Design Thinking a Fad or Reality

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Abstract

Identity crisis faced by design as a discipline is not new. Richardson's essay *The death of the designer* states that design is in the midst of a crisis of identity, purpose, responsibility and meaning, and 'The viability of the profession as it is currently practiced needs to be seriously considered, its boundaries examined, and its values reconsidered'. Bremer and Rodgers in their recent article state that design crisis comes from a number of different perspectives, including professional, cultural, technological, and economic forces. The crisis raises several challenges for design education. Empirical evidence is needed to demonstrate design's contribution to the viability of business and national economic development. In an attempt to resolve the design crisis, and take the discipline seriously, this paper defines the construct of design and design thinking. The paper describes new roles for design in addressing emerging global challenges. The paper discusses the lacunas in existing design education systems and the need for change, especially in relation to the requirements of multidisciplinary education.

Introduction

A hassled mother met me before my lecture to engineering students in India and said, '*Oh! So you are a professor of design here. Will my child need a colour box in the class?*' Next day, I met a corporate professional in Australia, who told me about the recent wave of 'design thinking'. I said, '*Design?*' He said, '*No. Design thinking,'* which according to him was a new technique propounded by managers to formulate creative strategy in organisations. He also mentioned that '*After taking a quick one week of training and a few months of trying to adapt, the company has lost faith and are leaning away from this word.'* Another innovator in Australia said, '*We don't need design thinking for ideating. We have enough ideas … and design thinking cannot do anything more, can it?'* I thought somewhere we, as design academicians, have been unsuccessful in providing an accurate picture of the various facets of design as a discipline. Design is either trapped in a cliché as an extension of art, or it is a corporate fad called design thinking. Ambiguity looms around the discipline called design, its value in innovation and also its relationship to the term design thinking.

This identity crisis faced by design as a discipline is not new. As Prof. Nigel Cross states, 'design crisis occurs every 40 years'. Even Richardson's essay *The death of the designer* states that design is in the midst of a crisis of identity, purpose, responsibility and meaning, and 'The viability of the profession as it is currently practiced needs to be seriously considered, its boundaries examined, and its values reconsidered.' Bremer and Rodgers in their recent article state that design crisis comes from a number of different perspectives, including professional, cultural, technological, and economic forces. This crisis raises several challenges for design education. Empirical evidence is needed to demonstrate design's contribution to the viability of business and national economic development. In an attempt to resolve the design crisis, and take the discipline seriously, this paper defines the construct of design and design thinking. The paper describes new roles for design in addressing emerging global challenges. The paper discusses the lacunas in existing design education systems and the need for change, especially in relation to the requirements of multidisciplinary education.

Design's historic roots lie in the very evolution of mankind. In prehistoric times, cavemen designed and carved their own tools and products. Later artefacts were made by craftsmen working either on their own or collectively in cottage industries or in design guilds. This produced localised designs which changed little over time in style or technology. Few master craftsmen formed their own design styles, and they could make only a limited number of exclusive objects. Creativity was of prime importance, creating the personalised, individual products one sees in museums nowadays. With the Industrial Revolution came the invention of

machines for mass production. The design of products relied on the technology available at the time. The Industrial Revolution not only transformed traditional crafts, but also accelerated the pace of technical innovation. Many new industries sprang up which applied mechanised processes to the production of new forms. At this point, design was often subservient to and dependent on technological limitations and advancements.

The Bauhaus, started by Walter Gropius in the early 20thcentury in Germany, was one of the most successful and far-reaching schools of design. The Bauhaus initiated a historic design movement, based on a vision of creating a new man from the disaster of World War I. It endowed design education with the sense that it could invent the present and the future of the modern century. In its brief 14 years of existence, the Bauhaus shared with the German public its design for physical and social renewal to shape a new society. It inspired successor schools all over the world, which adapted its philosophy and innovative teaching methods to create a bridge between technology and art – a new unity. At the Bauhaus each student was taught by a master craftsperson and a painter. This system of education is the foundation of today's art and design schools such as the Ulm School of Design.

