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From Whiteboard to User Testing: Educating Problem Finders

Abstract
Future designers need to be able to navigate within a shifting economic, social, cultural and technological landscape. Communication and design problems are becoming increasingly complex and are often part of larger systems. Meeting global challenges such as climate change and an aging population will require designers and design graduates to engage in these complex problems and become 'problem finders'. In the context of undergraduate communication design education typically focusing on creating employable 'problem solvers' rather than 'problem finders', it raises the question; to what extent can design thinking facilitate the education of designers who are able to meet future design and communication challenges? This paper describes the implementation of design thinking into an undergraduate media design learning environment. Over a period of two years, the effectiveness of the design thinking process and the extent to which students were able to develop a design mind-set that involved problem-finding and was solution-focused were investigated. Furthermore, benefits and challenges encountered by participants were explored. This research was conducted applying a pragmatic approach. Quantitative and qualitative findings from two trials are presented.
Keywords: Design Thinking, Undergraduate Design Education, Design Future Focus

Introduction

Future designers need to be able to navigate within a shifting economic, social, cultural and technological landscape. Communication and design problems are becoming increasingly complex and are often part of larger systems. Meeting global challenges such as climate change and an aging population will require designers and design graduates to engage in these complex problems and become 'problem finders'. Several authors (e.g. Barnett 2012; Welch 2011; Davis 2011; Vukić 2011) argue that new ways of educating design students are required. Students must develop strong creative thinking skills (Welch 2011) and more critical minds (Barnett 2012). In the context of increasing economic, environmental and social problems (Vukić 2011) educating design students needs to go beyond teaching the design process to producing artefacts as required by a client (Davis 2012). In the context of undergraduate communication design education typically focusing on creating employable problem solvers rather than problem finders, it raises the question; to what extent can design thinking facilitate the education of designers who are able to meet future design and communication challenges?

Designers, Design Futures and Design Education

According to Robertson and Sobol (2011) more designers want to engage in solving global problems of health, inequality, education and the environment. However, these design and communication problems are becoming increasingly complex. This situation is challenging for designers because more skills and knowledge than usually residing within one designer are required when addressing these complex problems (Friedman 2000; Kandachar 2010). Consequently, work environments that are based around multidisciplinary, interdisciplinary or transdisciplinary models are seen as providing fruitful ground to respond to the increasing complexity (Whyte and Bessant 2007; Marttila and Kohtala 2010; Hunt 2011; Friedman 2012). Furthermore, Davis (2012) argues that designers "needs to go beyond traditional mental modes of problem solving for user needs…designers will need additional capabilities…broader, systematic and complex thinking is required." Welch (2011) points to the crucial and proactive role designers have to play when leading future transformations. He argues that this requires "a different level of thinking from that associated with being capable of responding to the client's brief." Designers need to provide direction and contribute through informed debate (Welch 2011).

Consequently, if the ways in which designers think must change, the way designers are educated must change also (Davis 2012; Barnett 2012; Welch 2011; Vukić 2011). Barnett (2012) argues, that current

design education "fails to deliver critical minds" because the university "instead of being an institute for the pursuit of knowledge, has become a business-like institute for the pursuit of a career." Subsequently, universities fail to provide space for exploration and experimentation (Barnett 2012). Welch (2011) and others (e.g. Davis 2011, Norman 2011, Vukić 2011, Poggenpohl 2012) request rethinking design education since it continues to educate for the past instead for the future. Vukić (2011, 137) suggests that a "new curriculum should promote comprehension and awareness of the global context that designers must work in." Welch (2011) supports this view, adding that design students "need the mental set that will position them to embrace the social, political and economic challenges" and they must develop "creative thinking skills essential in developing the resilience needed to survive - and even thrive - in this volatile and uncertain future."

Educating Communication Designers: Design Future Focused?

