Hands on, hearts on, minds on: design thinking within an education context.

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1. Introduction

From a historical perspective, the basic tradition of Western thinking has aligned itself predominantly with scientific thinking as opposed to design thinking (Golsby-Smith 2008). Consequently, education, organisations, and business have all adopted and, in general, continue to utilise science or analytic thinking as the dominant mode of thought and problem solving. Today however, leaders are faced with progressively more complex problems which cannot be easily solved by utilising traditional problem solving processes or hegemonic systems of inquiry such as science. This belief is clearly echoed by Charles Owen (2005, 5) who, in a keynote speech given at the International Conference on Design Research and Education for the Future[i], stated that

> More than ever before, scientific advice requires serious consideration. And another kind of thinking deserves equal attention. Design thinking is in many ways the obverse of scientific thinking. Where the scientist sifts facts to discover patterns and insights, the designer invents new patterns and concepts to address facts and possibilities.

In keeping with this, there is a growing focus on design thinking as an alternate mode of inquiry within a contemporary decision-making context.

The notion of design as a credible and valuable way of thinking to deal with contemporary problems is being pursued within a widening domain. Changes in design practice and the understanding of design as a strategic tool have been important catalysts for a growing acceptance and appreciation of design. At present, design is increasingly viewed as an

activity or process which facilitates the creation of preferred and/or appropriate conditions, artifacts and environments for a specific intent and purpose. This definition of design traverses not only the traditional fields of design such as graphic design, information design, industrial design and interior design, but can also be applied to new design domains, namely 'organisational design, social systems design, educational systems design, work place design and healthcare design' (Nelson & Stolterman 2003, 2).

The changing nature of design practice and the role of design within a widening domain indicate that the survival of design as a profession may depend less on traditional design education and more on responding strategically to contemporary changes, influenced by ethical and environmental issues as well as technological advancements. As a result one of the challenges facing contemporary design educators today is how to prepare and educate design students in light of the expanding and shifting definitions of the profession as well as changes in social responsibilities.

To this end, the aim of the paper is to explore the nature of design thinking and to explore the application of this mode of inquiry within an education context. Seminal authors Nigel Cross (2006), Bryan Lawson (2006) and Nelson and Stolterman (2003) are consulted to present an overview of the design process and to arrive at the characteristics of design thinking. For purpose of the paper, reference will be made to *the lil' green box,* a social innovation project by a final year Information Design student from the University of Pretoria, as a case study to highlight the practical application of design thinking.

2. From design to design thinking

The work of designers is not fixed and, over time, has always been influenced and moulded by developments in technology, as well as societal and cultural shifts. Nonetheless, the widespread understanding of a designer's role remained fairly constant during most of the twentieth century. The designer's role was traditionally bound to the creation and function of forms such as images, information, objects and products (Brown 2008, 86). This understanding of the role of the designer stems explicitly from the word design, which is both a verb and a noun (Lawson 2006) and can either refer to an activity (the process of design) or to the result or outcome of that activity (usually referred to as a product) (Borja de Mozota 2003).

The traditional understanding of design focused primarily on the end products of design and within this context, design was often treated as a late-stage add-on or final step in the innovation or development process, where the designer was usually called on to 'put a beautiful wrapper around the idea' (Brown 2008, 86). Today, however, the practice and awareness of design is changing and there is a growing focus on design as a process. Rather than the designer merely playing a tactical role in making an idea look more attractive to the target audience, the designer is increasingly being consulted in a strategic capacity at the front-end of innovation (Brown 2008).