Over the last century, design as a discipline has evolved constantly as a consequence of the industrial and information revolutions. The development of design embodies the human capacity to manage and shape the surroundings we inhabit though new products and services. This has only been possible though innovative industrial mechanisation. In the flood of artefacts which now satisfy human needs and aspirations, and in the building of infrastructure, the contribution of various design disciplines to the shaping of society cannot be ignored. New mediums of communication such as printing, telephones, television, satellites and mobile phones have had a strong impact on our economic and social life. The information highway is creating a new social model based on the networking of human intelligence. As technological innovation has progressed, design has acted in varied ways to make things easy to use. When the computing era was beginning, complex systems were developed without the user in mind, and problems arose with user interaction, adaptation and acceptance. Human computer interaction (HCI) gradually emerged as a design discipline which focused on defining interaction problems between machines and users. To start with, instead of consulting HCI experts from the outset when technology engineers were devising new systems, they were only involved later to solve usability problems. (Usability here is to be understood as a second phase, where user testing is conducted only after a system is already developed.) Even if designers identify user interaction problems, it is too late to make changes to the system during its development phase. Thus all designers can achieve is a few changes in the widgets at an interface level.

In the last decade, it has slowly dawned on the computing community that system visualisation and user integration are required not as an aftermath but at the start of system development. User- and customer-centred design and systems thinking have slowly been integrated into the development of software. Ubiquitous computing and mobile technology has come to play a central role in creating the socio-technological systems that are now shaping society – whether in health care, smart cities or transport. With this has come a paradigm shift in the strategic roles and responsibilities of designers, who have entered new fields such as human factors, information design and interaction design. Designers have also started to play an active role in creating visualisations and specifications for new systems, in bridging the gap between the user, context, domain experts and technology engineers and managers. The huge market success of companies such as Apple, Wii and Bang & Olufsen showed the strategic role design can play in facilitating and often creating breakthrough innovations . CEOs such as Apple's Steve Jobs and Renault-Nissan's Carlos Ghosn have exploited the potential of design, placing design strategists in the boardroom to ensure that design is no longer an afterthought or relegated to the periphery, but is at the core of an organisation's business processes.

1. The birth of the design thinking fad

As Prof. Dorst states, 'Nowadays, design thinking is identified as an exciting new paradigm for dealing with problems in many professions—most notably IT and business.' Following the success of Apple, a big debate took place on the framing, application and use of the term design thinking among large business houses. Design thinking was the term coined by the business community to denote a process which would infuse creativity into management. The term was taken up hastily by people wanting design thinking to act as a silver bullet to promote innovation. In several cases it failed, because organisations adopted design disciplines in rushed and ill thought-out ways, with poor follow-up. Sadly, along with design thinking, design itself was also discarded by several organisations which had been caught out by exaggerated claims. This happened because the glamorous proponents of design thinking devoted too little time to explain the fine nuances of the design problem-solving process and design thinking, and tried to adopt and apply the design thinking framework as if it were a Six Sigma process. In the words of Bruce Nessbaum, 'In order to appeal to the business culture of process, design thinking was denuded of the mess, the conflict, failure, emotions, and looping circularity that are part and parcel of the creative process.' Popular, short commercial training courses, which oversimplified design thinking as a four-stage process of empathising, ideating, prototyping and testing, were extremely easy to digest. These were delivered in packages titled 'design-led innovation' and 'design-driven innovation'. Unlike certain quality-control processes such as Six Sigma, however, design does takes time to be imbibed within

organisations. The acceptance and change required at an organisation level were underestimated and were not a part of the training.

Recently published studies have declared the decade of design thinking is over and the success rate of companies reporting innovation by implementing design thinking has been low . In-depth investigation is still required however to establish why innovation is low in those companies. For instance, is it clear that the companies concerned couldn't adapt the design process to the extent required to bring creative change into the culture of the organisation? This roller-coaster ride of terminological gimmickry is typical of the way the market works. My worry is that the quick acceptance of design thinking in management followed by its equally quick disposal has diminished the validity and the innovative potential of design as a discipline. On the one hand, corporates which have spent large sums of money sending their employees to globally acclaimed institutions are now leaning away from engaging with design. On the other hand, those which were skeptical from the start – and often mistook design for art – were confirmed afresh in their lack of faith. To quote one business executive in Australia, '*We told you so. Art has no place in the technology and product-innovation space*. *Design thinking is about nothing beyond writing Post-its.'*
The term design thinking was raised to the heights with the hope that it would quickly catch on and gain commercial benefits; now it is slowly being abandoned. It is easy to talk about how fancy design thinking is; what is needed are constructive cases that show how it can be applied and can benefit managerial decision making or radical innovation. These are missing from the literature. If the commercialisation of design thinking had been backed by well-grounded design professionals, and successful applications had been documented in the literature, it would have sustained itself as a strategy in organisations. Sadly, this was not the case and so design thinking remained merely a fad.

