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Design & Determined Indeterminism

Vasilije KOKOTOVICH
University of Technology Sydney

Abstract

The world is filled with artefacts/products, systems, and environments. We consider these to be made by humans who determine their subsequent use as suggested by their embedded characteristics. Often these artefacts are the result of a design process. That is to say, they are developed by designers through some considered design process. This holds true for Product designers, Architects or Engineers. When developing their artefacts, these designers make many varied design decisions. In essence these designers determine the nature and characteristics of the artefact. These may include both functional and non-functional issues. These design decisions are sometimes related to each other in a determined way ["cause-effect relationship"], and sometimes they relate to each other in unexpected or non-determined ways [uncertainty]. Nevertheless, these design decisions demonstrate intent on the part of the designer. The intent may not be consistent with actual subsequent use of the artefact. This mismatch or more importantly an endeavour to move towards an absence of mismatch between intent and actuality, often affects the perceived "value" of the artefact. The proposition is that designers propose predetermined rituals of use, and certainly notions of value when developing the embodiment of an artefact. In doing so they make many assumptions which may or may not be consistent with the perceptions of the user and indeed the actual rituals once the artefact is utilised, therefore for every aspect of the artefact the designer determines there are a number of issues in need of resolution arising as a direct result of their determination there is a concomitant indeterminism. Drawing upon literature found in both Science and Design, this paper discusses the nature of the struggle [contradiction] between issues of determinism and non-determinism in design, suggesting some strategies for closing this gap during the design process.

Keyword: design thinking, uncertainty, value propositions, users

Introduction

It can be said that Design is not random it is determined. In point of fact generally accepted definitions of design relate to notions of planning/determining. At first blush the literature surrounding design processes and more specifically design processes which aid in the development of embodied artifacts appear to be at odds with this notion of plan/structure. The literature suggests that design problems are often ill-defined and ill-structured [see: Kunz and Rittel, 1970; Rittel and Weber, 1973; Buchanan, 1995]. Further, in Goldschmidt (1997:442), she points out the following: "*'imported' information obeys no rules whatsoever: it may come from any domain, be represented in any medium and penetrate any existing information structure at any point"*. This appears to suggest that design development is an indeterministic process and heavily reliant upon notions of chance. And yet there are aspects of the design process which are deterministic. That is to say there are "cause-effect relationships".

Design is not alone in wrestling with trying to develop our understanding of the dichotomy between determinism ["cause-effect relationships"] and indeterminism [chance]. Drawing upon literature in science, Popper (1972) uses the metaphor of clouds and clocks to develop a simple but vivid understanding of ideas of determinacy and indeterminacy in physical systems. We are encouraged to imagine a continuum where on one side there exist irregular, disorderly, and unpredictable clouds, and on the other end there are orderly and very predictable clocks. This end conceptually represents such phenomena as precision mechanisms and physical principles where we may calculate and predict results with relative precision, in essence a Newtonian perspective. The cloudlike end is indeterminate where he cites a cluster of gnats or small flies with each insect moving randomly except it turns toward the center when it strays too far away from the swarm. As human reactions, perspectives, heuristics, and attitudes are often largely unknown and indeterminate, we could conceptualize that human society and human beings may be at this end of the continuum. While the intent here is not to develop an in-depth review of the body of literature surrounding the various positions found within the domain of the philosophy of science, we intend to draw upon some core ideas found in that domain. Moreover, we will explore the relationship triad between designers, users, and notions of value propositions.