This widening domain in which design is currently practiced stems mainly from the changing nature of the design product. To understand the changing nature of the product and the designer's role since the twentieth century, Buchanan (1992) has suggested that there are four orders of design. The four orders are essentially four broad areas of design or more

specifically, areas of design thinking which have emerged as a result of the designer's encounter with new problems (Buchanan 1998). At present, instead of focusing primarily on the creation of symbols and material objects and strategic planning (first to third order), designers are now moving towards a fourth order or area of design which is characterised by the creation of complex systems and environments. According to Buchanan (1992, 7), 'this area is more and more concerned with exploring the role of design in sustaining, developing and integrating human beings into broader ecological and cultural environments shaping these environments when desirable and possible or adapting them when necessary'. In light of this, it is clear that the focus in design has shifted from material systems to human systems (Buchanan 2001), where the products of design began to take on a new meaning and often become activities or services with an increasing socially responsible stance. Nonetheless, this shift towards a fourth order of design does not disregard the first two orders of design communication and construction as they form the basis of what design is. Golsby-Smith (1996) also adopts a similar viewpoint when he states that each of the orders do not replace each other but rather build upon each other.

The changing conception of designed products points the way to new opportunities opening up for designers to traverse traditional design disciplines and to enlarge their range of activity. It is therefore essential for designers to keep their profession relevant and to develop and articulate new areas of design in order to deal effectively with change and complexity in the twenty-first century. As mentioned in the introduction, one such area or discipline which is receiving increasing recognition is design thinking. Within the widening domain of design, design thinking has surfaced as an important design tool or skill for innovation in general and more specifically, social innovation. The work of influential, global innovation companies such as Frog, Cooper and IDEO bears testimony to a focus on social innovation in

professional design practice. According to IDEO (Social Innovation 2011), their 'social innovation seeks to create transformational change in under-served, underrepresented, and disadvantaged communities worldwide' and hence they 'use design thinking to address issues such as poverty, nutrition, health, water and sanitation, economic empowerment, access to financial services, and gender equity.' Within a local context, there is also a growing focus on social innovation. For example, South African based Praekelt Foundation focuses specifically on using mobile technology for social and economic development on the African continent. A noteworthy project of theirs, Young Africa Live, is an innovative mobile health (more commonly referred to as mHealth) initiative which focuses on educating the youth about HIV/AIDS and also encourages sharing of information and dialogue amongst users of the mobile platform (Praekelt Foundation). Such focus on social issues, with an inherent human-centered underpinning, indicates new directions of professional practice for designers. Furthermore, new directions of professional practice also impact on education and hence there is also an increasing academic interest in the possibilities of design thinking.

3.   The design process

In order to actively pursue design thinking as a promising alternative approach to science thinking within an academic and professional context, it is essential for designers to be able to understand the nature of the design process. Owing to the complex nature of contemporary problems, design is not normal problem solving where the problem and solution are seen as separate entities that are bridged by a linear process. The complex nature of contemporary problems is in keeping with Horst Rittel's concept of wicked problems; Buchanan (1992) acknowledges that the concept was introduced by Horst Rittel during the 1960s when design methodology emerged as a key area of research in design. Furthermore, Buchanan (1992) indicates that the point of departure for the concept of wicked problems was the search for an

alternative to the dominant linear model of design that was adopted by design theorists and practitioners at the time. Rittel's argument was that 'the linear model of design thinking is based on determinate problems which have definite conditions' (Buchanan 1992, 15) and in contrast, he believed that the concept of wicked problems accepts the indeterminacy of design problems. Consequently, wicked problems were defined as 'a class of social system problems which are ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values and where the ramifications in the whole system are thoroughly confusing' (Buchanan 1992, 14). This definition hints effectively at the complex and unpredictable situations with which designers are faced.

Consequently, as design problems have become increasingly complex, design has become more of a problem processing task than a problem solving process (Julier 2000). Lawson (2006) also views design as being more than just problem-solving. Additionally, Lawson also adopts the idea of design as a conversation and in so doing his sentiments echo Schön's (1983) concept of design as a reflective conversation where both the design problem and solution are bound by a complex relationship. This implies that for a designer, the application of design thinking on an operational level is therefore inextricably linked to the activities that collectively constitute the design process. To facilitate a wider consideration of the nature of design thinking in this paper, it is therefore necessary to first explore the design processes and ways of thinking adopted by designers. This is done by presenting a model of designing. This paper does not present an existing model of design thinking as proposed by an innovation company such as IDEO for example. This is not to say that such model/s are not acknowledged or accepted but a reference to the selected authors - Nelson and Stolterman (2003), Cross (2006) and Lawson (2006) - is a conscious decision by the author to consider, collate and present information more rigorously from researchers who have been seminal in

contributing to contemporary design thinking discourse. Owing to the education context of this paper, this decision also allows for a wider consideration of the design process that students should consider.