2. Construct of design, creativity & design thinking

Design thinking is not a new process, but a new term propounded to popularise the problem-solving process of design. The origins of the word design can be found in the Latin word *designare*, which is made up of the prefix *de-* 'out' and *signare* 'to mark'. *Designare* means to devise, to choose, to designate, to strategise or to appoint. In other words, design integrates strategy as a part of its problem-solving process, which can also be called design thinking. According to Prof. Victor Papenek, 'Design is a conscious and intuitive effort to impose meaningful order.' 'The planning and patterning of any act towards a desired foreseeable end constitutes the design process. It is a basic of all human activity – all humans are designers.' Sir

Herbert Simon states, 'Design is changing the existing conditions to preferred ones.' Design thinking can be defined as 'a creative and systemic problem solving process that can create or shape products, processes, businesses, society, and environment by driving user- and context-sensitive solutions.' To adopt design thinking in an organisation doesn't require change just in a single process, but in the organisation's mindset. It means changing the way people in the organisation think, so that they move beyond business as usual to explore the business's future. Design thinking relies on individuals' capacity to be creative and to apply these processes as a team to bring systemic change.

Strategy and creativity are the very essence of the problem-solving process that is now popularly known as design thinking. Where creativity can be understood as unleashing potential and design thinking can be un capitalizing creativity to connect innovation to user and market. Creativity is one of the essential elements in design thinking, but creativity itself does not lead to tangible solutions; design does. In design there is always a pragmatic end point. Design is about the creation and convergence of an idea to a tangible product, devising and bringing a change in the existing order of things for people and for societies. It is this applied nature of design that separates it from art. Design includes many disciplines – among them industrial design, architecture, visual design, information design, packaging design, service design, animation design, fashion design, textile design, automobile design, and human computer interaction design. The boundaries between the different design disciplines are slowly blurring, and all design disciplines apply a similar problem-solving process. An architect will apply design thinking in designing spaces while a product designer will apply design thinking to decisions about functionality, materials and processes, and human product interaction.

Design problem-solving or design thinking functions beyond the established frameworks of deductive and inductive reasoning , and several of its processes remain tacit. Although a body of literature exists that analyses how designers think, this analysis has not been used to form a framework which can be adapted by other disciplines such as management and engineering. Each discipline has its own problem-solving process, and there are certain stages common to all. Yet design thinking is unique because it integrates several elements as discussed below. These elements have been elaborated from the original propositions of Prof. Owens and Prof. Dorst . To understand the context of a problem and to create solutions to it, design problem solving or design thinking uses following principles (Fig 1).

2.1 Reframing the problem

Design thinking understands the context of a problem and often reframes that problem by creating newer patterns. It immerses itself in the problem context to understand how users,

workflows, systems, technologies, and cultures are interconnected. In contrast to problem solving in engineering or management, design problem solving steps back from the micro level of the problem and seeks larger system-level correlations. This broader perspective allows solutions to be framed and applied better than can be achieved at the micro level.

2.2 Observation

Observation is design thinking's basic tool for understanding the context of a problem and for gaining ideas about approaches to it. Designers are skilled in observing micro and macro details to understand a context and to map constraints. The zoom-in and zoom-out technique, which allows them to keep one eye on detail while considering the larger context, is a distinctive feature of design observations. A designer might observe all the details of a context comprising work, products, and environment to establish how users interact with the context, how they use objects – or are not using them, how they make errors, how products are related to their context, their emotions and their life. This is called immersion in the problem context. At this stage designers are not asking users questions about what they want; instead, those questions arise after exhaustive observation.

Observation produces information on which three scenarios can be sketched about the development of products or processes.

- There is an Existing technology that's needs to find a new application in the user context,
- An existing product needs redesign to solve an observed problem.
- Nothing suitable currently exists and a proposition must be made for a new system or product.