Designer / Decision maker

As indicated above design problems may be perceived as being ill-defined and ill-structured. As designers move the design process forward, the information the designers rely upon changes and subsequently the 'rules' they use change. In short, problem solution possibilities change. Design decisions are determined incrementally in relation to shifting frames of reference and shifting perspectives and heuristics, as the design process can be considered one of co-evolution with respect to the problem solution, as discussed in Dorst & Cross (2001). Moreover, as discussed in Harfield (2007), both the context and the proposed solution changes and evolves, dependent upon the individual designer. These shifting frames of reference are viewed as being manipulable variables of context/contexts, as well as content. They play a central role in the design process. It may be argued that if the designer has difficulty in anticipating design problem solution possibilities then the design outcomes have the appearance of being indeterminate. Therefore, to a large extent the co-evolution of problem-solution is dependent on the personal perspectives; biases; knowledge base; sensibilities; and previous patterns of experience of the individual designer. In short, these form the individual designer's personal perspectives and heuristics which are limited by their personal pattern of

experience. Harfield (2007) suggested it is not the case that when giving one brief to fifty different designers, fifty different designs will emerge. He contends the one brief is merely the starting point, and the true case is that by giving one brief to fifty different designers each will recontextualise the brief resulting in fifty different new briefs yielding fifty different designs.

Given the above in a real sense it is the designer who determines and evolves the problem, and subsequently a number the characteristics of embodied artifacts. For example designers determine the form of an object. Associated with the form are characteristics of materiality, leading to notions of how the artifact may be manufactured. Following on from that, the designer may envisage how the artifact may be held, used, stored or recycled. In turning to an example, with respect to product design, let us say the designer is designing an office chair for an Australian furniture manufacturer that is to be mass produced and sold around the world. A great many issues would need to be resolved. Additionally, these are heavily dependent upon the imagined contexts, anticipated rituals of use, and scenarios generated by the designer, as s/he endeavours to be the 'advocate' of the imagined and largely unknown user. The product designer must both anticipate and address the needs, wants, and desires of an imagined user. In short there needs to be 'value propositions' for the consumer/user. As was suggested earlier, human reactions; perspectives; heuristics; and attitudes are often largely unknown and indeterminate. Therefore the final design may be perceived as being 'cloud like'. In this 'Chair' example, while the designers are developing the chair they will never actually know who will end up sitting in it, where it will be used, or even how it will be used. Consequently, to a large extent, the design issues in direct relation to the unknown user are indeterminate. Further, the designer will never actually know how the consumer/user attaches intrinsic value to the chair.

The above notwithstanding, the designer is charged with determining the physical characteristics of the chair. The designer will need to consider forces that act on the chair, the physical principles used in a lift or adjustment mechanism, geometry constraints as they relate to anthropometrics and ergonomics, color, form, and texture of the chair etc…. It can be argued that there is a symbiotic relationship that exists between a notions related to human sensibilities (indeterminate aspects) and physical principles (determinable aspects). One may consider human sensibilities as indeterminate (i.e. notions of comfort and aesthetic) and physical principles as being able to be determined (i.e. strength of materials, weight, wear characteristics etc…). The designer must account for the cloudlike nature of the human considerations / value propositions, and the clock like physical constraint issues related to the actual materiality of the chair. This apparent dichotomy coupled with issues relating to 'imported' information [arriving almost by chance], an evolving brief that driving alternates solutions, this makes the design process itself indeterminate, yet the process contains determineable aspects. It is some sort of combination of Indeterminism [chance] and determinism.

Popper (1972:228) suggests there is a "Middle-ground" in relation to clouds and clocks, *"animal behavior is something intermediate in character between perfect chance and perfect determinism something intermediate between perfect clouds and perfect clocks"*. Further, he acknowledges the need to understand how such nonphysical things such as **purposes**, deliberations, **plans**, decisions, theories, **intentions**, and **values** [our emphasis not Popper's], can play a part in bringing about physical change in the physical world. In a real sense this is the task set before a designer when they seek to embody an artifact for the real world. If designers plan/intend to add value to their artifacts and advance value propositions for consumer/users, this begs the question which strategies may best assist them in developing a capacity for moving a design forward.

Value Propositions

Given the discussion above in relation to developing value propositions, there is a body of literature in the domain of marketing which investigates this topic. At the core of value propositions, from a marketing perspective, are the twin propositions of promising value to the customer/user and the belief from the customer/user that value will be experienced by a product system or service. Further, Barnes et al (2009) put forward the idea that while value propositions are not addressed directly to the consumer/user. In short, they drive communications with the consumer/users, as they define and clearly articulate exactly what the company intends to make happen in the consumer/users life. Consequently, one of the core building blocks of value propositions creation are user experiences and all that it entails.

