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ADVANCING DESIGN ACTIVITY: CATALYSTS FOR SUSTAINED INNOVATION

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ABSTRACT:

This paper explores how practicing designers apply sustainability issues to design problems as catalysts for innovation. It was hypothesised that participants would integrate sustainability issues as part of the early design process only when prompted. The objective of this study was to observe the degree of variance between participants' responses during a design task. In order to explore how designers apply sustainability issues an experimental approach was adopted. The pilot study experiment involved an initial interview, observation and concurrent and retrospective protocols. During the experiments verbal, visual and observational data were collected. All data were analysed and coded with the assistance of textual and observational analysis software.

The preliminary findings suggest that including sustainability issues as part of the initial design problem affects design activity and prompts designers to consider more diverse ideas. The paper concludes by discussing the challenge for this research and future investigations.

Keywords: Design, Sustainability, Innovation

1. INTRODUCTION

Continued population growth is imminent and the world is ageing at a phenomenal rate. The implications of a rapidly increasing population upon the world's resources are becoming more apparent; so much so that the environmental agenda is briskly shifting from a grassroots level to a global consciousness.

The sustainability paradigm is quickly emerging as the main avenue for possible solutions across many industries as it embraces; social, environmental and economic concerns. It seems likely that sustainability will continue to provide possibilities for change in the coming decades. To ensure designers remain at the forefront of solutions that are innovative and responsive to these emerging trends; an exploration of how designers apply these issues in practice is required.

Literature tells us that there are many sustainability tools available (Ernzer and Birkhofer 2002, Ernzer, Lindahl, Masui and Sakao 2003, Jofre, Tsunemi and Morioka 2003). Unfortunately, most of these tools are designed for engineers and focus on the later 'end of pipe' stages of design (Lofthouse 2001). This in itself is not a problem, but focusing on the later stages of design generally only allows for incremental changes in product development. This paper will explore literature that supports the idea that early stage integration, as opposed to later stage, is a key factor in producing solutions that are not only responsive to the sustainability paradigm, but that are innovative as well (Bhamra and Evans 1999, Charter 2002, Ernzer and Bey 2003, Sherwin and Bharma 2001, Wylant 2002). Unfortunately, "relatively little research has been done on the idea generation process within Eco-innovation" (Jones, Stanton and Harrison 2001, p. 521). This is investigated through experiments conducted to explore how practicing designers apply sustainability issues during design activity.

This study differentiates itself from previous studies regarding eco-innovation in two primary ways. Firstly, this study is not based on testing or evaluating a sustainability or Design for Environment (DfE) tool. Secondly, it focuses on both the 'design activity' and its outcomes. The long term goal is to help close the gap that currently exists between theory (methods and tools developed) and practice (implementing them) by documenting designers' responses. Therefore, innovation is neither set as a design goal or constraint; providing a neutral platform for measuring this variable.

This paper will present the initial findings based on the observation of the degree of variance between participants' responses during a design task. The paper is broken into six sections.

The following section presents background literature and further contextualises this study within existing bodies of knowledge on sustainability, design and innovation. The third and fourth sections outline the methods used and the initial experiment. The final two sections present a summary of the initial findings and conclude the paper by outlining future research objectives.

2. BACKGROUND

It has been identified that the world is ageing and the population is growing, placing increased demand upon the world's natural resources. By 2050 the number of older persons will out number the young for the first time in the history of mankind (United Nations 2001). To contextualise this, "it has been estimated that over 90 percent of the resources taken out of the ground today will become waste within three months" (Chapman 2005, p. 8). The impact these trends will have upon the design community has not been completely explored.

The last three decades have seen a steady uptake of sustainability as a dominant philosophy for simulating innovative outcomes. It can be argued that the "central challenge of this century is the need to turn this "great innovative capacity" to balancing a sustainable way of life with the impending prospect of limited resources and population growth" (Dunphy 2004, p. 362). The problem is that designing for sustainability requires a different broader perspective and designers will need new skills compared with traditional design concepts (Charter and Tischner 2001). In order to do this, the broad mandate of sustainability must be part of the designer's knowledge (Walker and Dorsa 2001).