Design is often discussed in a broad and inclusive way despite the fact that design has different connotations in different fields, serves different industries and has different intentions, histories, theories, methods, and processes. The industry sector classifies product design, fashion design, textiles design and jewellery design under the *Manufacturing* industry sector; architecture design, urban planning, interior and exhibition design belong to the area of *Built Environment*; and the industry sector *Communication Design* comprises digital design, media design, multimedia design, interaction design, graphic design, visual communication, graphic art and advertising design (Design Council 2005; Design Institute of Australia 2009). The latter is defined by the International Council of Graphic Design Association (Icograda)–the world body for professional communication design–as an "intellectual, creative, strategic, managerial, and technical activity. It essentially involves the production of visual solutions to communication problems" (Icograda 2011, 8). A communication designer can engage in a variety or specialises in one of the following areas: "identity design; editorial and book design; typography; information design; advertising; illustration; photography; calligraphy; signage and pictogram systems; packaging; animation design; broadcast graphics and film titles; product, web and game interface design; interaction, environmental and exhibition graphics; data visualisation; and any other activity of online and offline shaping of visual form" (Icograda 2011, 8).

This broad spectrum makes it impossible to teach all communication design areas in one undergraduate degree programme; nevertheless, within a typical undergraduate communication design degree there is usually a wide range of subject areas offered; for example, graphic design (identity design, editorial and book design, typography), moving image (broadcast graphics and film title) and digital media design (web and game interface design, interaction). Students can often gravitate towards an area they feel suits their interest or talent (Fried 2001), or by choosing a pre-defined path leading to specialisation. Communication design programmes at undergraduate level are usually professional degrees and orientate students towards professional practice (McCarron 2001; Drew 2007). They usually have some typical characteristics (McCarthy and Almeida 2002) such as applying similar learning and teaching strategies, structuring learning experiences from simple to complex within the course of study and giving high priority to "individual performance and control of outcomes" (Davis 2008). In order to prepare students for a successful transition from the classroom to the workplace, many communication design programmes worldwide employ project-based learning as part of their curriculum (McCarthy and Almeida 2002; Duggan and Dermody 2005; Ellmers 2006; Shreeve, Wareing and Drew 2008; Poggenpohl 2012). These projects are often applied in nature and simulate or imitate professional practice (McCoy 1998; Shreeve 2011); hence, they are scenarios with authentic intent (Drew 2007; Fleischmann and Daniel 2010). For example, a design educator might require students to design a logo and brand for a fictional company. The design educator takes on the role of a client and introduces the brief to the students. At times, a real client (e.g. community group or non-profit organisation) may be brought into the learning environment in order to engage with students and participate in the project. Students then engage in the process of problem-solving, decision-making, self-directed learning, action-based learning, critical analysis and reflective activities to generate the finished product. Part of the training for students is the presentation of the solution to staff, peers and/or the external client.

Although an established pedagogy, Davis (2011, 73) criticises this approach because it often presents problems de-contextualised and asks students to follow "a process with the goal of fixed, 'almost perfect' results." This is particularly the case when design educators present design briefs because they are usually "tailor made for the students and […] written in an explicit or prescriptive manner"

(Duggan and Dermody 2005, 138). This can, according to Welch (2011), "easily turn into providing students with a toolkit of 'how to do it' techniques aimed at existing industry requirements." He sees this as "a major dilemma" in that "the efforts of students [and teaching staff] are so often directed more towards the existing job market, and the skills needed to earn a crust upon graduation, than to exploring entirely new territory".

To add to the dilemma, design students are almost always presented with an 'abstract' end-user or customer (McGinley and Macredie 2011) regardless of whether the project is fictional or real. Arguably, students often rely on the representation of the customer or end-user provided by the design educator or real world client rather than on primary and/or secondary research data collected. This is not only a problem in education but also in design practice as McGinley and Macredie (2011) point out, "[r]apid development in commercial projects allows little time for reflection upon real people…one has to question how closely designers' approximations of 'users' match the reality of those they are designing for, particularly in relation to diverse user groups." Sless (2011, 123) further points out that although it is known that for a communicative design to be successful it involves testing, redefining and participation of the community, "courses give little weight to these stages." This can, according to McGinley and Macredie (2011), result in a misalignment between designers' understanding and users' need and hence can lead to an unsuitable outcome.

