonough & Braungart's *Cradle to Cradle* (2002) and Janine Benyus' *Biomimicry* (1998).

However, good design in itself does not necessarily produce sustainability outcomes (Campbell 2009; Pettersen & Boks 2008; White & Stewart 2008). Campbell (2009, p. 2) infers a link between unsustainable design outcomes to business priorities, suggesting that "As it has evolved as a commercial, industrial, professional activity, design is motivated more frequently by commercial imperatives, personal reputation, functional economy and fine craftsmanship for its own sake than by social benefit."

It is within this context that an increased awareness of design's role in achieving (or not achieving) sustainable development goals is filtering through the design community (examples include Campbell 2009; Lockton, Harrison & Stanton 2009; Manzini 2006; Pilloton & Kuruvilla 2009). BusinessWeek's Bruce Nussbaum (2007) pointed out to a group of design students: "The broad new paradigm for design — the paradigm you will all work within for the rest of your lives — is sustainability."

Campbell (2009, p. 5) suggests that "Many designers are conscious of their complicity in consumerism since so much of their work is intended to coerce the acquisition of more and more goods and products," contributing to unsustainable behaviours. Fabricant (n.d.) cites designers' ambitions for "the products we design to have more immediate impact through direct social engagement," and a "growing awareness that every decision we make exerts an influence of some kind, whether intended or not."

Ezio Manzini has long advocated an increased role for design in achieving a sustainable future. Sydney-based strategic design agency Digital Eskimo have also been vocal proponents of this idea within the local design sector. Initiatives such as the Designers Accord (2010), established by IDEO designer Valerie Casey, and Dan Lockton's Design with Intent Toolkit (Lockton 2010a) are other visible manifestations of this increased awareness.

There are many facets to design's potential role in achieving environmentally sustainable outcomes. These can be broadly categorised as:

- **Eco-design:** materials efficiency, environmentally-preferred materials, efficiency in use, design for disassembly/recycling, durability/longevity
- **Design for purpose:** matching user needs, designing the right (and subsequently less) "stuff"
- **Design for behaviour:** design that influences user behaviour for more sustainable use
- **Systems design:** whole system thinking, designing within context, product service systems, design of organisations

Additionally, Manzini (2002, 2006) and Campbell (2009) both suggest an underlying theme that could apply across these categorisations – the idea of designing for "resourcefulness", in Campbell's terms, or creating "enabling solutions", to use Manzini's phrase. This is another area where the methods of design thinking, due to their inclusion of users in the process of design, can potentially contribute to achieving sustainability goals.

Eco-design

When first approaching sustainability, organisations may be inclined to reduce environmental impact by seeking efficiency gains within specific processes within their organisations. This might be facilitated through the introduction of an Environmental Management System (EMS), and as is consistently reported in the business press, such an approach can provide significant benefits to a business (for an example of business results from EMS, see Lee 2009).

However, such "eco-efficiency" measures may miss a larger opportunity. Stuart Walker (2002, p. 4) advises that:

> Rather than considering how to integrate the principles of sustainability into an existing manufacturing system, it may be useful to approach the problem from the opposite direction, and consider how functional objects might be designed and created in ways that are compatible with the principles of sustainability.

This approach reflects that an estimated "80–90 percent of their life-cycle economic and ecological costs have already been made inevitable" by the time the design of products is completed, but before manufacture (Design Council UK 1997, cited in Hawken, Lovins & Lovins 1999).

The over-arching principle of a sustainability focus for product design is referred to as "eco-design", a concept that in itself has many facets, including:

- **Materials efficiency:** designing to reduce the materials required to create a product – for example, designing packaging that uses less cardboard to achieve the same functional benefit. This includes consideration of the durability and expected life of a product to choose materials appropriate for this use.
- **Environmentally-preferred materials:** designing for use of materials that have a lower environmental impact in manufacture, use or disposal – for example, the use of bio-plastics instead of petroleum-based products.
- **Efficiency in use:** designing products that require less resources during operation – for example, reducing the energy required to run an electrical device.
- **Disposal/recycling:** designing using organic or recyclable materials, design for disassembly etc. – for example, designing a mobile phone using recyclable plastic parts that allows for quick disassembly into separate components for faster processing at the point of recycling.