Furthermore, the stance adopted in this paper is that the activity of design involves specific mental processes or distinct ways of knowing and doing and this standpoint is substantiated by consulting Nelson and Stolterman (2003), Cross (2006) and Lawson (2006). The authors consulted do not provide one clear-cut theory of designerly ways of thinking and doing. However, they provide several different explanations with a common thread binding their work, in that each of them argue that there is something that can be labelled a designerly approach, and that design is a unique activity deserving significant attention as an area of study. The selected authors also agree that such a design approach differs from the scientific approach and is based on design practice (Stolterman 2008). For purposes of this paper, Lawson's (2006) five overarching design thinking skills (formulating, representing, moving, evaluating and reflecting) are adopted to provide a basic skeleton for the following model of designing.

3.1   Formulating

Although the design process is non-linear and rather fluid, it nonetheless comprises a succession of activities. As a result, there must be a trigger for change in order for the respective design activities to commence. Since design is distinguished as a service activity (Nelson & Stolterman 2003), receiving a brief from a client generally initiates the design process. However, owing to the wicked nature of design problems, the design problem is often only loosely defined by the client. Consequently, neither the design problem nor the design solution is clear at the onset of the design process. In light of this, the skill of

formulating required by designers has to do with finding and understanding design problems. More specifically, the skills inherent to formulating are firstly, assessing the client's aspirations/desires in order to identify the problem and secondly, to frame the problem at hand.

Since the designer is considered as a change-agent who enters into a service relationship with the client to try to address their aspirations, the client's aspirations are regarded as the design intentions (Nelson & Stolterman 2003). It can therefore be said that the trigger for design action is not needs, but rather desires or aspirations. This emphasis on desire highlights the fact that change can be initiated. It also points once again to the role of the designer in facilitating the creation of design outcomes for a specific intent and purpose.

Once the design intention has been acknowledged and the design problem identified, it becomes necessary for the designer to frame the problem. The term framing was initially introduced by Schön (1983) and in this context refers to contextualising the design problem or situation. Framing is a way for the designer to selectively focus the problem in order to be able to handle the complexity of the problem. Framing also helps to provide structure and direction to the design process. According to Lawson (2006, 292-293), there are different ways of framing and formulating the problem. For example, Edward De Bono's (2000) *Six Thinking Hats* is one way of framing a problem and looking at it from different perspectives. Cross (2006, 91) substantiates the presence of such a skill in the design process by stating that 'successful, experienced and especially outstanding designers are repeatedly found in various studies to be proactive in problem framing, actively imposing their view of the problem and directing the search for solution conjectures.'

3.2   Representing

Designers are solution focused and work by generating ideas about potential solutions based on the client's intention and aspirations. A solution-focused nature of design behaviour is a fitting way for designers to respond to wicked or ill-defined problems. Ill-defined problems cannot be converted into well-defined problems; hence designers adopt a more realistic strategy of satisficing (finding a satisfactory solution) rather than focusing their energies on creating an optimum solution (Cross 2006). Naturally, the designer's ideas need to be externalised in order for the design process to advance and therefore during the 'generative phase' (Cross 2006, 16) of the design process representing becomes an essential skill for designers to employ as a means of giving form to their solution ideas. It is important to state here that owing to the co-evolution nature of the design process, representation is essentially a developmental process and is not restricted to this point in the design process. Representations or sketches are made and communicated throughout the design process and through feedback and reflection they are adapted and refined into more concrete versions during the design process (Nelson & Stolterman 2003). Similar to the design process, representation, too, is not linear but rather, as Nelson and Stolterman (2003, 176) state, 'sequentially emergent.'