Design is about making propositions. That is what architects, fashion designers and product designers do for buildings, clothes and products which have not existed before. This argument runs counter to the prevailing view in the debate about whether user-centered design process can lead to radical innovation. I believe the most important factor is where the designer enters the innovation or product-development process. If it is towards the end, then design is an afterthought and a designer can achieve little. But if the designer is engaged at the start within a multidisciplinary team, then new perspectives can be drawn.

2.3Visual thinking – the mental model

Visual thinking in design is first of all an internalisation of the observation, along with the constraints present in the context, which together create a mental model of the problem context and the solutions to it. For example, an architect will generate a mental model of the spatial view of a new building, visualising several user scenarios in the new environment .

Second, visual thinking externalises the mental models using tools such as sketches, 3D modelling etc. Sketches offer an interface between the tacit and the verbally expressed . This is an essential trait in creative experts in all domains – including surgeons , managers, leaders, scientists and designers. Expertise in generating new patterns and correlations out of problems depends on experience. Visualisation is also linked to foresight. To envision something is to work with a set of unknowns for a set of users who don't exist within a context that is evolving. A designer's greatest strength is the ability to make propositions about things and processes that do not yet exist.

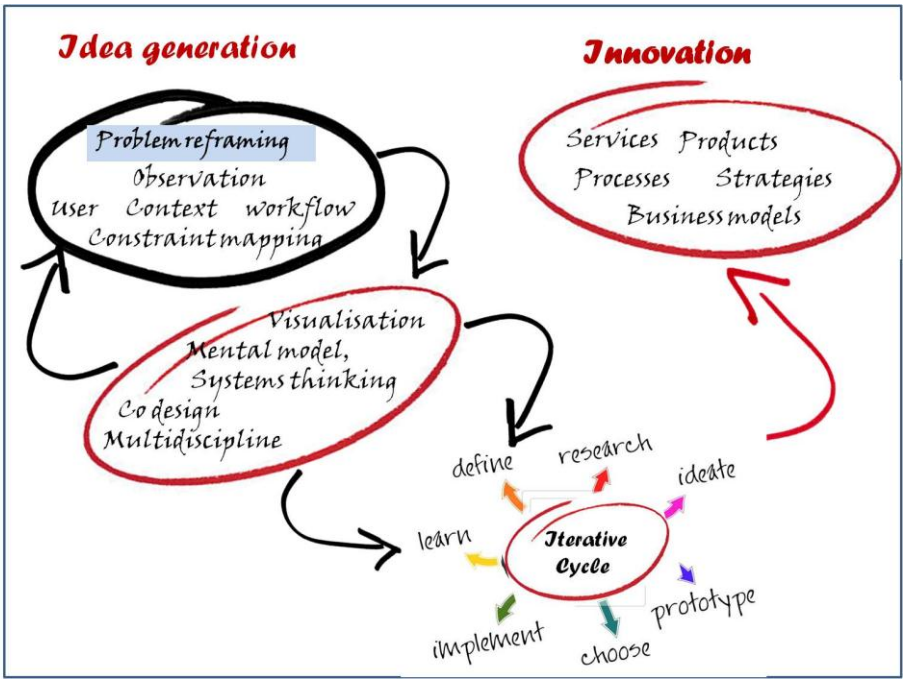

Figure 1: Design problem solving process or Design thinking

2.4 Systems thinking

A critical part of design thinking for situations where people (users) play a central role is the context in which processes, technologies, structures, cultures and workflows will operate. Systems thinking is the process of understanding how elements, regarded as systems, influence one another as an ecosystem.

2.5Constraint mapping

Constraints can be understood as possibilities and boundaries within a particular context where a product or proposal will be deployed. In complex workspaces, constraints become critical factors in both the process of design and in evaluating a design.

2.6 Research and multidisciplinary integration

Field research is a critical part of the design problem-solving process. This involves not only understanding the context, users, teams and stakeholders, but also background research to find out whether similar problems have been solved in a similar work context. At every stage of ideation and testing, research involves understanding competitors and also recent technological advances. Design has the flexibility to adapt theories from other disciplines such as social sciences, cognitive science, psychology and computer science to build an integrated framework for resolving complex social problems. Inspiration can be drawn from many sources. Some problems find excellent solutions in nature; biomimicry is the process of drawing on them to propose solutions.

