Toward a Holistic Undergraduate Curricular Model in Design Thinking

Ann Donar (née Szeto)

A Thesis

In the Department of

Art Education

Presented in Partial Fulfillment of the Requirements
For the Degree of Doctor of Philosophy in Art Education at
Concordia University
Montreal, Quebec, Canada

February, 2012

CONCORDIA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

This is to certify that the thesis prepared

By: Ann Donar (née Szeto)

Entitled: Toward a Holistic Undergraduate Curricular Model in Design Thinking

and submitted in partial fulfillment of the requirements for the degree of

Doctor of Philosophy in Art Education

complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

Signed by the final examining committee:

Linda Szabad-Smyth — Chair

Paul Sproll — External Examiner

Rhona Richman Kenneally — External to Program

Cathy Mullen — Examiner

Linda Szabad-Smyth — Examiner

Lorrie Blair — Thesis Supervisor

Approved by

Linda Szabad-Smyth
Chair of Department or Graduate Program Director

Catherine Wild
Dean of Faculty

ABSTRACT

Toward a Holistic Undergraduate Curricular Model in Design Thinking

Ann Donar (née Szeto), Ph.D.
Concordia University, 2012

This dissertation explores the emerging subject of Design Thinking amidst the increasingly accelerating evolution of the subject. As the term *design thinking* is becoming more popular and is being taught in diverse disciplines in higher education, both in and beyond the traditional realms of design such as graphic design, a question arises as to what exactly it is and how it could or should be taught. This dissertation combines reflective practice and action research to contribute to the understanding and subsequent proposal of a holistic approach in the teaching of Design Thinking.

A review of literature published on the subject from the 1980s onwards brought forth some common themes and concerns that have been addressed, initially from the disciplines of engineering and architecture, and later on in product development and business. In the course of the reflective journey, the guiding vision of using design to create a better future for mankind took shape. Reflecting on and combining themes and strategies found in literature, a number of selected ideas were refined to be implemented in a pilot teaching project.

The selected ideas were organized and integrated in the planning and implementation of the pilot course, a 200-level course in Design Thinking offered in a trans-disciplinary, technology-oriented undergraduate program. Within the context of action research, data was collected throughout the course, including personal observations and notes, assignments, tests, discussion forums, surveys and evaluations. The data was then analyzed and reflected upon.

Since the pilot teaching project in the fall term of 2009, the subject of Design Thinking has burgeoned, resulting in a significant number of publications stemming simultaneously from isolated disciplines within the course of a year. New insights gained from this literature, along with the findings gathered from the pilot teaching project, converged to furnish suggestions for potential future directions in practice and research.

This dissertation is illustrated with 18 sample slides used in the pilot course, 45 artworks collected from students, 6 tables and 1 diagram.

ACKNOWLEDGEMENTS

There are a great number of people that I need to thank and without whom this significant milestone in my academic and professional life could not have been reached.

First and foremost, I would like to thank my associate deans at Sheridan College, all of whom have been the most supportive and accommodating administrators who value professional development and research. In the course of this five-year-journey, I have had the pleasure of having three of the most wonderful individuals as associate deans. They are André Plante (currently Associate Vice President, Corporate Planning, Finance and Administration), Ronni Rosenberg (currently Dean, Faculty of Animation, Arts and Design), and Michael Rubinoff. I would also like to thank the current coordinator of the CCIT program at Sheridan, Michael Jones, the former coordinator, Gail Benick, and Director of the CCIT program at the University of Toronto Mississauga, Anthony Wensley.

Special thanks go to Michael Large, Associate Dean of Design at Sheridan, who was my mentor in the initial stage of my doctoral study. Other internal colleagues who have most helpfully contributed to my research include Elizabeth Littlejohn, Mary Ann Maruska, Brian Donnelly, and Ed Naus. External colleagues who have generously contributed their time and input include Keith Rushton (OCAD), Susan McCahan (University of Toronto), Heather Fraser (University of Toronto), Paul Sproll (RISD), and Rhona Richman Kenneally (Concordia University). The professional insights and passions of these scholars have played an important role in my academic endeavours.