As communication design pedagogy at the undergraduate level has changed little over the years, the question arises; will learning to problem-solve be sufficient to confront future challenges? According to Welch (2011), "problem-solving is clearly an important aspect of creativity, just as important, if not more so, as problem-finding." Dubberly (2011, 78) argues that "[p]roblem-framing becomes more valuable than problem-solving." Skaggs, Fry and Howell (2009) argue that shaping the problem needs to be part of the design process. This is a major shift in practice–one that needs to be reflected in the education of communication designers. Icograda (2011, 10) states that the role of communication design education is to "prepare students for technological, environmental, cultural, social and economical change. To this end, it should evolve from teacher-generated projects to more participatory problem definition." This is to enable a student to become a communication designer who "identifies and frames problems, and solves them collaboratively exploring possibilities through critical thinking, creativity, experimentation and evaluation" (Icograda 2011, 9).

Design Thinking

Design thinking is described as a "human-centred innovation process that emphasizes observation, collaboration, fast learning, visualization of ideas, rapid concept prototyping, and concurrent business analysis, which ultimately influences innovation and business strategy" (Lockwood 2010). Sørensen and Leerberg (2010) argue that design thinking "both stems from a humanist paradigm and represents an abductive way of reasoning that makes designers think in a radically different way and far removed from traditional causal reasoning in business." As tool for driving innovation, design thinking is best used in teams of people who bring different ideas, methods, experiences and discipline cultures together (Brown 2010, Lockwood 2010; Curedale 2013). Design thinking has increasingly been introduce into areas beyond traditional design in order to accelerate the process of inventing a product or a service that sets the enterprise apart and ultimately makes it more competitive (Brown 2010)[1]. Design thinking can, however, also "play an important role in strengthening the public sector's capacity to be an intelligent customer as it involves bringing together different perspectives, including industry and users of a service or product, to understand needs" (Department for Business, Innovation and Skills 2011, 86).

Figure 1 overviews the design thinking process which is usually undertaken in multidisciplinary teams to be truly effective (Bailey 2010).

[1] The term 'design thinking' has become ambiguous in its use, referring either to traditional research on design thinking or to a recently emerging innovation strategy. For a discussion on this issue refer to Badke-Schaub, Petra, Norbert Roozenburg, and Carlos Cardoso. 2010. Design Thinking: A Paradigm on Its Way from Dilution to Meaninglessness? Paper read at 8th Design Thinking Research Symposium (DTRS8), 19-20 October, at Sydney, Australia.

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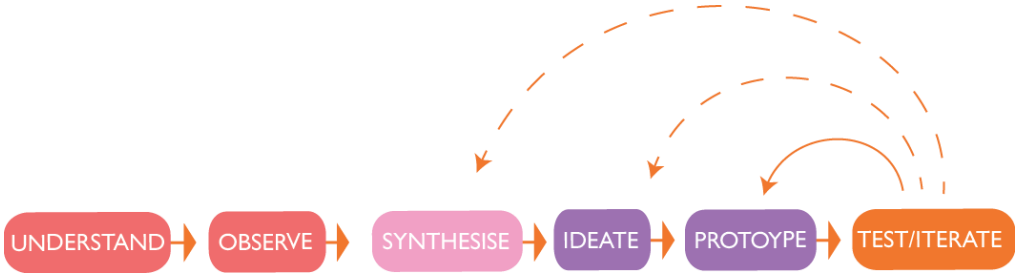

Figure 1. Design thinking process[2]

The nature of design thinking is intrinsically human-centred (Brown 2009). Developing empathy for user groups is central in design thinking during the process of developing a product or service. The steps 'observe', 'understand' and 'test' all involve the end-user or customer and this allows designers to "pay close attention to what is visible and articulated, while sensing what is below the surface and unarticulated" (Fraser 2010).

Design thinking has become increasingly popular in higher education. In the academic environment design thinking is best known from the d.school of the Hasso Plattner Institute of Design at Stanford University (USA) and the University of Potsdam (Germany). Another example is the relatively new Masters in Multidisciplinary Design Innovation at Northumbria University (UK) which is built around the principles of design thinking. Design thinking is, however, mostly applied at the postgraduate level.