2.7 The iterative cycle: Problem, insight, idea, prototyping and filtering

The iterative cycle involves repeating and reframing all the phases of the design cycle including re-defining, researching, empathising, ideating, prototyping, selecting, implementing and learning. Idea generation can be understood as the process of creating, developing, and communicating ideas that are abstract, concrete, or visual. Ideation is **the** conversion of design problems or design observation into design insights and then generating design ideas , as in the following example.

- *Design observation*: migrant workers cannot use ATM machines because of language constraints.
- *Design insight*: customisation of the ATM interface for migrant workers from Bangladesh.
- *Design idea*: multilingual interfaces catering to a migrant population.

In this case, several versions of ATM interfaces with content and specific terminology are developed and tested on users to see which is most readily accepted and contains the fewest errors. Design is not only about idea generation, but about generating several ideas and then testing and selecting the right one. The design thinking process can relate an idea to the problem context and evaluate the solution against the constraints which were found during the observation stage.

2.8 Co-design

Co-design – also known as participatory design – involves understanding problems and finding solutions in the field, together with end users, experts and stakeholders. It also adapts theories from several disciplines to develop a common communication ground. The value of co-design is often downplayed or underestimated at a management level. Yet even for policies to be

effectively adopted and deployed, co-creation and co-design with the participation of end users are critical. Like products, policies require an adoption framework. It is often observed however that few policies have well drafted frameworks which have been tested on end users. To address this shortcoming, several governments, including the Australian and British governments, are actively involving end users while evaluating and implementing policies.

The following sections discuss the lacunas in existing design education systems, and the need to revamp them, especially in relation to the requirements of multidisciplinary education.

3. Challenges for decision makers: an emerging role for design

The world is moving into an era where challenges are complex, fuzzy and interdependent. Here, complexity can be defined as uncertainty – where the structure of society is changing due to economic forces, rapid globalisation, and the exponential growth of nanotechnology, and information and communication technology (ICT). The question today is not whether innovation is led by design or by research and development (R&D), but rather, what are the new tools and methods that are needed to address the innovation challenges in these complex times? Are the graduates from various disciplines prepared to face these challenges? Have we as academicians updated our curriculum and pedagogies to meet these demands? The answer perhaps lies in evolving multidisciplinary frameworks. To address the challenges of innovation in complex times, disciplines such as management, design, engineering and the sciences, the arts, humanities, and social science need to consolidate their knowledge frameworks. The time has come to diffuse the boundaries that exist between disciplines. I draw upon three critical issues where design as a discipline, together with other disciplines, can contribute to addressing these issues.

3.1 Stimulating innovation and user experience

As our world continues to evolve, new challenges require experts to work at the intersection of disciplines to seek solutions. Instead of working in silos, they must adopt holistic, integrated approaches. In complex times it is the innovators turned leaders who have the vision to see beyond common patterns, who understand the big picture enough to create new patterns – who will stay ahead. By involving design thinking at the strategy development stage where key decisions are made – that is, by redefining how problems are framed and approached – new opportunities for action can be identified, and holistic and resilient solutions can be delivered. The entrepreneurial and innovative capabilities of individuals and organisations are strengthened by the following design thinking strategies:

- involving end users as co-designers

- involving multidisciplinary stakeholders as co-creators
- allowing the rapid iterations of ideas in the decision making process
- selecting and filtering of ideas while keeping users and the context in mind in building the new value proposition.

Thus, putting the right team together and creating opportunities for collaboration will generate more effective outcomes. Duplication will be reduced, and solutions will be targeted so they are more economically efficient, more socially beneficial, and more relevant to those who are to use them.

Figure 1, above illustrates how design thinking process is applied for idea generation which may lead to innovation of new strategies, products, process, business and services. But innovation is not just about generating ideas. It is also about converting ideas to tangible end points and diffusing them in the market. This is where different disciples of design start playing a critical role. Figure 2, below illustrates how different fields of design can be applied to develop a strategy for an integrated user experience in the entire value chain of the a product- Right from ideating, creating and diffusing it to the market. For example, Apple created an elite product concept for a mobile phone. Its user experience was defined not only in its product vision, functionality, technology and form, but also in user friendly human computer interaction, product ergonomics and packaging. Further, it executed a user centered service design which acts as a critical bridge to create a smooth experience between user, product and Apple. The same strategy of an exclusive product can be seen in its advertising, communication, branding, exhibitions, retail stores and even in its offices (architecture space). Hence from start till the end the user is repeatedly getting one single focused image of Apple and a unified user centered product experience. Although, one may innovate at any or all of these touch points see in Figure 2, but global strategy must remain consistent with the intended user experience. Often when an overview is ignored, it leads to break downs in a executing a holistic strategy for creating a complete user experience.