I must thank my academic advisors and mentors in the Department of Art Education at Concordia University most sincerely, especially Lorrie Blair, Cathy Mullen, Linda

Szabad-Smyth, and Paul Langdon, for their unconditional support and recommendations, without which I would not have had received the generous scholarship, awards, and fellowship that mean so much to me.

Last but not least, I must thank and share this accomplishment with my family: my parents, Ming and Harriet, sisters Christine, Elaine, Joanne (brother-in-law Fraser), and my husband David, to whom I owe a real summer vacation. I must thank Elaine especially for playing the instrumental role in dropping me off and picking me up at the bus station, week after week for a year, so that I could commute to Montreal smoothly and come back to a delicious hot meal, for which I will be forever grateful. A special figure to remember at this time is my late uncle Wah, whose life dedicated to the fight for democracy and social justice acts as a daily reminder that there are many who are less fortunate in this world.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF DIAGRAMS

LIST OF SAMPLE SLIDES

LIST OF ARTWORKS

CHAPTER 1: INTRODUCING THE REFLECTIVE JOURNEY

How It Started

As a professor of design thinking, I am constantly evaluating my curriculum and pedagogy, gauging the scope and relevancy of the material against the changing needs and demographics of the student population and society at large. My colleagues and I from the design, engineering, and business arenas have varying notions of what design thinking is, what it entails, and what a curriculum in design thinking should encompass. These questions and answers are still evolving, posing noteworthy implications for contemporary design curriculum development.

This thesis, therefore, is a research project that will allow me to investigate the question: "What happens when some contemporary ideas in design thinking are implemented in an undergraduate, interdisciplinary Design Thinking course?" To that end, this thesis will be informed by both reflective practice and action research, in the ongoing development and implementation of the course CCT204: "Design Thinking," a 200-level undergraduate course in the joint program of Communication, Culture and Information Technology, between Sheridan College and the University of Toronto Mississauga. The focus and contention of this project will revolve around guiding values and purposes of design that may impact on the vision, philosophy, and motivations of what design could and should do.

Preliminary Thoughts

A quick search of scholars who have featured design thinking in their doctoral dissertations yields a few results. The following list identifies some of these scholars and aspects of their work:

- Neeley (2007), in his dissertation "Adaptive Design Expertise: a Theory of Design Thinking and Innovation," develops the Theory of Adaptive Design

Expertise comprising the active, abstractive, and adaptive dimensions (p. 71). Predominantly conducted in the domain of engineering, Neeley's research summarizes the dimensions of design expertise as discussed in literature and attempts to propose a theory that is "(1) supported by research, (2) reflective of practice and (3) teachable" (p. 68). Neeley's work will enhance my understanding of "the dynamic, human and adaptive nature of the design process" (p. v).

- Lee (2007), in her dissertation "Storied Objects: Design Thinking with Time," proposes to include the expression of time, in addition to form and function, in the design of everyday objects. The contention of Lee's work is the inclusion of a specific feature of design, that is, the "audio time-lapse," while acknowledging the aspect of "aesthetic and cultural value" in design (¶ 2). Lee's work will lend a different level of awareness to the contemporary approaches in the design of material objects.
- Wigum's dissertation, "Human and ecological problem solving through radical design thinking: analyses and development of design theory and design framework based on long-term human needs" (2004), presents an in-depth look at design thinking in the realm of sustainable development. Her research will provide me with a wealth of information on many aspects of sustainable design, including design products as value carrier, social and spiritual sustainability, and Factor 10 design: a concept evaluating long-term prognosis from a global perspective.

Some ideas that I have selected based on my reflection thus far are, in my opinion, significant and appropriate points of departure to consider a new model for design thinking. They represent ideas that have surfaced but have not yet been fully exploited, systematically promoted, and duly

integrated in a design curriculum. To the best of my knowledge, this thesis is the first in which the teaching of design thinking in higher education is researched. Even though these ideas could influence future design practitioners help shape a better world, and to bring about positive, collective values for the benefit of humanity, there has been no documentation as to how these ideas could be integrated in a design thinking curriculum, and what happens when these ideas are integrated in the curriculum. Therefore, to engage in reflective practice by responding to and synthesizing the conceptual shifts in design thinking found in literature, to rework the contemporary ideas of design thinking by maintaining a dialogue between my own concrete practice and these overarching ideas, to modify the existing content, framework, and mode of delivery of CCT204, "Design Thinking," with these ideas, and to implement an action research project while teaching it, would allow me to investigate what happens when these ideas are integrated and implemented in a design thinking curriculum, and subsequently to re-situate them in a theoretical context.