A number of ways of imagining or representing have been identified by authors such as Cross (2006) and Lawson (2006). For example, drawing, writing, modelling and making are some of the tools which designers use to think about design problems and solutions and ultimately to externalise their ideas. Although designers use a combination of verbal and visual modes of representation it is the visual or non-verbal modes, such as sketching, which are generally dominant in the design process. Both verbal and non-verbal representations help to facilitate a

dialogue: between the designer and his representations and also between the designer and the respective client and/or other stakeholders. Therefore, representations need to be comprehensive and meaningful (Nelson & Stolterman 2003).

3.3   Moving

As mentioned above, once representations have been generated, designers begin to engage in dialogue with the representations. What results from this dialogue is a process of solution generation: the designer starts moving closer towards the creation of the design outcome by means of making design propositions. Lawson (2006) believes that the set of skills employed by designers to propose solutions essentially have to do with making moves, and consequently he refers to them as moving. This activity of moving in the design process has also been explored by Cross (2006), however he refers to it as a creative leap that takes place in design. According to Cross (2006, 57), the creative leap should be viewed as 'the throwing of a bridge across the chasm between problem and solution'. In essence, the creative leap is a move towards recognising a satisfactory concept or solution to the problem at hand.

Under the general heading of making moves, there are different types of moves that a designer can initiate. Since one of the aims of design is to initiates novel forms, the designer can make a new move which has not been seen previously. Alternatively, the designer may alter or further develop an existing solution (Lawson 2006). Essentially, these different types of design moves are dependent on two main factors: firstly, the intention of the client and secondly, the level of the designer's skills and abilities. In turn, these skills and abilities are specific to the design discipline within which the problem is situated as well as the skills level of the designer.

3.4   Evaluating

Not only do designers generate multiple representations and alternatives for design solutions, but they also need to limit their choices in order to propose a possible solution. In a complex situation such as this where designers need to make moves and take action, they need to rely on evaluating (Lawson 2006) and judgement (Nelson & Stolterman 2003) skills. It should be noted that although the skills of moving and evaluating are presented under separate headings in this model, they are, in practice, interdependent. In the design process the two sets of skills are inextricably linked and therefore evaluating skills are exercised in conjunction with moving skills.

In order to make moves, the designer needs to make design decisions – which ideas to abandon and which to pursue – and therefore judgement is regarded as a form of decision making. Unlike traditional decision making which relies on a divergent process, to make true judgements, design judgement is dependent on a convergent process and comprises adequate and critical judgements within the context of satisficing. Design judgement goes beyond mere intuition and instead has practical and pragmatic value since it initiates intentional change in the real world. Within a design context, Nelson and Stolterman (2003) believe that judgement is at the root of innovation and is therefore an essential skill.

In addition, this type of decision making 'takes place within the constraints of a reasonable time frame based on a time line of realistic expectations and limitations' (Nelson & Stolterman 2003, 188). The designer needs to continuously consider the design criteria and requirements set by the client in the brief. The designer also has to consider self-imposed criteria such as aesthetics as well as technical and legal issues (Cross 2006). Nelson and

Stolterman (2003) also adopt this viewpoint in their proposal of different types of judgement which include intellectual judgement, practical judgement and ethical judgement to name a few. These types of judgement should not be seen as separate skills but overlap with one another and are often used simultaneously during evaluation to ensure relative objectivity. Furthermore, these judgements do not impose uniformity and are applied in the context of the individual design problem. Hence, design judgements can be applicable to all design disciplines, irrespective of the final design outcome.

The abovementioned types of judgement are used primarily by designers but it must be acknowledged that evaluating and judgement are skills which are not exclusive to designers. Clients also engage in a process of making judgements. Furthermore, the increasing emphasis on human and user-centered design today means that it is not unusual to have the end-user present during the design process. When this is the case, the end-user's judgement is also taken into consideration for the solution selection process.