The work of Brand (1991) models delivering value propositions to consumers/users via a Quality Function Deployment model. That is to say, QFD is simply a system for designing a product or service based on customer demands and involves all members of the producer or supplier organization. This process is dominated by a visual planning matrix which assists in developing artifacts linking closer customer requirements and design requirements target values and competitive performance into an easy-to-read chart. Conversely, Barnes et al (2009) frame value propositions in terms of a “Value Pyramid”. Components form the base, offers are bundle components, and solutions drive processes next, with co-created value at the top of the pyramid. Whereas Kaplan and Norton (2004) hold that clearly defined value propositions is the single most important strategy for moving forward. They advocate a strategy based on a differentiated customer value proposition. Further, they discuss four major value propositions to assist in this. They have observed a number of organizations and practices finding that the four common value propositions are as follows: (1) low total cost (2) product leadership (3) complete customer solutions, and (4) system lock-in. Further, these core value propositions may be refined to eight typical customer values of *price, quality, availability selection, functionality service partnership and brand*, which may be grouped into three themes of product/service attributes, relationship, image.

In order to shape solutions that include the core value propositions attributes, highlighted above, Kaplan and Norton (2004) contend a successful design and development process culminates in a product that has the appropriate functionality; is attractive to the target market; and can be produced with consistent quality at a cost that enables acceptable profit margins. In their suggested product development process Kaplan and Norton (2004) advise many companies introduce a formal *stage-gate process* [as depicted in Figure 1 below]. This stage-gate model firstly draws upon customer needs and technological possibilities in order to generate possible concepts for selection for subsequent design of the product or service. Once the product/service is designed it is prototyped and tested prior to pilot production, manufacturing, and release. Each gate/phase of the development process offers a go/no go decision opportunity. They suggest this *stage-gate model* provides discipline in what appears to be an often chaotic indeterminate product development process. In a real sense the gates act as filters.

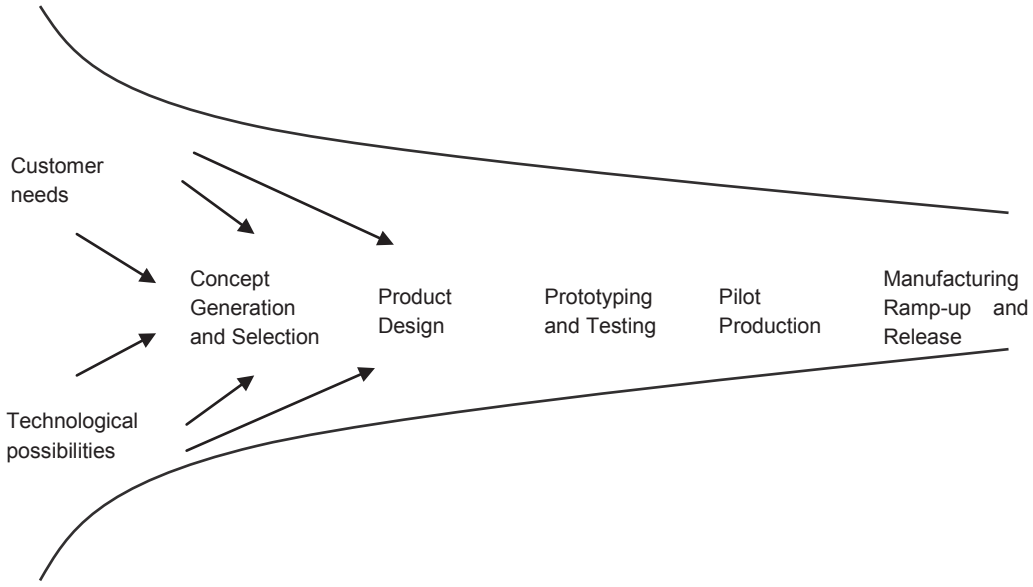

Figure 1. Product Development Funnel
Source: Adapted from Kaplan and Norton [2004]

A review of the literature surrounding new product development processes finds that Kaplan and Norton (2004) are not alone in their views relating to clearly defined filtering/stage gates. The work of Wheelwright & Clark [1992], and van Aken & Nagel [2004], as depicted in Figure 2 below, also describe the need for filters in the new product development process [NPD].