The discipline of industrial design has been identified as a possible key player regarding the sustainability debate due to the undeniable and often unavoidable interactions of design with both technology and manufacturing. The industrial design process has been identified as a useful tool to aid/simulate innovation. The idea generation process itself is a means for designers to create and generate new ideas (Wylant 2002). Before exploring if sustainability can provide a catalyst for innovation; an understanding of how designers apply this issue during design activity must be obtained.

Understanding how to implement the sustainable philosophy into design activity has instigated the development of a number of methods and tools. Jofre, Tsunemi and Morioka (2003) identified over 20 different methods of varying complexity. The more popular tools include: Life Cycle Analysis (LCA), Life Cycle Design (LCD), Design for Environment (DfE), cradle-to-cradle design, 'green' design, EcoDesign, Environmental design and emotionally durable design.

Unfortunately these tools are mostly designed with engineering processes in mind and therefore fit better into the later stages ‘end of pipe’ of design (Jofre, Tsunemi and Morioka 2003). As a result many of these methods are unable to be applied throughout the whole process (Ernzer and Bey 2003).

The early stage of design has been identified to be the most effective avenue for implementing sustainability criteria, and that their implementation may foster more innovative outcomes (Lindahl 2005). Unfortunately the number of designers using these tools and methods is limited (Charter 2002, Ernzer, Lindahl, Masui and Sakao 2003). This is a concern because the point at which sustainable considerations are integrated is critical and few companies integrate sustainability at the idea stage (Ernzer, Lindahl, Masui and Sakao 2003). This is because many current methods and tools are inflexible, time consuming, only look at the environmental issues and many seem overwhelming. As a result, they are not integrated into standard practice. Ernzer, Lindahl, Masui and Sakao (2003) discovered through their review of Stempfle and Badke-Schaub (2002) that the “theory building and research conducted under the normative strain has often neglected to look at what people actually do – simply prescribing a methodology may not meet the needs of designers ‘out there’”. Furthermore, Ernzer, Lindahl, Masui and Sakao (2003) state as per Lenox and Ehrenfeld (1995) that it is “not surprising that DfE methods and tools are commonly developed to become stand-alone packages, focusing on a simple objective, for example minimizing environmental impact” (Ernzer, Lindahl, Masui and Sakao 2003, p. 126). It is any wonder that “there is a clear gap between theoretical framework and industrial practice” (Bhamra and Evans 1999, p. 265). For ecodesign to be effectively achieved, it is important to integrate sustainability into the early stages of design; rather than the later detail ‘end of pipe’ stages where the designer is less free to make radical changes (Bhamra and Evans 1999, Jones, Stanton and Harrison 2001).

How do designers apply sustainability issues to design problems and can sustainable ‘constraints’ drive innovation? There is currently no clear or explicit methodology of what equates to an innovative idea. This study is influenced by the theories of Dosi (1988) and Sinclair-Desgagne (2000) who state that innovation involves the *solution of problems* (Dosi 1988). It is believed a parallel can be drawn between innovation theories and the design process. Understanding innovation is important, as this study looks at how novel ideas can emerge during early stage design.

Van Gorp (2007) states that for innovation to occur the problems are typically “ill structured”, in that the available information does not provide by itself a solution to the problem. Comparatively, Leinbach (2002) states that design problems are generally “ill-structured” and as a result there is often more than one solution meaning a range of solutions could be valid.

Therefore; what relationship (if any) exists between design and innovation? Considering *design processes* and *innovation problems* are both referred to as “ill-structured”.

Elzen and Wieczorek (2005) affirm that “the results of the creative process are normally unanticipated, novel conclusions. They are often reached by asking questions, reformulating conceptual issues, challenging assumptions, and acquiring knowledge” (2005, p. 653). Moreover it has been identified that integrating sustainability further up the hierarchy results in more innovative solutions to design problems (Ernzer and Bey 2003). Therefore, it is speculated that “working towards environmentally conscious solutions fosters innovation because it forces product developers to think in new ways. That is “out side the box” in many ways” (Jones, Stanton and Harrison 2001, p. 520). Snoek and Hekkert (1998) believe that it is possible to direct designers to create innovative solutions. Unfortunately Jones, Stanton and Harrison (2001) identify that none of the existing Eco-Innovation methodologies focus specifically on the idea generation process (2001, p. 519). This study hopes to fulfil this gap in knowledge by exploring the early stage of the design process *only.* To do this the study will draw on innovation theories outlined by Kuhn (1996), Dosi (1988, 1992) and Sinclair-Deseagne (2000).