3.5   Reflecting

One of the key skills employed by designers is that of reflecting. Lawson (2006) acknowledges that since the introduction of Donald Schön's concept of the reflective practitioner during the 1980s there has been growing recognition and acceptance of the idea of reflecting upon action. Specifically within a design context, designers are constantly looking and thinking about their designs and as a result, designers can be regarded as reflective practitioners. The continuous monitoring and learning skills which designers use are grouped collectively as reflecting skills in this model of design thinking. In line with Schön's overarching concept of reflection, Lawson (2006) highlights that the idea of

reflection is open to two interpretations in design, namely reflection in action and reflection on action.

As the name suggests, reflection in action is an activity which takes place while designers are in action and busy exercising their design skills with the aim of creating the design outcome. During this phase of the process, designers constantly stand back and reflect on their actions. What results from this is the continuous moving back and forth between formulating, representing, moving and evaluating. Such a way of reflecting can be said to focus on and monitor the design decisions taken during the process rather than the final state of the designed outcome. In contrast, reflection on action, as the second interpretation of reflecting in design, takes place once the design outcome has been produced. The design process does not end with the production of the final design but continues even after the design makes its appearance in the real world or the domain of the client. Reflection in this instance therefore encompasses the act of monitoring the final design outcome against the client's intention as well as the intention of the designer. In addition, the designer questions whether the 'processes involved in representing, formulating and moving have all been brought to bear on the case' (Lawson 2006, 299).

There are a number of reasons why the skill of reflecting is important for designers. Firstly, the act of reflecting allows the designer to focus on the entire design process instead of merely focusing on the result of the process (the final product). Secondly, reflecting allows the designers to explore important avenues during the design process and also encourages them to take responsibility for their actions. Thirdly, it enables the designer to measure the success of the design process as well as the final result of that process.

4.   Characteristics of design thinking

The model of designing presented above shows that the design process consists of distinct yet interacting mental acts in which designers establish relationships with the real world with a view to creating design outcomes. Although the model of designing has been presented sequentially, the five different sets of skills, are not practiced in a prescribed way but overlap and are contingent to the unique circumstances or problems with which the designer is faced. The dynamic nature of the design process and the uniqueness of every process reaffirm that the design process is non-linear in nature. However, irrespective of the sequence of activities in the design process that is adopted, there are a number of cognitive abilities or ways of thinking which are almost implicit in the nature of the design process. According to Cross (2006), these ways of knowing are embedded in both the processes and products of designing. From the model of designing, the following characteristics of design thinking can be identified:

- Designers tackle and resolve ill-defined problems

- Designers are solution focused rather than problem focused

- Designers frame their problems in a way that is unique to the problem at hand

- Designers focus on synthesis

- Designers use non-verbal, visual language as a tool

- Designers employ abductive or forward thinking

- Designers engage in continuous evaluation and reflection

- Designers take a broad systems approach to the problem

- Designers take a human-centred approach

- Designers adopt an integrative and collaborative team-based approach

**5.	Design thinking in action: Hands on, Hearts on, Minds on**

The stance of considering design thinking as a skill is clearly echoed in the writings of authors such as Lawson (2006) and De Bono (2000), who state that design thinking need not be an ability that a person is born with, but it is a trait which can effectively be nurtured and honed. Bearing this in mind, it is fitting to position design thinking within a context of teaching and learning. A brief discussion of an Information Design student project now follows to illustrate the application of design thinking as a problem processing methodology within an academic context.

**5.1	*The lil' green box***

The lil' green box is a project completed by final year student, Micaela Reeves (2010), for the Design Achievers national award scheme. The annual awards scheme is an initiative of the SABS Design Institute and aims to encourage South African design students to propose strategic design solutions to address a social, environmental, or industrial problem currently experienced in South Africa. Every year, the brief calls for design concepts that could make 'a profound contribution to the betterment of life and the environment' (Design Institute 2011). The humanist underpinning of the scheme is clearly evidenced by the guiding principles of the awards scheme, namely Hands-on, Hearts-on, Minds-on.