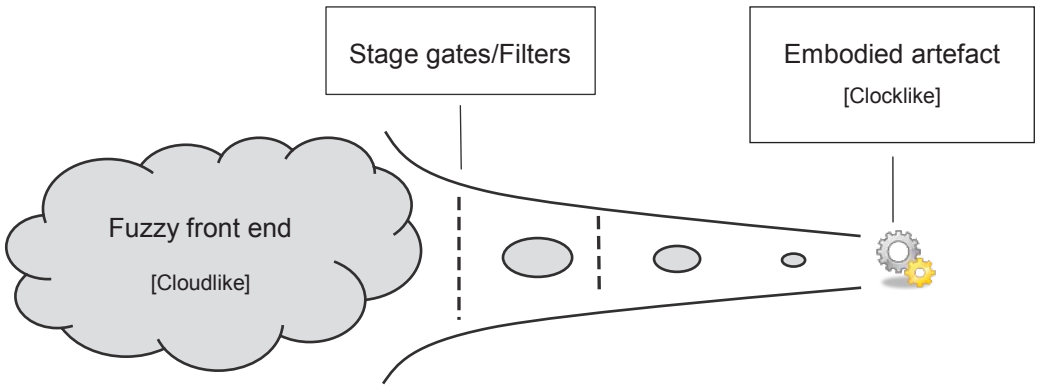

Figure 2. The FFE of mainstream NPD
Source: Adapted from Wheelwright & Clark [1992], also van Aken & Nagel [2004]

When reviewing the literature highlighted above, in relation to [NPD], there is a determined absence of feedback loops built into the *entire* design/development process. It can be argued that these feedback loops would greatly assist the product designer in determining if the value they are designing into the product does indeed offer value to the customer. If, as discussed earlier, the designer must account for the cloudlike nature of the human considerations / value propositions, and the clock like physical constraint issues related to the actual materiality during design/development, then having a greater understanding of the indeterminate "Cloud like" aspects, determined via feedback loops, should assist in offering "Value" to the customer. These feedback loops in a sense "Pull" information/ideas/issues from the users/customers. Conversely, when reviewing Figure 1 above we find that the technological possibilities are typically introduced or "Pushed" into the concept generation selection phase by the Designer.

“Pull” vs “Push” design

Much research examining the validity of 'push-pull' theory has taken place in literature relating to the domains of engineering/R&D management, process innovation, manufacturing strategy, or production systems [e.g. see Zmud (1984); Olhager & Ostlund (1990); Spearman and Zazanis (1992)]. In the work of Zmud (1984) he sought to construct a robust model of innovative behavior examining the validity of 'push-pull' theory (i.e., that innovation is most likely to occur when a need and a means to resolve that need are simultaneously recognized). Further, he sought to explore the applicability of 'push-pull' theory, along with the intuitive nature of this paradigm for explaining innovation success. He submits that the theory be expanded to include social issues as well as purely technological (performance) concerns.