Implementing Design Thinking in Undergraduate Communication Design Education

The Bachelor of New Media Arts degree programme is a three year study course which allows students to major in media design, under the broad umbrella of communication design. During their first two years of study media design students engage in typical communication design projects such as developing logos or corporate designs for clients (fictional or real world) and developing websites for real world clients. Hence, students learn to apply the design process to given/pre-defined problems to become effective problem solvers.

In 3rd year, students undertake the subject Interactive Media Design in which they work in collaborative teams with students from information technology to create an interactive multimedia application with advanced new media functionalities. Students are required to use a media rich approach including the use of a variety of software applications encompassing 2D computer graphics, computer animation techniques, and digital video and audio. Advanced navigation concepts and original interactive new media applications are researched and studied as exemplars of good practice.

In the subject Interactive Media Design, students were usually introduced to a project brief involving problem-solving which asked them for example to sell a fictional product via an online shop. The brief was intentionally open to allow for creativity and give students the opportunity to engage in larger problems concerning society. The fictional product could have taken any 'shape or form', touching on a range of topics such as environmental issues. However, students largely failed to embark on socially engaging topics and instead developed shops that sold imaginary best friends, auctioned collected odours from celebrities or sold superpowers to help students pass their exams. While these projects did not necessarily lack creativity or technological finesse, there has been a relative lack of deep consideration for the end user in many projects. As a result, it was decided to implement the design thinking process into the Interactive Media Design subject.

Two different projects were trialled. Trial 1, based on the brief of the Design Thinking Research Symposium (DTRS) in 2012, ran under the broad topic "*How can the design of products, spaces, and services make growing old seem more attractive and inviting?"* Students were asked to design a

[2] For a detailed description of each step see for example Skaggs, Paul, Richard Fry, and Bryan Howell. 2009. Design Thinking. In *ICSID World Design Congress* Singapore; and Scheer, Andrea, Christine Noweski, and Christoph Meinel. 2012. Transforming Constructivist Learning into Action: Design Thinking in Education. Paper read at Research: Uncertainty Contradiction Value; Design Research Society (DRS); Biennial International Conference, at Bangkok.

domestic product, living environment, or service for older people that surpasses conventional expectations. The design idea needed to be developed in the form of an application (app) for an iPad or other mobile device.

In Trial 2 students were given the following brief: More and more people have cars while at the same time traffic infrastructure may not be well enough developed to cope with such an amount of people using streets to go to their desired destination. Especially, traffic incidents often cause serious problems and create chaos which might be avoided. You are asked to develop and design a Traffic Incident Report System (TIRS). This system should make use of modern technology (e.g. mobile technology, web, twitter, RSS feeds, etc.) and interconnect such technologies within the system.

In both projects students were not given a specific problem but were required to frame or shape the problem first before finding a solution. The projects were structured around the six steps of the design thinking process and students were encouraged to experiment, design, fail, and design again.

Both trials followed the same structure and students engaged in the following activities:

- Introduction to design thinking process;
- Understand: discover and begin building empathy by conducting research on what is known already about the problem (secondary data collection);
- Observe: interview user group (primary data collection)
- Synthesise: make sense of findings, find a compelling point of view and clear direction for ideation;
- Ideate: brainstorm radical ideas, anything is possible, defer judgement, evaluate and select most promising idea;
- Prototype: design product or service;
- Iterate: user test and change if required.