The student's project stemmed from the environmental damage South African society produces by the incorrect disposal of regular household batteries (that is, in regular household waste). The complexity of the identified problem required that the student carry out extensive research within the three week timeframe of the project. Research, conducted by Reeves (2010) during the problem identification phase, indicated that South African society lacked an awareness of such environmental issues and that an information system that allowed

willing members of society to take action was required. As a response to this, the student proposed a household battery disposal system created for the safe and correct disposal of hazardous batteries. The initiative consists essentially of two parts: part one is aimed at school children and part two at the general public. Both parts have similar aims and objectives, namely to create awareness through educating and informing people about the negative environmental impact of batteries, as well as encouraging correct and safe disposal of batteries. For purposes of this paper however, only part one will be discussed.

The lil' green box is predominantly aimed at primary school children between the ages of seven and eleven. Reeves's intention for the project was for it to be a fun, yet educational system which encourages children and, in turn, their families to collect and dispose of their batteries correctly and safely. Many schools have introduced recycling into their curriculum and so *the lil' green box* initiative was proposed as an extension of this theme to be incorporated as a class project (Reeves 2010). Firstly, the project constitutes the distribution of flat pack green boxes at primary schools, making them accessible to teachers and children. The flat pack boxes are a tool for teachers to educate children about the negative environmental impact and dangers of batteries. To this end, all the environmental information is provided on the inner side of the boxes (figure 1). Ideally, once the teacher has gone through all the information, the children are encouraged to turn the box around and interact with the box by personalising it through drawing and writing (figure 2). In addition to the class activities, it is proposed that students should be given some homework. This would require the children to assemble the boxes and take the boxes home where they can be the 'battery educators' of their homes and encourage sustainable behaviour amongst their parents (figure 3).
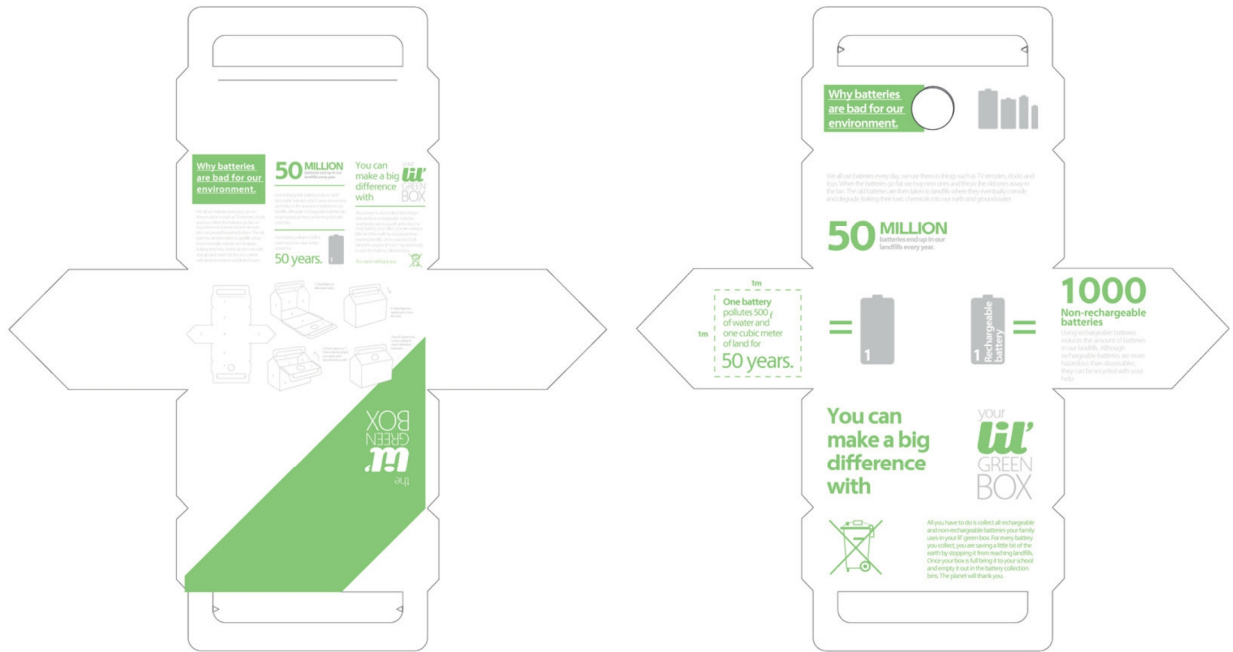
Figure 1: The *lil' green box* for pupils, with information provided on the inside (Reeves 2010)