Within his work he suggests that generally, 'need-pull’ innovations may be characterized by having higher probabilities for commercial success than have ‘technologies push' innovations. However, while innovation may be induced by either a performance gap or by recognizing a promising new technology, successful innovation is believed to most often occur when a need and the means to resolve it simultaneously emerge. While the existence of performance gaps and of technological means for resolving these gaps are clearly important for successful innovation, social features of organizations often emerge to inhibit this success. This position in relation to the need for seeking a balance between Social needs “pull” and ‘technologies push' parallels the discussion earlier in relation to designer finding the “Middle-ground” in relation to clouds and clocks. That is to say, the need to understand how nonphysical things such as **values, intentions**, and **purposes** can play an integral part in bringing about physical change in the physical world. If designers plan/intend to add value to their artifacts and advance value propositions for consumer/users, they must learn to balance the determinable aspects of their design and indeterminate aspects of their design ['need-pull’ innovations and ‘technologies push' innovations or the social and technological issues facing them].

It can be argued that if designers begin to be more inclusive with respect to real user needs not “assumed” user needs ['need-pull’ innovations] when shaping technological innovations, implied by Zmud (1984), their design may have a higher probability of success in the marketplace. Consequently, involving the user/customer in an appropriate manner at strategic points throughout the *entire* product development processes would prove to be a great advantage. It would appear a detailed understanding of potential users is seen as significant. Literature surrounding user centred design suggests there is an ever growing importance in considering users in the development of design solutions [see for example: Karat (1997); Bodker (2000); Redstrom (2008) Jacobs & Ip (2005)]. This begs the question of how we may bring together both users and designers into the product development design process.

It can be argued that if a designer or group of designers and a user or groups of users are able to externalise and share the way in which they process and draw upon their understanding of a design problem, then sharing their perspectives and heuristics both at the design brief and potential solutions phase, more considered, creative and enhanced solutions/value propositions may emerge. If we are to teach designers and users how to work together, it stands to reason that we may begin to shape the longer term design culture by educating the next generation of designers [current design students] about these important issues.

If a central goal of Design Education is to shape our students thought process and design experiences, then, as often is the case in the industrial commercial world, design and technology problems are often resolved by groups of people working in a synergistic way.

This occurs throughout the *entire* design development process in order to develop solutions to problems presented to groups of individuals (Users). The students must not be locked into operating only in the cloud like regions of the "fuzzy front end". This activity draws upon the individual knowledge bases, creative abilities, and shared understanding / identification of the problem's constituent parts. These individuals operating as a synergistic whole are by definition developing a 'collective intelligence', that is to say while each student draws upon their personal perspectives and heuristics they may both adopt and adapt the users perspectives and heuristics. The recent work of Barlex & Rutland (2008) makes it clear this does not tend to occur in design classes.

If we are to cultivate within our students the ability to balance the determinable aspects of their design propositions and indeterminate aspects of their design propositions, ['need-pull' innovations and 'technologies push' innovations or the social and technological issues facing them], then they will need to actively engage with the users in real not artificial contexts. Further, they will need to experience the entire process through to the point where the *real life context,* is analyzed.

While the work of Sanders & Stappers (2008) build a compelling case for the role of the user in the act of co-design, it may be argued that much of the work in the area of Participatory Design [PD] and User Centered design [UCD] as suggested by Oostveen and van den Besselar (2004) and others [see; Tollmar (2001); Constantine and Lockwood (2002)] is principally applied to small-scale projects within the academic domain rather than to the design of large, strategic design. Further, much of the research with user participation and co-design occurs in relation to the "Fuzzy Front End" [FFE] of "New Product Development" [NPD]. Typically, users [stakeholders] are brought into the studio environment to co-design with students. It in a real sense it is not that dissimilar to a social anthropologist bringing into the University setting members of a tribe that live it the wild. In point of fact the recent concept "*Designing in the wild"* [see Stompff et al (2011)] is gaining notoriety. In a real sense in the future design students will need real opportunities to work with the users in their environments. The students will need to experience *"Design In the wild"*. That is to say they need to learn to work outside the studio environment, more often than not students are taught in design studios [artificial environments for many design problems]. Further, as highlighted above the work often stops nearer to the "fuzzy front end". While the students may start with their heads in the "Clouds", ultimately they need to determine with "clocklike" precision the final embodiments. Clock-like aspects remain untested, as no real embodied artifacts are typically generated, or more to the point not co-designed. More often than not student do not properly evolve and test their real prototypes by going into "the village" or "the wild" and analyze the results of how their embodiments [a real working prototype] may fit in a real context.