Design thinking can assist in the eco-design process in a number of ways. Linking people from across an organisation, each with their own domain expertise, is a key component of successfully integrating sustainability within an organisation's practice (White & Stewart 2008). Design thinking's collaborative and multi-disciplinary approach are well suited to creating such linkages and encourage cross-functional dialogue.

Understanding user behaviour and use of products in context through observational research can uncover opportunities for improving materials or in-use efficiency through redesign that better reflects 'real-life' usage. For example, switching from plastic to cardboard for single use packaging, as cardboard has a much lower impact, and is therefore more suitable for some single-use purposes. Electricity power boards that are linked to a computer's USB port to automatically turn of peripherals when a computer is not in use is another. Or the "blind mode" on televisions devised by Rodriguez & Boks (2005, cited in Wever, Kuijk & Boks 2008, p. 3), in which sound is played without picture, could reduce in-use energy consumption. (In this instance, the proposed design *reflects* behaviour, not *influences* it – a distinction that is important when we consider *Design for behaviour* later.)

While an important part of the design mix, eco-design alone is widely considered insufficient to address the sustainability challenges we face. Critiques revolve around three key points:

1. Underlying production systems are inherently unsustainable, thereby any changes to the design of products will have minimal effect, or in some cases negative consequences (Hawken, Lovins & Lovins 1999; Manzini 2002, 2006);
2. Product usage and user behaviour may have significant negative side- or so-called "rebound" effects (be they social or environmental) outside the product's manufacture, direct use and disposal (Lilley, Lofthouse & Bhamra 2005; Manzini 2002; Werbach 2009; Wever, Kuijk & Boks 2008);
3. Eco-design does not question whether or not a product makes "a meaningful and responsible contribution to material culture," (Walker, S 2002, p. 6) resulting in products that may be produced using 'eco-friendly' attributes (such as materials etc.), but ultimately provide limited societal benefit.

Design for purpose

It is said that most sustainable product is the one that's not produced. Matching productive activity to user needs and perceived value is a useful strategy for reducing *muda* (as discussed in Chapter 7 of Hawken, Lovins & Lovins 1999) and by extension increasing business returns (Kumar 2009). Wever, Kuijk & Boks (2008, p. 7) call such considerations "functionality matching."

User engagement in the "fuzzy front end" or "pre-design" phase of the product development process can help to "define the fundamental problems and opportunities and to determine what is to be, or should not be, designed and manufactured." (Sanders & Simons 2009, p. 3) It is at this point in the design process that co-creation is most likely to result in social value being generated (Sanders & Simons 2009, p. 4)

By taking a human-centred approach and placing the emphasis on user needs and motivations, design thinking has the potential to guide designers away from solutions that, while seemingly good ideas, are less likely to be useful to or adopted by end-users. This is a less-documented benefit of design thinking's contribution; commentary on design thinking tends to focus on the outputs of the process – that is, innovations produced – rather than the reduction of social and natural capital waste afforded by design processes that steer designers away from sub-optimal solutions that are less likely to support their intended objectives.

Observational research and iterative delivery and prototyping can also play a role in creating products that are more suited to achieving their objectives, such as in Wever, Kuijk & Boks (2008, pp. 10–13) examination of the design of an energy usage meter.

Figure 4: Wever, Kuijk & Boks illustrate on-screen (left), physical simulations (middle) of the product during user evaluations (middle and right), demonstrating a process incorporating iterative delivery and prototyping with observational research.

Co-design activities may also "lead to a better match of design features and practices of usage and are crucial for the successful dissemination of technologies", with potentially market-wide implications (Ornetzeder & Rohracher 2006, p. 140).

Designing for behaviour

Pettersen & Boks (2008, p. 107) note that the roots of eco-design and design for sustainability in the technical disciplines has resulted in limited research focus on demand-side and consumption aspects. This is despite awareness that a significant proportion of environmental impacts from products occur during use (Wever, Kuijk & Boks 2008, p. 2).