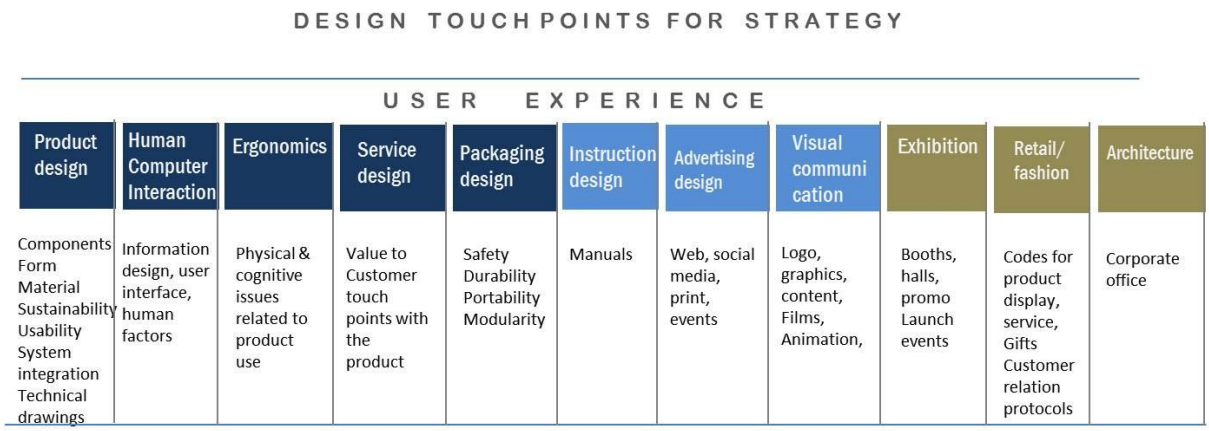

Figure 2 Fields of Design applied to create an integrated strategy for idea generation, conversion and idea diffusion

3.2 Intelligent products, systems, workflows and cities

The era of the information highway is creating a new economy based on wireless and sensor-based networking of embedded products, systems, and cities. The structure of society is changing such that information is at every touch point; where once it was data driven, it is coming to be knowledge driven. Seamless connectivity between devices, ubiquitous computing, the technology vanishing act, omnipresent communication opportunities and information workflows are driving and creating new challenges for business analytics and product development. For example, home networking to facilitate smart homes, homes for the elderly, smart hospitals, operating theatres, intra-operative visualisation system for clinicians, and sensor-based point-of-care devices to monitor a patient's disease. Technologies or technology-centred approaches alone when offered as solutions will not fit into larger systems and hence will not be adopted in the longer run. Design can play an important role in envisioning future societies, their cultural constructs that can drive technological innovation. Going further, information design, product design, architecture and communication design together can play a critical role in designing these systems – for example,

- by analysing existing workflows and visualising new ones for future systems with a seamless transfer of technology
- by defining information flows, interactions and cognition between a product and its users to improve decision making
- by defining the persuasive interaction between products
- by adapting products to the local context to ensure they are more widely accepted.

3.3 Shaping society and behaviour

The global environment is throwing up new challenges which are also governed by dwindling resources, population pressures and social unrest. In an era of mass consumption sustainability becomes a critical issue. Design can offer systemic solutions here, by ingraining sustainability as a strategy all the way from product development to disposal. Behavioral change which, for example, automatically requires a new product to be reusable, can be ingrained within a systemic product value chain. In this way, sustainability can be achieved not only through technological developments such as renewable energy, but also through changing behaviour so that people prefer simpler lifestyles. Behavioral change whether in energy consumption, or in improving health, or in other fields, will not happen through new technology alone; technology must be reshaped so that it persuades the user to change behaviour. 'Governments need to assist here: policies must take account of the social structure as much as the interests of various stakeholders to bring about social change in areas as diverse as reducing crime,, or encouraging innovation in manufacturing by changing attitudes. Disciplines such as social science, psychology and computer science do not have solutions for such complex problems by themselves. That is why development teams, like designers, need to be multidisciplinary to devise such solutions.