If we are to cultivate an ability within our students to make the indeterminate aspects [socio-cultural cloudlike issues] of a design problem and more determined technological [Clocklike issues] balance, as they develop their design proposals, it is argued that we must get them out of the studio. They need to begin communicating with, and working with users in the "real" environment. While Shih et al. (2006) argue the central purpose of the design studio is to facilitate information sharing among peers, it may be argued students may miss out on the rich interactions with users in their contexts. If we have the students work with users in contexts outside to the studio environment then new behaviors, perspectives and heuristics emerge.

Consumer/Users

For all the discussion above in relation to users, if the designers [note; this includes users who are also in a studio operating in a co-design context] are not practiced in exploring design proposals outside a studio environment; practiced in examining the rituals of use; practiced in obtaining views; practiced in understanding motivations, and values of the users; the issues remain indeterminate. It is argued owed to the environment being largely imagined many design issues remain unknown and therefore indetermined at the detailed clocklike level. In a real sense if design students are “trapped” in the confines of a design studio, they are heavily dependent upon the imagined contexts, anticipated rituals of use, and scenarios generated by the designer and co-designers, as they endeavor to be the ‘advocate’ of the imagined and largely unknown user. Conversely, if design students are forced to experience *“Design In the wild”* they may work with the users and determine what was once indeterminate.

Let us return to the ‘Chair’ example described earlier. While the designers are developing the chair in conjunction with the users, in an effort to make determinable issues which were indeterminate, it is accepted they will never actually know ALL persons who will end up sitting in it, where it will be used, or even how it will be used. However, by working “in the wild” with the users the design students will substantially increase their ability to both anticipate and address the needs, wants, and desires of the users they work with and imagined users. By interacting with the users feedback loops become built into the design/development processes. In working with users this feedback serves to greatly assist the product designer in determining if the value they are designing into the product does indeed offer value to the customer. While it is acknowledged that co-design at the fuzzy front end is very important, it may be argued it is equally important design students experience co-design and testing at embodiment end in the real context.

If, as discussed earlier, the designer must account for the cloudlike nature of the human considerations / value propositions, and the clock like physical constraint issues related to the actual materiality during design/development, having a greater understanding of the indeterminate “Cloud like” aspects [determined via working with users] assists in offering “Value” to the customer. In short, many of the indeterminate aspects [socio-cultural cloudlike issues] of a design problem and more determined technological [Clocklike issues] of their design proposals may be balanced. Consequently, what was once indetermined may be more determined by working with users outside the studio environment.

Discussions and conclusions

When reviewing some core underlying constructs within the domains of design, marketing and philosophy of science, this paper revealed it is the designer/design student who *determines* and evolve the problem, and subsequently *determines* a number the characteristics of embodied artifacts. However, the individual designer brings with them their personal perspectives, biases, knowledge base, sensibilities, and previous patterns of experience. It was argued these personal perspectives and heuristics are limited. In more complex design problems many issues would need to be resolved. From a product design perspective the designer is heavily dependent upon the imagined contexts, anticipated rituals of use, and scenarios they generate. In a real sense they are an ‘advocate’ of often imagined and largely unknown user. As indicated earlier the product designer must both anticipate and address the needs, wants, and desires of an imagined user that are more often than not *indeterminate*. In short there needs to be properly validated ‘value propositions’ for the consumer/user.

If designers/design students are to deliver a successful design that represents 'value propositions' for the consumer/user, the design development process must lead to a solution that has appropriate functionality. Further, the proposed design needs to be attractive to the target market, and can be produced with consistent quality at a cost that enables acceptable profit margins allowing a company to remain viable. At the core of value propositions, are the central ideas of promising value to the customer/user and the belief from the customer/user that value will be experienced by a product, system or service. Often the designer is uncertain if what they are proposing holds "Value" for the user. Therefore, it is imperative the designer drive communications with the consumer/users, as they define, clearly articulate, and shape exactly how the company intends to shape the value propositions in the consumer/users life. Consequently, one of the core building blocks of value propositions creation are user experiences and all that it entails. Moreover, it is essential, designers, when developing artifacts, link customer requirements and design requirements with target values and competitive performance.