These negative environmental, economic or social impacts are sometimes caused by unintended user behaviour – commonly referred to as 'rebound effects' – suggesting that technological innovation alone is insufficient to achieve the desired outcomes (Lilley, Lofthouse & Bhamra 2005, p 6.).

Whereas 'eco-design' and 'design for purpose' focus on "fulfilling functions in a more sustainable way, within a given use-profile" (Wever, Kuijk & Boks 2008, p. 2), 'design for behaviour' considers how user behaviour can be influenced through product and service features designed to curb unsustainable practices (Campbell 2009; Fabricant n.d.; Lockton 2010a). Design interventions that take into account user's behaviour can provide low cost opportunities to prevent undesirable and potentially costly side effects of product use, as Wever, Kuijk & Boks' (2008, p. 1) illustrative example of car door locks that disallow drivers locking their keys in the car demonstrates.

Changing people's behaviour is a complex challenge, with inter-dependent habits and practices, along with functional and symbolic reasoning influencing individual consumption patterns (2008, pp. 110–111). Actual behaviour can also differ from intended behaviour or expressed attitudes, as Martiskainen (2008, p. 87) explains:

> Our behaviours are not simple but based on various components, of which habits and routines form the most challenging and complex part. Even though a person's attitude may be positive towards certain pro-environmental behaviours and the person may have an intention of undertaking that behaviour, his or her habits can get in the way and prevent that behaviour from happening, or the person may act opposite to his or her intention without even realising it (e.g. I will turn my television off at the end of the day as it saves electricity, but in the evening my habit of leaving it on standby takes over without me realising it and I wake up in the morning with the television on standby - again).

As such, Martiskainen (2008, p. 87) suggests that changing people's behaviour requires consideration of a range of influences which he summarises into three groups:

1. Internal factors: personal values, attitudes, beliefs
2. External factors: regulations, institutions, cultural settings
3. Habitual: habits and routines

In *The 7 Doors model for designing & evaluating behaviour change programs* Robinson (2004) outlines four factors that need to be addressed to achieve the sustained, voluntary adoption of a behaviour or product:

- **Pre-disposing factors:** which lead to a person to consider change
- **Enabling factors:** which remove barriers to or actively support change
- **Triggering factors:** which prompt the person to attempt behaviour change
- **Satisfying factors:** which reward the changed behaviour and contribute to ongoing adoption

Whereas the *7 Doors...* model examines the factors that lead to behaviour change from an individual's perspective, Robinson's later *Enabling Change Theory* evolves this into a model containing five elements to successful change programs. In this model, communication through social networks (physical and virtual) is introduced ("Buzz"), and enabling factors are further expanded upon to include self-efficacy (which includes "increasing familiarity", "social proof" and "being part of a purposeful group") and enabling environments (the physical and social settings in which people act).

Robinson's two models can be roughly overlaid:

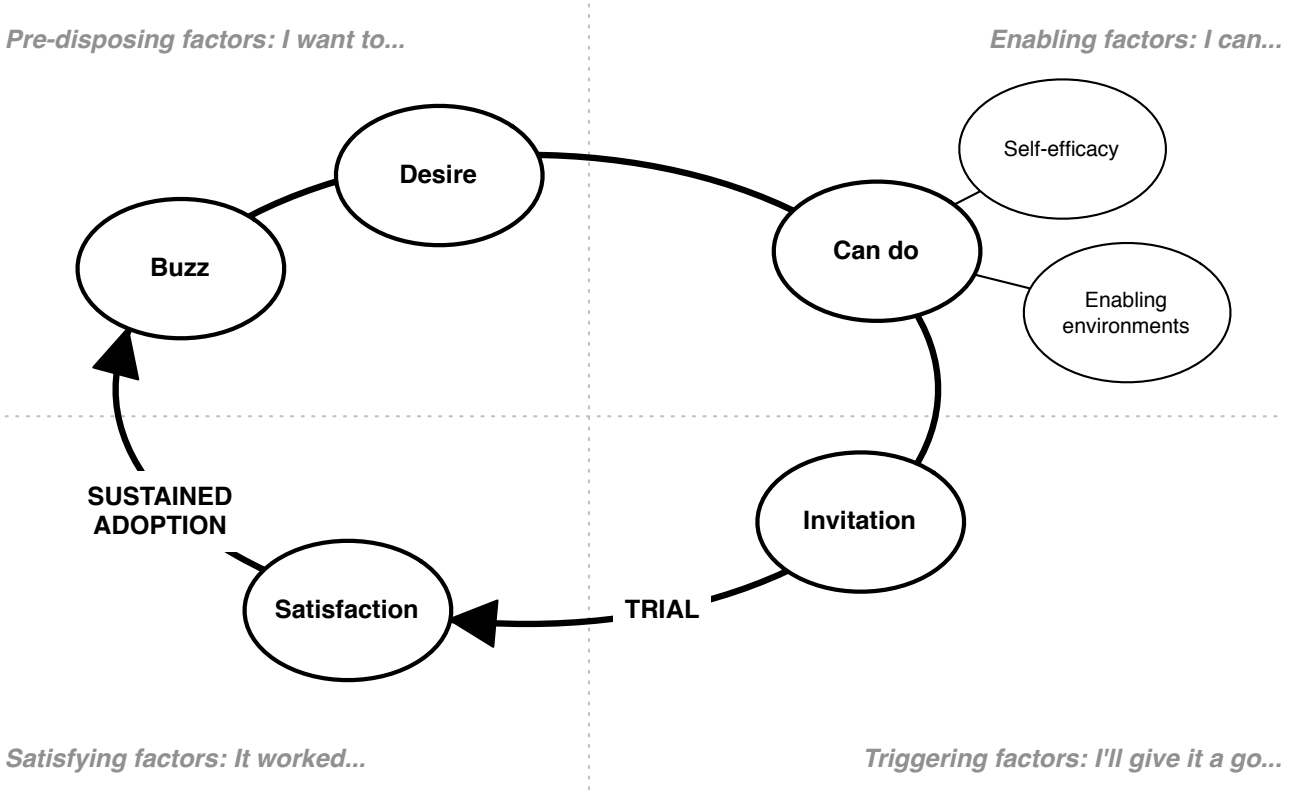

Figure 5: Factors in achieving voluntary behavioural change. Adapted from *Enabling Change Theory* and *The 7 Doors model for designing & evaluating behaviour change programs*, both by Les Robinson

While this mapping is not perfect (for example, "Buzz" is not limited to being a pre-disposing factor, it is also part of successful communication of change programs), it is useful in exploring design thinking's role in achieving behaviour change.

In reviewing literature encouraging behaviour change through design, Lilley, Lofthouse & Bhamra (2005, p. 7) identify three primary methodologies:

- **Scripts and Behaviour Steering**: products or systems that contain 'scripts' or prescriptions for use to encode the designers use intention
- **Eco-Feedback**: those that inform users of their impact in an attempt to persuade them to modify their behaviour
- **'Intelligent' Products and Systems**: those that circumvent rebound effects by ceding decision making to an 'intelligent' product which mitigates controls or blocks inappropriate user behaviour

The *Design with Intent* framework (Lockton, Harrison & Stanton 2009) takes a different tack, identifying methods for influencing behaviour from across a variety of design disciplines. The related *Design with Intent Toolkit* (Lockton 2010a) acts as a guide for designers aiming to influence user behaviour for social benefit. The toolkit outlines eight lenses that can be applied when considering a design challenge to influence user behaviour:

Lens	Description
Architectural	The Architectural Lens draws on techniques used to influence user behaviour in architecture, urban planning, traffic management and crime prevention through environmental design (see also the Security Lens).