Research Design

Although information technology students also participated in the subjects, the focus of this research study was on media design students, of whom 25 were enrolled in Trial 1 and 37 in Trial 2. After each trial media design students were asked to complete an online questionnaire designed to evaluate the effectiveness of the design thinking process and the extent to which they were able to develop a design mind-set that involved problem-finding and was solution-focused. Furthermore, benefits and challenges encountered by participants were investigated. The choice to use an online questionnaire (as opposed to interviews, for example) was a pragmatic one. The online questionnaire would not only return data on measurable indicators (e.g. How many media design students liked approaching the project by using the design thinking process?) but would also provide deeper insight into the researched phenomena by collecting qualitative feedback through open-ended questions (e.g. What did you like most/least about the design thinking process?). It would be possible to collect both sets of data in a short timeframe. For the quantitative data obtained, SurveyMonkey automatically provided basic statistical data such as the tally of response totals, percentages and response counts. The qualitative feedback was analysed using the qualitative data analysis programme NVivo. Although some findings could have been shown in summarised form it was decided to present exemplar quotes from media design students to add richness to the data and to present the authentic voice.

Project Outcomes

In Trial 1 students developed the concept for an iPad app for elderly people that would provide a product or service to make growing old seem more attractive and inviting. All projects showed a deep concern for the end-user expressed through elderly-specific idea development and also in applying age-specific interface and navigation designs. Some project teams extended existing apps for the elderly in innovative ways (e.g. a medication-taking reminder was equipped with rotatable 3-D graphics of the medication package as this was identified as problematic for elderly people who at times cannot remember which medication to take, especially after a package design change). Other project concepts

were completely original; for example, a GreyNomads scrapbook app was developed for retired people travelling and wishing to stay in contact with family and other GreyNomads throughout Australia[3].

Similarly, in Trial 2 student teams extended already existing Traffic Incident Report Systems (such as Roadside Assistance Club RACQ in Queensland, Australia) with innovative features. Some teams succeeded fully in framing a problem and developing a solution. For example, one student team discovered the need for a system that notified arriving students of parking opportunities at university. During their primary research phase (observing) the team discovered that students' punctual arrival for lectures or tutorials often depended on finding a parking space nearby, or at all. The developed app *Get to JCU in Time* (James Cook University) provides students with a reporting system on the availability of parking spaces at university. The app is user-controlled and takes advantage of GPS tracking. Users of the app report available parking space when leaving a space in an area of high demand or encountering a parking area already full[4].

[3] A detailed description of how the design thinking process was applied and a description of some project outcomes can be found in Fleischmann, Katja, Gemma Visini, and Ryan Daniel. 2012. "We Want to Add to Their Lives, Not Take Away…." In *Articulating Design Thinking*, ed. Paul Rodgers, 107-133. Faringdon: Libri.

[4] Outcomes of projects are featured in AUC. 2012. Crossing the Pedagogical Divide. *Wheels for the Mind* (Spring 2012, 1st Digital edition): 14-17.

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Research Findings: Media Design Students' Feedback

Over a period of two years 50 media design students (3rd year) provided feedback. Table 1 shows students' views on the design thinking process applied to their project development process.

Table 1. Media design students' perspective on introducing the design thinking process in the learning environment

The project development process was approached by using the design thinking process. Did you like approaching the project in this way?			
	Yes	**No**	**Total no of responses**
Trial 1	89% (16)	11% (2)	18
Trial 2	78% (25)	22% (7)	32

The feedback shown in Table 1 provides evidence that the majority of media design students were in favour of approaching a problem through the design thinking process. The qualitative feedback provided insight into this positive view. One student noted: "I think we found the right solution instead of just solving the problem" (2011). Another student reflected: "Because I was working on a project that is useful for a user. That was very interesting and I do feel that my skills are important to society" (2011). The majority of students were positive about applying the design thinking process because "It made us think in a different way" (2012) which is expressed in the previous two comments. However, some students found the process more challenging: "It seemed authentic and feels like a representative example of how this would work in the real world. It did make it more difficult to complete the work, as the process is less straightforward" (2012).

Table 2 shows media design students' feedback on the process of problem-finding/problem-framing as part of the design thinking process.