Earlier it was argued within the *stage-gate model* there is an absence of important feedback loops built into the design/development processes. These feedback loops would greatly assist the product designer in determining if the value they are designing into the product does indeed offer value to the customer. It was suggested they need to understand how nonphysical aspects such as **values, intentions**, and **purposes** can play an integral part in bringing about physical changes in the physical world. Further, they need to learn how these may be embedded in the design. This is particularly true if designers plan/intend to add value to their artifacts and advance value propositions for consumer/users. Successful innovation most often occurs when a need and the means to resolve it simultaneously emerge. It is important designers, and more importantly future designers, learn to balance the determinable aspects of their design and indeterminate aspects of their design ['need-pull' innovations and 'technologies push' innovations or the social and technological issues facing them].

A detailed understanding of potential users is seen as significant. Hence it is claimed we need to find ways to develop a fresh perspective on the designer's shifting frames of reference, which plays a central role in the design process. If we are to achieve this goal it is essential we develop and offer experiences which teach designers and users how to work together. We hold that we may begin to shape the longer term design culture by educating the next generation of designers [current design students] about these important issues.

The co-design literature suggests, working in the wild. However, to be truly wild one should go into the wild, into the world at large. In their work discussing co-creation Sanders & Stappers (2008:9) give us a hint at where we may venture into "the wild" or find a "village" when they note the following:

> *In many parts of the world, the needs that capitalism has worked so hard to meet have been met and so new needs are now being invented. Meanwhile, in other parts of the world, basic human needs (e.g. clean water) are not met.*

Based on the above quote, one proposal would be to visit and stay in the environments of people in less developed countries. A simple example would be to hold/run a "summer school" class in a rural outback or village community. The class may consider clean water problems or find there is an entirely different problem to solve. In this way they may live with the community and co-develop designs. They may move from co-developed inception, to mockup development, through to building working prototype and prototype evaluation. We consider a working prototype to be indistinguishable from the product

which would ultimately be used. It would not be merely a sketch model often found at the "fuzzy front end" and used to "*represent"* the product/solution proposal. It should be noted that while some Universities around the world may have some ethics and/or insurance issues, it is not unheard of for anthropology students or geology students to attend "digs" in various parts for the globe. While Sanders & Stappers (2008:9) lament that it may take years to shift our design culture from consumerism towards a considered consumptive/creative balance, our proposal would seek to address this by offering these opportunities for rich learning experiences to the new generations of designers. It would be great if a few Universities could manage to pool the resources, both human and financial, to have a number of classes from divergent cultures converging on a given community. Students from various countries would then work to identify, and resolve issues found. During their stay *"in the wild"* they would learn to co-design with the local community, assisted by their university tutors and mentors.

While each student draws upon their personal perspectives and heuristics, they need to both adopt and adapt the users perspectives and heuristics throughout ***the entire*** design process in the context of the environment the proposal will function within. Consequently, while it is incumbent upon us to shape design students learning experiences, we argue they need to involve the user/customer in an appropriate manner at strategic points in the product development processes. A detailed understanding of potential users functioning in the target environment is seen as significant. They need to actively engage with the users in real not artificial contexts. They will need real opportunities to work with the users in their environments not artificial studio environments. The students will need to experience *"Design In the wild"*. We hold that if design students are forced to experience *"Design In the wild"* they may work with the users and determine what was once indeterminate. In the future it will be increasingly important for product designers to develop the capacity to DETERMINE INDETERMINISMS [Balance Clouds and Clocks] by working with users outside the studio environment co-designing from inception through to prototype analysis and testing. It is argued the students should not always keep their head in the clouds.

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