Lens	Description
Errorproofing	The Errorproofing Lens treats deviations from the 'target behaviour' as 'errors' which design can help avoid, either by making it easier for users to work without making errors, or by making errors impossible in the first place. Errorproofing doesn't care whether or not the user's attitude changes, as long as the target behaviour is met.
Interaction	The Interaction Lens brings together some of the most common design elements of interfaces where users' interactions with the system affect how their behaviour is influenced.
Ludic	The Ludic Lens includes a number of techniques for influencing user behaviour that can be derived from games and other 'playful' interactions, ranging from basic social psychology mechanisms such as goal-setting via challenges & targets, to operant conditioning via unpredictable reinforcement and rewards, to common game elements such as cores, levels and collections.
Perceptual	The Perceptual Lens combines ideas from product semantics, semiotics, ecological psychology and Gestalt psychology addressing how users perceive patterns and meanings as they interact with the systems around them, and puts them into forms which invite the designer to think about how they might influence people's behaviour.
Cognitive	The Cognitive Lens draws on research in behavioural economics and cognitive psychology looking at how people make decisions, and how this is affected by 'heuristics' and 'biases'. If designers understand how users make interaction decisions, that knowledge can be used to influence interaction behaviour. Equally, where users often make poor decisions, design can help counter this.
Machiavellian	The Machiavellian Lens comprises design patterns which, while diverse, all embody an 'end justifies the means' approach of the kind associated with Niccolo Machiavelli. These will often be considered unethical, but nevertheless are commonly used to control and influence consumers through pricing structures, planned obsolescence, lock-ins etc. Elements of game theory are present in some of the patterns.
Security	The Security Lens represents a 'security' worldview, i.e. that undesired user behaviour is something to deter and/or prevent through 'countermeasures' designed into products, systems and environments.

Table 1: Adapted from Design with Intent: A3 workshop sheets (Lockton 2010b)

Design thinking can help achieve behaviour change through design in a number of ways. Taking a human-centred approach shifts perspective from the technical to one in which human biases and heuristics play a role, and where personal values, attitudes, beliefs, cultural settings are considered when designing solutions. Fabricant (n.d.) also suggests that empathy is an essential component of designing for behaviour change, which, as identified earlier, is a key benefit of a human-centred approach.

Observational research can help identify which ‘pre-disposing’ and ‘triggering’ factors have the most resonance with end-users so that these can be amplified and accommodated in design responses. Research can also help identify the key barriers to self-efficacy as well as deficiencies in the enabling environment that need to be addressed, further pinpointing design interventions.

As noted previously, observational research methods can uncover unconscious behaviours, habits, routines, attitudes and beliefs – such factors that have been identified in supporting or influencing

unsustainable actions. Recognising these is especially important when such factors cause behaviours that are in contradiction to consciously expressed attitudes and desires – illuminating the gap between what people *actually* do and what they *say* they do.

Co-design techniques can be employed to address these barriers and support the process of behaviour change. The social proof that supports individuals' sense of self-efficacy (Robinson 2009) could conceivably be generated by the outputs of co-design activities, as hinted by Hagen & MacFarlane (2008) idea of 'seeding'. The sense of ownership identified by proponents of co-design approaches may increase the resultant uptake of the behaviour/product within the community it is aimed to benefit (Ornetzeder & Rohracher 2006, p. 2).

In addition to its more well-recognised benefit in refining a product or service, iterative delivery and prototyping can also help identify where design responses may cause unanticipated effects that can be designed out if negative, or potentially amplified if positive, in the final product. They can also facilitate the exploration 'invitations' and efficacy of 'satisfaction' factors, including the design of eco-feedback mechanisms. Schultz et al's (2007) research into the use of 'smiley faces' to represent energy consumption in comparison to social norms is an example of how such an approach can overcome rebound effects in the context of eco-feedback.

In addition to the more general benefits of collaborative approaches, the *Design with Intent* (Lockton 2010b) lenses demonstrate how a multi-disciplinary approach can play an important role in responding to the challenge of behaviour change.