Kuhn (1996) states that scientific progress is paradigm dependant and Dosi (1988) identified that the technological paradigm is important for studying technological trajectories. Sinclair-Deseagne (2000) builds on both these theories to propose a method for assessing innovation. That is to measure the “distance” between *existing* and *new* products. Figure 1 illustrates these theories and their relevance to this study.

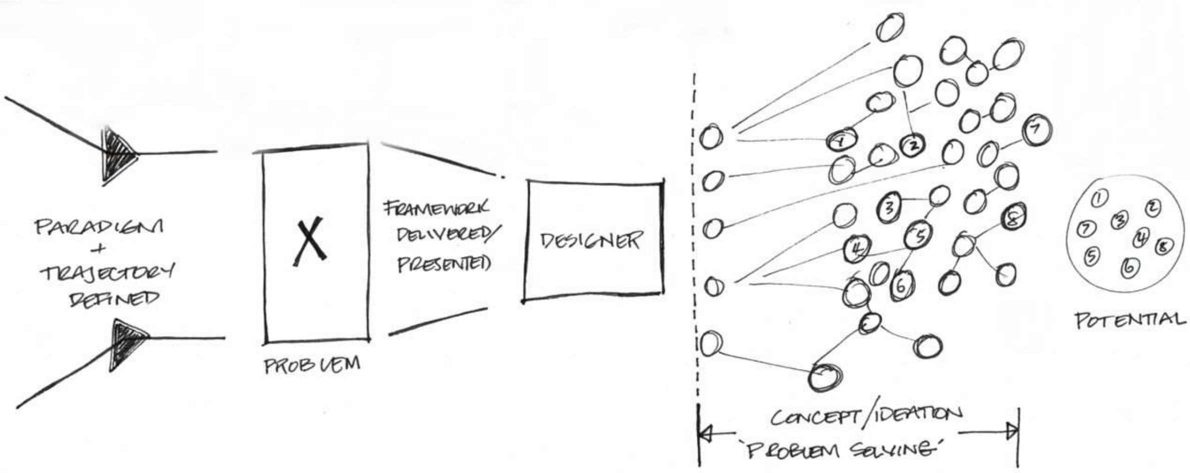

Figure 1 Overview of the paradigm, trajectory and innovation relationships, influenced by Sinclair-Deseagne.

As illustrated, the ‘problem solving’ phase will yield a higher number of ideas more responsive to the sustainability paradigm, if sustainability issues are included as a design constraint. Additionally, Figure 1 shows the solutions generated will have a higher degree of innovation, represented at ‘potential’. From this, it has become clear that a method or tool for measuring innovative capacity (to identify the extent of the innovation) will need to be developed.

The following section details the methods used for this study.

3. METHODS

This study compared two cohorts of designers during the early stages of design activity; one cohort who were prompted to consider ‘sustainability’ and one who were not.

All experiments were conducted at the QUT Human Centred Research and Usability Laboratory. This laboratory is fitted with cameras and audio tapes to record participants’ activities. Participants’ included practicing industrial designers with a minimum two years industry experience. Participants were grouped into pairs and divided into two cohorts; Cohort A the control group and Cohort B the experimental group. Each cohort was issued with a corresponding design brief. One cohort was issued with a *control* brief and not (explicitly) requested to address ‘sustainability’. Whilst the other cohort was issued with an *experimental* brief and directed to address ‘sustainability’. The study focused on the early stage of the design process.