Table 2. Media design students' perspective on "problem-framing" being part of the project development process

Would you have preferred a project brief that asked you to design 'a pill-taking reminder for the iPad' (Trial 1) or a flood reporting app' (Trial 2) for example?				
	Yes	**I am not sure**	**No**	**Total no of responses**
Trial 1	28% (5)	5% (1)	67% (12)	18
Trial 2	22% (7)	22% (7)	56% (18)	32

Unsurprisingly, the feedback is diverse. While over 60 per cent of media design students in Trial 1 and over 50 per cent in Trial 2 prefer a project brief which requires "problem-framing", a considerable number found this approach challenging and would prefer a "problem-solving" brief or were unsure. The following comment is brief but illustrates the point: "It [the project/app] would be simpler to make" (2012). Some students struggled with the ambiguity of the problem: "I think it would have been better to design a detailed system, rather than something that was completely changeable like the traffic system" (2012). It should be noted that some students may resent the topic rather then the newly introduced design thinking process as the following comment illustrates: "Traffic incident report is boring and not strictly needed" (2012).

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When asked to comment on what they liked most or least about the design thinking process, a range of benefits emerged which clearly illustrates the qualities inherent to the design thinking process. One student stated:

> "I liked that it changed my outcome of the application. Sometimes I just get caught on an idea without thinking about the reason why I am making it or thinking about my target audience." (2011)

Another media design student commented:

> "I think the 'solution finding' objective widens the possibilities of creative thinking. We were not limited by one problem to solve; instead we examined solutions from every angle and decided upon the most appropriate one." (2012)

Overall it was interesting that a large number of students reflected positively on the brainstorming and many commented positively on working in a team:

> "I liked evolving our ideas from a whiteboard of suggestions to a refined idea." (2011)

> "It was good to brainstorm in a team from day one. We were all part of it and it was a great positive experience within this multidisciplinary group." (2012)

Furthermore, a large number of media design students reflected positively on directly engaging with the users (interviewing and prototype testing), as illustrated by the following two comments:

> "Interviewing people made so much more sense; it makes you see what the users are like instead of assuming what they are like." (2011)

> "The user testing gave the project more realism. He [the user] saw things that we did not because we were "too close" to the project. Trying to find out what the user wants was a good part of thinking up what features the app needed." (2012)

Discussion and Conclusion

The introduction of design thinking in the 3rd year Interactive Media Design subject has created a variety of beneficial outcomes for media design students. The design thinking process (opposed to the usually executed problem-solving process) required of students to frame problems first through research and by actively engaging with the user target group. This active engagement with the end-user allowed students to develop greater empathy and develop an understanding what needs to be developed. Solutions created were thoughtful, relevant and made a difference in people's lives. The prototype user tests allowed media design students once again to engage with the end use and gain feedback on their experience. Incorporating the feedback has led to improved design solutions. Although for some students it was challenging, the majority reflected positively on the introduction of the design thinking process and particularly positively on the participatory aspects of the process. The feedback from media design students shows that design thinking can facilitate critical thinking, and helps students to think in a different way and to focus their thinking onto real people and their problems. Consequently, design thinking is a useful process that can help communication design students to design meaningful, innovative and sustainable solutions as part of multidisciplinary or transdisciplinary teams.

Approaching complex design and communication problems using the design thinking process is increasingly utilised as a strategy in the economic, social and public innovation sector. In order for communication designers to participate in this process they must learn to extend their problem-solving skills to also master problem finding or problem framing as part of the design process. Furthermore, it is necessary to develop a deep understanding of customer, user or human that will use a product, a device, or service. User participatory design and innovation approaches have grown increasingly popular with design thinking being one expression of these recent developments. While none of this is new to some design areas (e.g. product design), design thinking is nevertheless a novel approach when

applied in and across other disciplines. For communication designers, engaging in design thinking is a major shift in practice away from being merely problem solvers towards becoming problem finders. Design education must be reflective of this changing status quo and provide the opportunity for communication design students to experience and learn problem-framing as part of the design process.

References

Bailey, Mark. 2010. "Working at the Edges." *Networks* (11): 42-45.

Barnett, Rebecca. 2012. Event-Based Learning- Urmadic Education and the Pedagogy of Sustainment. *Zoon Technica - The Journal for Redirective Design* (02), zoontechnica.com.

Brown, Tim. 2009. *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*. New York: HarperCollins.