Systems design

To maximise the benefits of design, Hawken, Lovins & Lovins (1999) suggest applying "whole system thinking" in response to sustainability challenges. Rather than simply 'balancing' or 'trading off' different sustainability objectives, they propose an integrative design approach "at every level, from technical devices to production systems to companies to economic sectors to entire cities and societies," (Hawken, Lovins & Lovins 1999, pg. xi) observing that:

> The greater the degree to which the components of a system are optimized together, the more the trade-offs and compromises that seem inevitable at the individual component level becomes unnecessary. These processes create synergies and felicities for the entire system. (Hawken, Lovins & Lovins 1999, p. 113)

For example, a building that employs passive solar principles and eco-efficient materials in a systematic way can remove the need for expensive cooling or heating equipment that would otherwise be required. Such an opportunity would be missed if only the sustainability (for example, energy efficiency) of that cooling or heating equipment was considered (Hawken, Lovins & Lovins 1999, p. 87).

They further warn that:

> Without a fundamental rethinking of the structure and the reward system of commerce, narrowly focused eco-efficiency could be a disaster for the environment by overwhelming resource savings with even larger growth in the production of the wrong products, produced by the wrong processes, from the wrong materials, in the wrong place, at the wrong scale, and delivered using the wrong business models. (Hawken, Lovins & Lovins 1999, p. x)

This suggests that systems-level thinking beyond the scope of individual products, or even individual businesses, is an important consideration in tackling sustainability challenges. Design interventions may thus be retargeted to address underlying conditions that cause unsustainable

behaviours or outcomes, rather than trying to alleviate symptoms (for example, through the design of products that are likely to be ineffectual given larger system biases/pressures).

The parallels between Hawken, Lovins & Lovins' "whole system thinking" concept and the broader contextual view of design thinking seem reasonably clear. There are other aspects of design thinking, however, that are also relevant in this context.

While noting that consideration of sustainability "often takes a systems approach to problems to account for and chronicle the complex intertwining of resource, social and economic ecosystems," White & Stewart (2008, p. 11) state that such an "approach often fails to provide a clear map for changing that system." They suggest that human-centred design can augment the more technical aspects of sustainable design thinking with consideration of human interests.

Providing an example of small-scale system considerations, Tang & Bhamra (2008, p. 12) document how observational research examining refrigerator usage identified opportunities for the design of food storage systems that could facilitate more sustainable energy and food consumption behaviour.

As part of the Fast Company/Designers Accord Biomimicry Challenge, design firm Smart Design put together a multi-disciplinary team including biologist Mark Dorfman to examine sustainable city design – an example of a large-scale system design exercise. This multi-disciplinary approach had impacts in both directions – mapping human-systems using a biological lens and biological systems serving as inspiration for solving human-centric challenges (Walker, A 2010). Broad stakeholder engagement is also highlighted as a key element in the success of the design of ING (then NMG) Bank's headquarters (Hawken, Lovins & Lovins 1999, p. 83).

When dealing with systems design, iterative delivery is also important, as rebound effects and unanticipated side-effects are likely to be more common given the complexity of the challenges being tackled. In this vein, Manzini (2003, p. 1) suggests that:

> given to its complexity, the transition towards sustainability will be very far from being a linear evolution. On the contrary, it will be a complex social learning process: a sequence of events and experiences thanks to which, progressively, amid mistakes and contradictions as always it happens in any learning process – human beings will learn to live in a sustainable way.

The Brazilian city of Curitaba's use of the "architectural charrette" where "Conceptual tests of new ideas lead quickly to their application [and] Risks are taken in the expectation that mistakes will be made, quickly detected and diagnosed, and corrected," (Hawken, Lovins & Lovins 1999, p. 300) and Stuart Walker's (2002, p. 7) encouragement of "diversity and variety, trial and error, and experimentation" also infer the importance of an iterative approach. A Better Place's incremental roll-out of its battery swapping stations internationally is another example of an iterative delivery approach for a larger scale system (A Better Place 2010).

Product Service Systems

There is one particular aspect of systems design that warrants further investigation in relation to the role of design thinking, that of Product Service Systems.

Product Service Systems (PSS) stem from the idea that the value people ascribe to services or products don't necessarily relate to the good or service itself, but instead are derived from the resultant benefit the good or service provides. To illustrate, Martiskainen (2008, p. 74) presents the example of gas or electricity: energy consumers benefit from the services these energy sources provide, such as heating, cooking, lighting and using electrical appliances. Kimble's

(2009, pp. 2–3) consideration of “value-in-context” versus “value-in-exchange” also relates to this concept.