Figure 2 : Decorated and assembled *lil' green box* (Reeves 2010)

Secondly, since the class would be required to bring their collection of used batteries once a week to school, each class should be provided with a battery disposal chart (figure 4). 'In order to provide a more tangible incentive and understanding of the cumulative effect of correct battery disposal,' Reeves (2010) indicated that the purpose of the chart is to allow the class to keep count of the so that at the end of each month the teacher can work out how much water and land the class has saved as a whole: one battery correctly disposed saves 500 litres of water and 1 square meter of land. For reasons of sustainability, the poster itself would be laminated so that at the end of each month the poster can be wiped clean and the count can start again. The intention is that monthly results are recorded by the teacher and at the end of the year the class can work out their yearly score. Thirdly, in order to make the concept viable, it is imperative that bins are made available for the correct disposal of the used batteries. All the batteries collected by the children would therefore be disposed of in *lil' green bins* (figure 5) that would potentially be made available at the schools by a company such as Uniross. This project required students to think about the practical roll-out of the projects, and relevant organisations or companies that needed to be contacted if necessary. Consequently, Reeves (2010) identified Uniross as a potential stakeholder.

The brief description of the three abovementioned products fall within the domain of fourth order design thinking because collectively, they can be characterised by the creation of a system. With regard to the design process to devise the system, the student consulted regularly with the appointed lecturer at the University and in this way, she was guided with her design decisions as she moved towards a problem solution. The characteristics of design thinking noted previously are evident, in varying degrees, in the process employed by the student to finalise her solution to the problem.

Figure 3 : Assembled *lil' green boxes* to be taken home by the pupils (Reeves 2010)
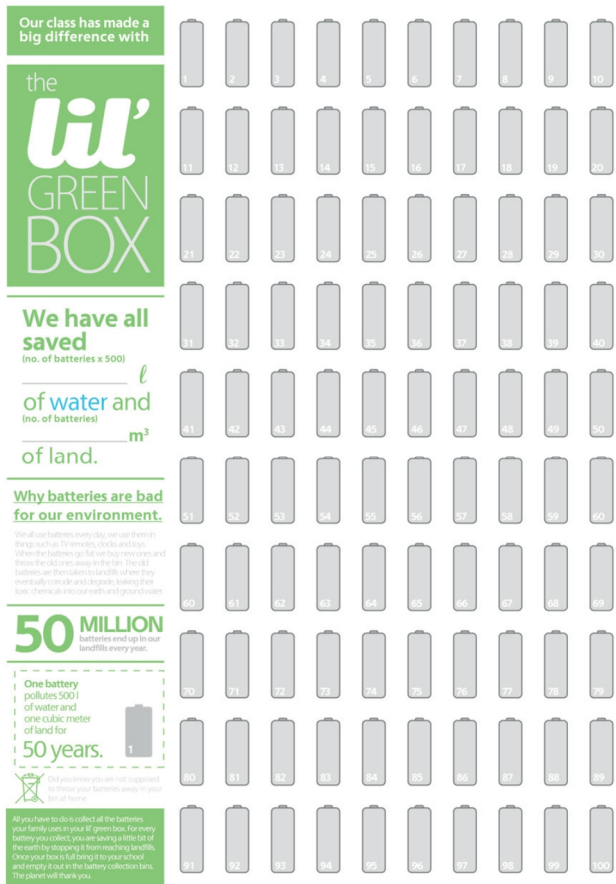

Figure 4 : Battery disposal chart (Reeves 2010)

The final design of the battery disposal system was facilitated by the research conducted throughout the process. Once the preliminary research was completed and the system considered, the student took to designing the individual items comprising the system. Consequently, in order to test this system as well and the appropriateness of the information design of the products, the student created prototypes of the boxes and visited a local primary school that was willing to participate. Here, Reeves spoke to teachers and also interacted with grade three students in their classroom.