4. Rethinking design education

For design to mature to a point where it has the strategic capacity to address issues such as those mentioned above, and to embrace this emerging role, design education and design research must evolve. Other disciplines such as engineering and management have reflected on social, economic and technological advances in their fields and have revised their curriculums to match., Design academics however have been slow to change design education. Perhaps it is time to build further on the Bauhaus movement to create a new design movement. Perhaps it is time for modern master craftsmen to impart the fundamentals of design problem-solving and design thinking not only to designers but also to managers and engineers. I set out below some thoughts on revamping design education.

4.1 Strategic design should promote innovation in organisations

'Design education has not been updated to train designers to take a strategic role in organisations' as commented by Prof. Dorst. This opinion is concurred by Prof Buccollo, Prof. Dong and Mr. Watson, eminent design professionals and academics in Australia. Design schools focus on imparting expertise specific to a particular discipline – packaging design, product design, architectural design, say – but not on the interconnections and correlations between disciplines and how these can play a critical role at the strategic and advisory level

within organisations to promote innovation (see Figure 2). Each design discipline is so focused on providing its own micro-level expertise that they all omit the strategic correlations between design disciplines within an industry. For example the field of human computer interaction trains students to investigate and define users' interactions and interfaces with machines. The students are not always trained to look beyond to the way that interaction is also linked to defining the system's requirements, the information architecture in the machine. Similarly, students of packaging design are not asked to study how packaging is also linked to the way users interact with a product, and how in the entire value chain of the product, that interaction can drive innovation. Examples of success,,such as Apple, are rare. – where top management is aware of the correlations between these value chains and pushes the team to accept a strategic role for design. Few design engineering institutes include strategic design as a specialization; notable exceptions are the Industrial Design Engineering Department of the Technical University of Delft, the Netherlands, and very recently, the Industrial Design Department of Hong Kong PolyU. However, even these do not teach how the different design disciplines set out in Figure 2 can be integrated while developing a corporate strategy.

4.2 Multidisciplinary education

Complex global problems such as environmental degradation, and transforming societies through IT interventions, require multidisciplinary approaches to problem solving, as no single discipline has complete solutions. Hence multidisciplinary education should be supported within the various design disciplines (e.g. fashion, architecture, product) and also across disciplines such as engineering, science and management. Design education should support multidisciplinary education modules using project-based learning so that engineers, scientists, managers and designers can work together and learn to communicate. To support interdisciplinary work between the design disciplines, those disciplines should also share introductory courses which explain both the fundamentals of design itself, and the strategic correlations between its various disciplines. Design education is extremely strong in understanding users and testing ideas on users; management education is strong in understanding markets; and engineering education is strong in building devices. These different aspects of the design, engineering and management approaches are critical for problem-solving, and students of each need to be trained in ways that develop a common ground for communicating with professionals from the others. In response to this need, several top technical universities and industrial design engineering departments in Europe, England, Scandinavia, the United States and Australia have been piloting multidisciplinary capstone projects. However, this is still not a regular feature of traditional design schools.

4.3 Strategic design to promote innovation and entrepreneurship

If it is true that design and entrepreneurship are closely linked, why don't we see many successful design entrepreneurs? Here, what has been described as the designer's inherent 'facility for avoiding necessary choices' – , the freedom *not* to come to a decision quickly, but to think all possibilities through – is the restraining factor. To be a successful entrepreneur the ability to make quick decisions and follow up on them is critical. But designers also lack knowledge of the basics of finance, intellectual property, ethics, and the law, and thus the skills and confidence required to set themselves up in business or seek venture funding. These should be included in design courses.

4.4 Research and publications

Even though individuals have produced some exceptional research in different design disciplines, in general the interest in design research has been quite uneven, with stronger body of literature found in Human Computer Interaction, Architecture and Product Design **.** One aspect of Design research has also focused on how designers think , but very few studies have been published of how design thinking might be applied to solve real cases and support innovation in areas such as health care, crime and behavioral change. Few studies have been published which evaluate the role of design in improving the economics of an industry or a country . The lack of design publications which cross domains is one reason for the ambiguity regarding the contribution of design thinking to innovation and product development. When managers have to choose whether to invest in R&D or design or both, there are few published descriptions of cases on which to base the decision. Unless designers themselves can make the case at a strategic level, the decision will be made by default. Most books on design and design thinking are written either by computer scientists or by managers. Computer scientists became involved in the field because they needed training to design user-driven interactive devices. Since the literature was missing, they created it. In other areas, however, very few designers have taken the lead in writing about the role of design in innovation.