Manzini (2002, p. 1) suggests that the idea of PSS is linked to a shift in perception of wellbeing – from the dominant “product-based wellbeing”, where a sense of wellbeing is derived from product *ownership*, to “access-based wellbeing”, where this sense instead is derived from *freedom of access* to the service or experience a good provides.

Pettersen & Boks (2008, p. 110 citing Røpke 1999) note that, as manufacturers have to-date largely externalised environmental and social production costs, “relative prices favour industrially manufactured products over non-industrial products and services, contributing to material consumption and individual ownership.” This could be extrapolated to infer that as such costs are internalised, PSSs may become more cost-effective, and subsequently more desirable and prevalent.

In support of the PSS concept, Hawken, Lovins & Lovins (1999, p. 10) suggest that "an economy that is based on a flow of economic services can better protect the ecosystem services upon which it depends." They argue that the PSS approach aligns business returns with sustainability outcomes, as the financial benefits of increased efficiency, durability (longevity) and recyclability are captured by the producer of the goods, incentivising improvements in these key areas. The thinking goes, this results in lower materials intensity for the same level of service provision, an outcome also highlighted by Pettersen & Boks (2008, p. 119 citing Mont 2001).

Riversimple founder Hugo Spowers explains (as reported by Pearce 2010):

> “In the ‘sale of product’ world you are rewarded for unreliability, high maintenance and short product life. We want to reverse that,” says Spowers. “Using the ‘sale of service’ model, we want the car to be reliable and long lasting, and for the customer to use as little fuel as possible, because we’re paying for it.
>
> “Similarly, if we are leasing a component from a supplier, the longer it lasts, the more revenue they can squeeze out of it. They can have a higher margin and it can still be cheaper to us, so everyone wins. That makes the relationship between the manufacturer and the supplier more collaborative.”

While there are some valid criticisms of the “access-based wellbeing” model (Manzini 2002), there is evidence of a growing interest in such models within the business and design communities, an interest that extends beyond their applicability to sustainability (Aaltonen 2010; Amit 2010; Campbell 2009; Kimbell 2009).

PSSs take three main forms (adapted from Pettersen & Boks 2008, pp. 120–121):

1. **Product-oriented services:** services are added to existing systems. The popular iTunes/‘iDevice’ ecosystem is one example of a product-oriented service, where the physical products of audio CDs, DVDs and books are replaced with a hybrid of software, an online service and a physical music player device. In this model, the physical product (the music player) is still owned by the end-user.
2. **Use-oriented services:** intensified product use through pooling or sharing. Australian car sharing service GoGet (GoGet 2010) is an example of a use-oriented service.
3. **Result-oriented services:** where the utility of products are provided through a service, rather than ownership, model. Examples include InterfaceFLOR’s provision of “floor-covering services” (Hawken, Lovins & Lovins 1999, p. 17) and the aforementioned Riversimple personal mobility system (Riversimple 2010). In this model, ownership of the physical product resides with the service provider.

Design thinking sees the relationship between the firm, the customer and the object as the locus of value-creation, where "value is co-created in practice." (Kimbell 2009, p. 7) This suggests that design thinking – especially as manifested in the emerging area of service design – can play a positive role in the identification of opportunities for, and design of, PSSs.

Taking a broader contextual view provides an understanding of the surrounding systems and context of use of products, potentially illuminating PSS opportunities. Observational research with design-oriented 'mapping' (such as customer journey mapping (Tassi 2009)) techniques could also conceivably support this goal in identifying the relationships between products, services and the various actors involved in a user's activities.

More generally, design thinking principles including iterative delivery & prototyping can assist with streamlining and refining product and service delivery, as evidenced by livelwork's work with Streetcar (livelwork 2010b). Similarly, observational research can be used to identify and address conceptual and other barriers that may impact the uptake of such services.