As a specific cohort participants’ were requested to engage in a design task within a one and a half hour timeframe. Each cohort were issued with their corresponding brief and requested to achieve the specific objectives of the brief. The experiments provided an opportunity to observe participant engagement during the process of designing. The design brief asked for the expression of initial ideas/concepts of ‘portable CD storage’. Each brief provided general design constraints and a list of online resources. As detailed above the only difference between the two briefs was the inclusion of ‘sustainability’ as an additional design constraint, issued to participants in Cohort B.

Participants were required to, read and interpret the brief issued to them, interact with the other participant including concurrent verbal and retrospective protocol and express their initial design concepts/ideas through whatever medium they needed to, including but not limited to, brainstorming, sketching, rendering, participant interaction and or verbal communication. All materials required to complete the task were provided including; pens, paper, and a computer connected to the internet.

Cohorts are used in this study to provide a platform for experiment outcome(s) comparison and analysis. All participants were subject to the same screening process. It was anticipated that dividing the participants into cohorts would aid the data analysis process and subsequent coding of themes and categories, by helping to reduce the categorisation of complex data sets. The experiments consisted of a mix of qualitative research methods and were divided into three stages, initial interview, concurrent protocol and observation and retrospective interview. Various data were collected including visual data (sketches and annotations), verbal data (concurrent and retrospective protocols) and observations. These data were analysed and coded with the assistance of textual and observational analysis software.

This study adopted an inductive approach, as the coding process required multiple data passes. The data was progressively coded, themed and categorised. A significant coding structure emerged. This paper presents the observations and preliminary findings of this study.

4. EXPERIMENT

Participants in both cohorts were observed to conduct their work in two primary ‘spaces’. These were coded and themed as either a problem space or a solution space. These ‘spaces’ evolved during the coding process. Participants were observed to either;

- work on the problems relating to the brief; this has been coded as; **P**roblem **S**pace (PS); or
- work on the possible solutions to the brief; this has been coded as; **S**olution **S**pace (SS).

The problem space (PS) included participants defining the scope of the problem(s); working through scenarios and discussion of the problems with current and or similar products.

The solution space (SP) included participants defining the scope of the possible solution(s); working through scenarios and considering either divergent product directives or improvements to current or similar products.

4.1. VISUAL DATA

Figure 2 shows the visual coding. It illustrates participants’ visual exploration through annotations and sketches. Here participants have documented the problems with existing products as well as possible solutions (to the problems identified). This illustration provides an example of participants exploration of problems regarding usability and materials and the subsequent coding method employed. As seen in Figure 2 usability and material issues have been coded as PSC-U (**P**roblem **S**pace, problems with **C**urrent artefacts, **U**sability/operation) and PSC-M (Exploring **P**roblem **S**pace, problems with **C**urrent artefacts, **M**aterial). Additionally Figure 2 shows the participants describing their task goals by highlighting three possible directions to pursue. Each of these has been coded SSR (Exploring **S**olution **S**pace, **R**e-defining goals) and SSN (Exploring **S**olution **S**pace, **N**ew directions).