4.5 Communication

"*When designers and managers talk, they talk as if they belong to two different worlds.*" – Prof. Andy Dong

Those who have to solve complex problems cannot now avoid working in cohesive teams. Like engineering and management training, design education should equip young designers with design communications skills and basic communication tactics. The new role designers now have to fill will often require them to facilitate communication between multidisciplinary co-design teams of experts. This requires specials skills and training – training which is often

missing in design schools. At present designers are assumed to possess the inherent ability to communicate ideas to stakeholders and to mediate between teams. To complicate matters further, the terminology of design is not standardised. For example, the definition of design itself, and the differences between design methods and theory, will vary between disciplines. Words such as visualisation and workflow mean different things in engineering design, management, architecture and computation. Visualisation is a critical activity in design thinking, and where the terminology is ambiguous, scientific glitches and communication gaps between disciplines can arise. For that reason, corporate communication and team leading skills must be a part of design education.

4.6 The role of design in engineering education

The literature on training engineers for 2020 emphasises the need for more real-world problem solving. Design thinking can play a critical role here, educating a new class of engineers who can benefit society by devising new products and services that solve real-world problems . By introducing design methods into their training early, educators give trainee engineers a strong foundation for innovation based on the following design skills: problem identification and solving, user empathy, field research, team work, and knowledge of the processes related to user-centred product development. Those skills, combined with domain knowledge, lead to innovation. Although design has been offered as a capstone project in engineering schools, design is rarely the framework or a core subject for engineering education. Design educators need to create a bridge between the domains through literature, cases and courses. Technology is evolving quickly and design thinking may seem elaborate, but the two must come together so that technology develops in ways that benefit society.

4.7 The role of design in management education

Recent management literature states the need to:

- develop entrepreneurial and innovation capabilities in managers
- emphasise fieldwork-related projects .

Design can help address both these needs. Design thinking can enhance strategic decision-making and business competitiveness by providing a systemic, human-centered, and hands-on perspective on creating and identifying new business opportunities. Further, design disciplines can contribute at various stages in the product value chain to innovation and to enhancing the user's experience (See Figure 2). It is critical that management professionals are sensitised to the design process and its attributes so that they can:

- develop an innovation culture in their organisation

- identify innovative talent in teams
- develop competitive advantage by applying design as a strategy in all parts of the value chain.

In the past few years, some of the world's top business institutes, including the Harvard Business School, Columbia Business School, Rotman Business School, Copenhagen Business School and the Indian Institute of Management, Ahmedabad, have introduced design courses as electives in management education. However, there is a dearth of literature and research on how best to teach design as part of management education. Process-based design contributions to core management are still lacking.

Conclusions

The design fraternity must take a larger role in publicising its work, by sharing its successes with other disciplines in cross-domain scientific publications. We as design academics should ask ourselves why there is such ambiguity about the design discipline, and how we can strengthen the positioning of design within the framework of innovation. In the absence of written case studies from design academics, terms such as design thinking are confusing and can obscure design's wider contributions to society. It is clear that ambiguity surrounds the design discipline because design academics have not responded to the market's needs by preparing specialists or creating a design literature., Specialists from other disciplines such as accounting and management have adopted certain methods and terminology to suit their needs. Design must evolve and take a strategic role by rethinking design education and design research. Design schools today concentrate on imparting design expertise which is specific to given disciplines (packaging design, say, or product design, architecture design), and not informing students of the interconnections and correlations between disciplines and the critical strategic role these play within organisations to promote innovation. The challenge for educators of design students is thus to embrace a more strategic role for design in business development and to create new job profiles. Design can play a critical role in offering innovative skills to both engineers and managers – which means design education must be introduced for these disciplines. Although there have been some recent attempts to address these gaps, the literature of design and design education is still sparse. This paper has presented an area where design education needs to be strengthened to meet the complex challenges of globalisation. It is an attempt – by no means complete – to persuade design academics that it may be time for a new design movement to bring together all of design's disciplines and strategies to build a design-centric era.

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