The prototypes were useful within the classroom setting when the children were allowed to interact with and draw on the boxes. This activity was mutually beneficial: the students learnt about safe and correct battery disposal and for Reeves it was a form of participatory action research and reflection. According to Reeves (2010), the learners engaged positively with the project and through their actions, displayed an 'understanding of the current status of the environment as well as their affinity towards the natural world.' For example, one pupil wrote on his box: 'I was born on earth and the world makes me alive...we care about the world because if we don't we will die.'

The limited timeframe of the project however was an obvious limitation for the project and resulted in minimal end-user involvement through the process. Nonetheless, the limited interaction proved to be extremely beneficial to Reeves and gave her a good opportunity to reflect. The following is a sample of her reflection-on-action:

- 'Children were only introduced into the design process after the design was finalised, which missed the opportunity for a user-centered design approach. Intuition results in superficial solutions, where if the children were involved from the beginning, a broader and a more comprehensive understanding of how children interact with the

Figure 5 : The *lil' green* bins made available at schools (Reeves 2010)

design could have been achieved and potentially prevented future obstacles' (Reeves 2010).

- Reeves (2010) realised that 'without in-depth knowledge of the user, the design could result as being superficial.' This realisation emerged from the pupil's reaction to the layout and design of the boxes; they were expecting lines to write on instead of the blank spaces.

- The student acknowledged the advantage of a multi-disciplinary and collaborative design effort when she stated that in addition to working sooner with the pupils, 'it would have been beneficial to work together with educators, parents, learners as well as psychologists' (Reeves 2010).

6. Conclusion

The student's reflection points towards an understanding of the design process as an inclusive approach to managing social innovation and it also highlights the impact the application of design thinking may have on a student's personal growth as a designer. Firstly, the first-hand experience with a real-world problem offered an action-based method of advancing the student's knowledge. Secondly, the shortcomings of the project were self critically constructive for the student. This skill of noting shortcomings and collecting future reference is inherent to the reflection process and according to Lawson (2006), this practice highlights the fact that designers use episodic knowledge more than procedural knowledge. This case study therefore aligns itself with the design theory covered at the beginning of the paper and substantiates that through practice, and the opportunity to explore real world problems, students are able to nurture and hone their ways of thinking and to advance their practice.

Following from this, more attention needs to be given to the nurturing of design thinking skills within an educational context and strategies for education need to be considered and devised. Since design knowledge and research are inextricably linked to design practice, design research aimed at improving design education and design practice may need to be grounded in a deep understanding of the nature of design methodologies.

Within a South African context design thinking as a methodology is of relevance as it can play a strategic role in framing and answering many of the social, economic and environmental problems with which the country is faced. For example, design can have an impact in South African society through services and systems such as housing, planning, health, transport and recycling. In particular, owing to South Africa's multi-cultural population, the human-centered nature of design thinking makes it relevant.

Ultimately, the goal of design education is to foster and nurture in students

> a people-oriented attitude as well as a deep rooted understanding and mastery of a set of discrete skills in design thinking and making. This attitude and understanding, if applied in service of human beings and from the perspective of being human may ultimately contribute towards generating a culture of designers that pursue the "global good" in all their endeavours' (Information Design 400 Studyguide 2011).

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[i] The keynote speech titled, *Design Thinking. What It Is. Why It Is Different. Where It Has New Value.* was given by Charles Owen, on October 21st in South Korea, at the International Conference on Design Research and Education for the Future, conducted in conjunction with the Gwangju Design Biennale 2005.

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