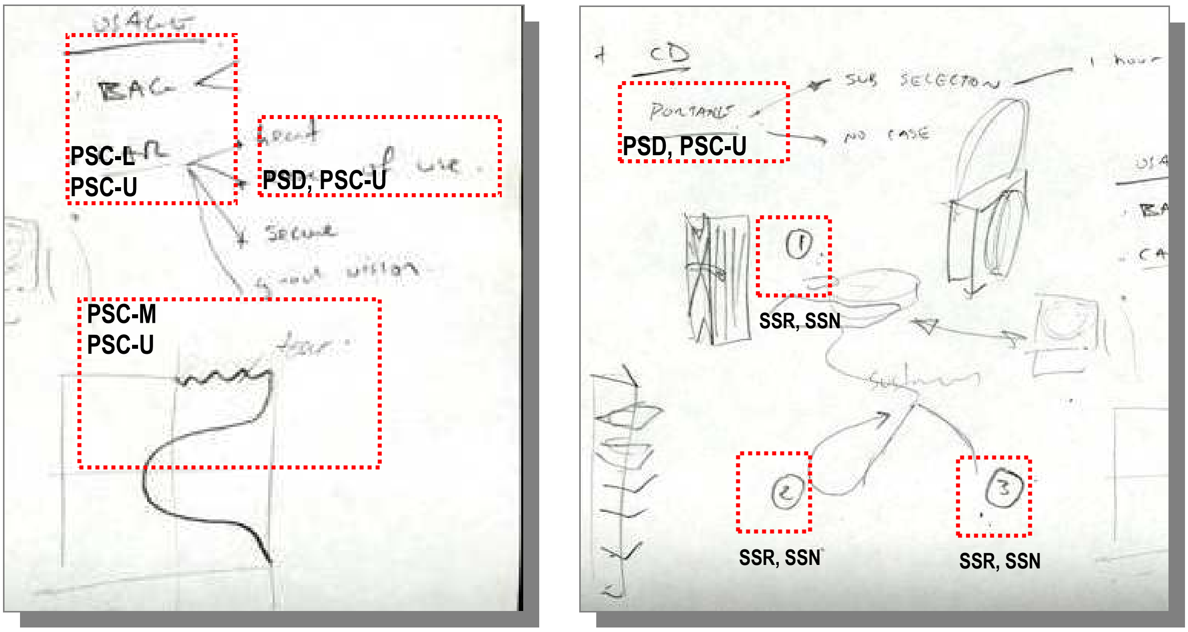

Figure 2: Visual data collected from Cohort B

4.2. TEXTUAL DATA

The complete design activity was audio recorded and transcribed. The transcripts provided rich textual data. With the assistance of professional software ATLAS.ti these data were analysed and coded.

Cohort A

Cohort A specified that they wanted to develop a 'different' and 'innovative' solution; they indicated they were happy to breach the boundaries of the brief to achieve this. This Cohort identified usability as the primary design directive i.e. "*I'm thinking something innovative to begin with… I'm thinking the way you can make it innovative is…the way in which you interact with the device"* (Participant 1, Cohort A). To do this Cohort A identified two avenues for approaching the activity: either;

(1) design a variation of what currently exists ("*make it cool*"); or

(2) conform to the design constraints issued, whilst innovating through usability.

Cohort B

Cohort B explored materials, manufacturing processes and lifestyle choices. This cohort considered examples of products outside the scope of the 'problem space'. They identified a key feature such as 'durability' to be one possible 'sustainable' directive.

Cohort B stated that the brief enabled them to think about different solutions by enabling them to "…*think[sic] outside the square in a sustainable way instead of just a functional way"* (Participant 3, Cohort B).

Cohort B also identified two ways of tackling the problem, to either;

(1) design for recycling (materials), or

(2) make the product last forever (using design cues and or materials).

4.3. OBSERVATIONAL DATA

In addition to the audio recording the complete design activity was also video recorded. With the assistance of professional software Observer XT; observational data was analysed and coded. The observational data complimented the textual data analysis. The observational analysis was important in observing participant interactions during the design activity.

Cohort A decided it was important to research current products to be able to identify how they could differentiate their concepts. As a result Cohort A spent the majority of their time discussing current products, materials and usability problems. These participants moved away from the desk space provided and worked solely at the computer so they could use the internet to 'research' and 'discuss the problems' with current products as seen in Figure 3.

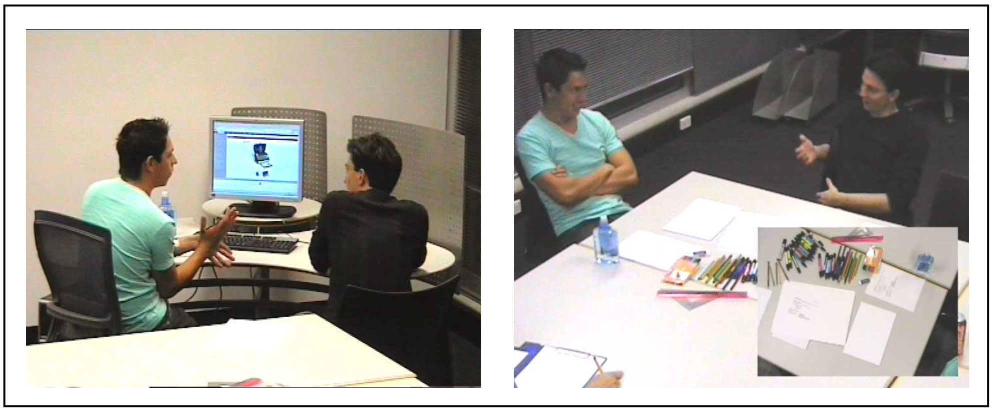

Figure 3: Participants (Cohort A) engaged in the design activity and retrospective protocol.