Multi-disciplinary teams are required, almost by definition, to define and implement PSSs. There are potentially significant ramifications for the underlying business models of organisations shifting from 'sale of product' to 'provision of service' models (Pettersen & Boks 2008, p. 120, citing Tukker and Tischner 2006). Heapy (2010) suggests that service design can play a role "in addressing business and social challenges beyond the design of individual products and services," including changes to business models.

Enabling solutions

Manzini (2006, p. 4) notes that design is often invoked as a means of solving problems, with a tendency to create what he terms "disabling solutions" – which he describes as systems that "sequester formerly widespread knowledge and skills to integrate them into technical devices". Such solutions have the rebound effect of "reducing the skills, abilities and know-how that traditionally enabled individuals and communities to deal with the most diverse aspects of daily life: to take care of the environment, of others and often themselves." (Manzini 2006, p. 4)

Campbell (2009, p. 2) picks up on this theme when she asks (emphasis mine):

> In one classic definition of design as problem-solving, *design takes problems away*. ... But can design do more? Can it show you how the problem is to be solved without doing it for you? ... Is it possible for designers to redefine themselves – or expand their definition of themselves – not merely as making more beautiful resources, but as *making people more resourceful*?

In contrast to "disabling solutions," Manzini (2006, p. 4) refers to designs that support such resourcefulness "enabling solutions". To create enabling solutions, he suggests that designers need to change their ideas about the user's role in design, moving from considering them as a passive recipient to active participant in developing solutions, in part "because he/she is best acquainted with the specific problems to be solved." (Manzini 2006, p. 4).

This, of course, is aligned with the philosophy of co-design. Along these lines, Sanders & Simons (2009, p. 2) highlight that "The social value of co-creation is fueled by aspirations for longer term, humanistic, and more sustainable ways of living," echoing Manzini's view. Suri & Howard (2006, p. 250) also share their belief that "the power of corporate ethnography—its biggest impact—will be to uncover opportunities that mutually benefit all of the people who participate in the economic and social network."

Ornetzeder & Rohracher's (2006) examination of the relationship between self-building groups and the development of the thermal solar collector market in Austria from the early 1970s into the 1990s, which has strong parallels to the ideas of co-creation, provides an example of what Manzini calls a 'creative community' (Manzini 2006, p. 5), which he suggests play an active role in the generation of enabling solutions.

It is apparent, then, that collaborative and multi-disciplinary theme of design thinking, especially as manifested in co-design activities, could play a positive role in the development of the enabling solutions that Manzini (2006) envisions.

Conclusion

As creativity and the designer's approach to problem solving become a necessity for business management in an increasingly complex world, the already increasing role for design in business is expected to grow further. Design thinking techniques encompassed by the key themes presented in this paper – human-centred, research-based, broader contextual view, collaborative & multi-disciplinary (incorporating co-design), and iterative delivery & prototyping – are often utilised by businesses seeking competitive advantage and innovation.

However, the complexities facing business now include the need to become more resource efficient and implementing business models that increase value to customers while simultaneously reducing material inflows and waste – stated plainly, business needs to achieve more with less. Sustainable design and its many facets – including eco-design, design for purpose, design for behaviour and systems design, along with the philosophical shift towards "enabling solutions" – is an important part of the response to these challenges.

This paper argues that same design thinking tools gaining currency in the business/innovation frame can play a constructive role in enabling sustainable practice, if applied to such ends. Among other benefits, design thinking can assist businesses in adjusting to new business models, such as those provoked by a shift to Product Service Systems, among other competitive and market pressures.

As the tools of design thinking are considered a way to deal with the increased complexity of the business, natural and social environment, it could be argued that design thinking increases in importance and utility the further along the path from 'eco-design' to 'enabling solutions' we progress.

Thus, while examples of the application of design thinking applied to environmental sustainability are somewhat scarce at this point in time, this paper suggests that more examples will become apparent as design thinking plays a larger role in sustainable practice into the future.

And with business focusing on the innovation outcomes of design thinking, coupled with the growing evidence of a link between financial performance and both sustainable practice and design, there perhaps is also an opportunity to link a focus on sustainability with innovation practice. At a minimum, this is an area worthy of further exploration.

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