Brown, Tim. 2010. Design Thinking. http://www.designcouncil.org.uk/about-design/How-designer.

Curedale, Robert A. 2013. *Design Thinking: Process and Methods Manual*. Topanga, CA: Design Community College Inc.

Davis, Meredith. 2008. Toto, I've Got a Feeling We're Not in Kansas Anymore…. In *AIGA* BOSTON.

Davis, Meredith. 2011. "Relevance in a Complex World — Icograda Design Education Manifesto." In *Icograda Design Education Manifesto* eds Audrey G. Bennett and Omar Vulpinari, 72-75. Tapei: International Council of Graphic Design Associations.

Davis, Beck. 2012, 12th August *The Future of Design*. "the-words." Gold Coast. Griffith University, School of Design.

Department for Business, Innovation and Skills (BIS). 2011. *Innovation and Research Strategy for Growth*.

Design Council. 2005. *The Business of Design*. http://www.designcouncil.org.uk/publications/The-Business-of-Design/.

Design Institute of Australia. 2009. Structure of the Design Industry: A Structural View of Design Disciplines. Accessed 20 August, http://www.dia.org.au.

Drew, Linda. 2007. "Designing the Interface between Research, Learning and Teaching." *Design Research Quarterly* 2 (3).

Dubberly, Hugh. "Input for Updating the Icograda Design Education Manifesto." In *Icograda Design Education Manifesto* edited by Audrey G. Bennett and Omar Vulpinari, 76-81. Tapei: International Council of Graphic Design Associations, 2011.

Duggan, Brenda, and Brenda Dermody. 2005. "Design Education for the World of Work: A Case Study of a Problem-Based Learning (Pbl) Approach to Design Education at Dublin Institute of Technology (Dit)." In *Handbook of Enquiry & Problem Based Learning*, eds T Barrett, I Mac Labhrainn and H Fallon, 137-145. Galway: CELT.

Ellmers, Grant. 2006. Reflection and Graphic Design Pedagogy: Developing a Reflective Framework to Enhance Learning in a Graphic Design Tertiary Environment. In *ACUADS 2006*, edited by Su Baker and Susan Fereday. Monash University, School of Art, Victorian College of the Arts, Melbourne, Victoria.

Fleischmann, Katja, and Ryan Daniel. 2010. "Enhancing Employability through the Use of Real-Life Scenarios in Digital Media Design Education." In *Preparing Graduates for the Professions Using Scenario-Based Learning*, ed. Ed Errington, 85-96. Mt Gravatt: PostPress.

Reference:
Fleischmann, K 2013, 'From Whiteboard to User Testing: Educating Problem Finders', *The International Journal of Design Education*, vol. 7, pp. 45-56.

Fraser, Heather M.A. 2010. "Chapter 4: Designing Business: New Models for Success." In *Design Thinking: Integrating Innovation, Customer Experience and Brand Value*, ed. Thomas Lockwood, 35-46. New York: Allworth Press.

Fried, Geoffry. 2001. "The Wrong Horse?" In *The Education of an E-Designer*, ed. Steven Heller, 10-13. New York: Allworth Press.

Friedman, Ken. 2000. Creating Design Knowledge: From Research into Practice. In *IDATER 2000: International Conference on Design and Technology Educational Research and Development* Loughborough University.

Friedman, Ken. 2012. "Models of Design: Envisioning a Future Design Education." *Visible Language* 46 (1/2): 133-153.

Hunt, Jamer. 2011. "Icograda Design Education Manifesto." In *Icograda Design Education Manifesto* eds Audrey G. Bennett and Omar Vulpinari, 86-89. Tapei: International Council of Graphic Design Associations.

Icograda. 2011. Icograda Design Education Manifesto. In *International Council of Graphic Design Associations*. Tapei.

Kandachar, Prabhu. 2010. "Designing for Global Sustainable Solutions: Challenges and Opportunities." Paper presented at the LeNS Conference, Bangalore, India, 29th September to 1st October 2010.