Cohort B however, decided they would proceed to undertake the design activity with no additional reference material other than previous experience. They too discussed current products, materials and usability problems but also referred to other products and or materials as exemplars of (what they believed to be good) sustainable directives. Unlike Cohort A, Cohort B decided it was unnecessary to utilise the computer and opted to work through the design problem at the desk provided as illustrated in Figure 4.

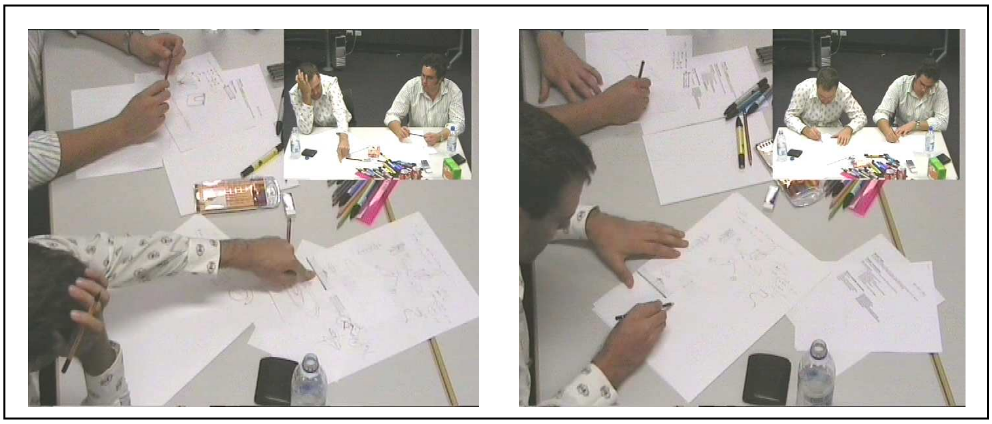

Figure 4: Participants (Cohort B) engaged in the design activity.

5. FINDINGS AND DISCUSSION

It is interesting to note that both cohorts provided similar outlooks regarding sustainability and design. All participants reflected the predominant thoughts identified in literature that is; sustainability is something they would normally consider at a later stage. Cohort B did, however, indicate that they moved in a direction that they wouldn't normally simply due to 'sustainability' being included during the early (idea) stage. It was found that Cohort A defined usability as the primary focus whereas Cohort B identified sustainability and usability as joint primary considerations. As a result the outcomes of Cohort B were more responsive to the sustainability paradigm.

Jones (2001) identifies that environmental criteria generates more ideas. This was confirmed as Cohort B (the experimental Cohort, directed to consider sustainability) generated a greater volume of sketches. It was observed that Cohort B engaged more actively in the design process and produced a total of 42 sketches during the design activity whereas Cohort A produced 18 sketches. A greater understanding of the impact of this data outcome is expected to be obtained through the main study.

In general, the two Cohorts approached the task differently, Cohort A opted to 'research' the current market and Cohort B decided this was unnecessary. Furthermore Cohort B indicated that their 'normal' design activity was affected by considering sustainability during the idea stage. It can therefore be argued that normal ‘design activity’ was affected by the introduction of the sustainability constraints. These discrepancies and the ‘level of disruption’ these constraints have upon everyday design activity will be explored further in the main study.

6. CONCLUSION

The preliminary findings are promising and suggest that including sustainability issues as part of the initial design constraints affects design activity by prompting designers to consider a more diverse range of ideas. The challenge for future research will be to determine if sustainability issues can be utilised as a catalyst to help generate more innovative outcomes. In addition to this, criteria necessary for measuring early stage innovative activity will need to be developed. It is expected that this research will provide a theoretical framework or tool for advancing design activity to provide innovative and sustainable product/service systems.

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