Lockwood, Thomas. 2010. "Foreword: The Importance of Integrated Thinking." In *Design Thinking: Integrating Innovation, Customer Experience and Brand Value*, ed. Thomas Lockwood, vii-xvii. New York: Allworth Press.

Marttila, Tatu, and Cindy Kohtala. "Towards Transdisciplinarity: Understanding Current Multidisciplinarity in Designing Sustainable Urban Solutions." Paper presented at the LeNS Conference, Bangalore, India, 29th September to 1st October 2010.

McCarthy, Steven, and Cristina Melibeu de Almeida. 2002. "Self-Authored Graphic Design: A Strategy for Integrative Studies." *Journal of Aesthetic Education* 36 (3): 103-116.

McCarron, Carolyn. 2001. "A Matter of Degrees: The Ph.D in Design." In *The Education of an E-Designer*, ed. Steven Heller, 28-37. New York: Allworth Press.

McCoy, Katherine. 1998. "Education in an Adolescent Profession." In *The Education of a Graphic Designer*, ed. Steven Heller, 3-12. New York: Allworth Press.

McGinley, Chris, and Robert Macredie. 2011. Towards Diversity and Empathy in Design Development. *Zoon Technica - The Journal for Redirective Design* (01), zoontechnica.com.

Norman, Don. "Design Education: Brilliance without Substance." *core77 - design magazine and resource* (2011).
http://www.core77.com/blog/columns/design_education_brilliance_without_substance_20364.asp

Poggenpohl, Sharon Helmer. 2012. "Envisioning a Future Design Education: An Introduction." *Visible Language* 46 (1/2): 8-19.

Robertson, Jason, and Daniel Sobol. 2011. The Designer's Paradox. *Zoon Technica - The Journal for Redirective Design* (01), zoontechnica.com.

Shreeve, Alison, Shân Wareing, and Linda Drew. 2008. "Key Aspects of Teaching and Learning in the Visual Arts " In *A Handbook for Learning and Teaching in Higher Education: Enhancing Academic Practice*, eds Heather Fry, Steve Ketteridge and Stephanie Marshall, 345-362. New York and London: Routlege.

Reference:
Fleischmann, K 2013, 'From Whiteboard to User Testing: Educating Problem Finders', *The International Journal of Design Education*, vol. 7, pp. 45-56.

Shreeve, Alison. 2011. The Way We Were? Signature Pedagogies under Threat. In *Researching Design Education: 1st International Symposium for Design Education Researchers; CUMULUS ASSOCIATION// DRS*, edited by Erik Bohemia, Brigitte Borja de Mozota and Luisa Collina. Paris, France CUMULUS ASSOCIATION// DRS SIG on Design Pedagogy.

Skaggs, Paul, Richard Fry, and Bryan Howell. 2009. Design Thinking. In *ICSID World Design Congress* Singapore.

Sless, David. 2011. "Critical Reflection on a Manifesto." In *Icograda Design Education Manifesto* eds Audrey G. Bennett and Omar Vulpinari, 121-123. Tapei: International Council of Graphic Design Associations.

Sørensen, Kirsten Bonde, and Malene Leerberg. 2010. Reframing Business – and Design? – a Critical Look at Co-Creation. In *Design and Complexity, Design Research Society International conference (DRS 2010)*, edited by David Durling, Rabah Bousbaci, Lin-Lin Chen, Philippe Gauthier, Tiiu Poldma, Seymour Roworth-Stokes and Erik Stolterman. Montreal.

Vukic, Fedja. 2011. "Design for Tomorrow?" In *Icograda Design Education Manifesto* eds Audrey G. Bennett and Omar Vulpinari, 136-139. Tapei: International Council of Graphic Design Associations.

Welch, Donald. 2011. Issues in Teaching Creative Thinking to Design Students. *Zoon Technica - The Journal for Redirective Design* (01), zoontechnica.com.

Whyte, Jennifer, and John Bessant. 2007. *Making the Most of UK Design Excellence: Equipping UK Designers to Succeed in the Global Economy*. Innovation Studies Centre, Tanaka Business School, Imperial College, London