Methodology and Framework

This research project will be informed by both reflective practice and action research, as follows:

1. While investigating and responding to the contemporary ideas of design thinking, I will engage in reflective practice and attempt to contextualize these ideas against the traditional framework of design thinking, that is, one that focuses on functional skills. I will synthesize these ideas from literature and rework the conceptual shifts by maintaining an active and critical dialogue between my own concrete practice and these overarching ideas.
2. Upon further systematic reflection and synthesis, I will modify a design thinking curriculum, CCT204, by integrating the contemporary ideas in a modified framework of design thinking, that is, one that is guided and motivated by values

and purposes of design, and supported by integrated principles and processes.

3. While teaching the modified course CCT204 in the fall semester of 2009, I will engage in action research and "reflection-in-action" (Schön, 1983, p. 60) on what happens when these contemporary ideas are implemented in the curriculum. I will review and analyze the process as well as the products encountered during this cycle of "look, think, act" (Stringer, 2007, pp. 8-9) and then revisit and re-situate these ideas in a theoretical context.

I believe that the combination of reflective practice and action research outlined above will yield significant results in both practical and theoretical contexts. As Schön states:

> Each view of professional practice represents a way of functioning in situations of indeterminacy and value conflict, but the multiplicity of conflicting views poses a predicament for the practitioner who must choose among multiple approaches to practice or devise his own way of combining them" (1983, p. 17).

Schön's description above is an appropriate synopsis of what I will be doing for the most part in this research project. By reviewing and reworking the contemporary ideas from literature and then synthesizing them in a modified framework of design thinking, I must choose among multiple approaches and devise my own way of combining them. Such an endeavour will shape my own unique, theoretical and practical views of design thinking in the realm of design education.

Notes on how reflective practice and action research transpire in the chapters of this thesis can be summarized as follows:

In "Chapter 2: Literature Review – *What is Design Thinking?*," key literature that directly address Design Thinking will be examined, summarized, and reflected upon. The works will be

reviewed chronologically, i.e. by their dates of publication. An attempt will be made to extract and summarize ideas that are related to this thesis. The disciplines in which these works are published will be acknowledged but subdued, in hopes of identifying themes or concerns that could be amalgamated in an interdisciplinary manner. Each piece will be summarized and reflected upon individually, culminating to an overall reflection at the end of the chapter. In essence, mini-cycles of "look, think, act" will take place as each piece of literature is reviewed and reflected upon, as the emerging themes are noted and synthesized against the backdrop of more recently published literature. The entire chapter in turn comprises a bigger cycle of "look, think, act," as all emerging themes are synthesized and significant ideas are filtered. These selected ideas will be acted upon in the next chapter.

In "Chapter 3: Developing a Voice – *Selected Ideas*," emerging ideas that have been identified in Chapter 2 will be further reflected upon. Additional literature that are related to these ideas but are not necessarily directly related to Design Thinking will be consulted (look), with the goal of targeting and articulating the key issues that will surface (think). Thus refined, the ideas will be selected, arranged, combined, and modified with my personal philosophies and views so as to develop a strong voice in preparation for implementation (act).

"Chapter 4: Learning from Colleagues – *How is Design Thinking Taught Currently?*" is a paper written previously and which is currently being prepressed for an upcoming issue of the Canadian Review of Art Education (CRAE). The paper surveys and compares five different post-secondary Design Thinking courses taught in the Greater Toronto Area. One of the courses surveyed is the one that is the subject of this thesis. For this reason, information about that course is more readily available as the author is (I am) the professor of that course. By comparison, information about the other four courses surveyed was obtained through informal interviews with the respective professors. During the informal meetings, participants were encouraged to talk freely in an informal manner and to communicate whatever information they wished to share. The

degree of flexibility enabled them to comfortably withhold information or materials that they deemed proprietary. For this reason, the survey serves as an overview of the subject rather than an in-depth scientific analysis. The most significant drawback in this framework is therefore the lack of a standardized format in terms of collecting and comparing data. This factor of variance ought to be considered when looking at the survey. Nonetheless, some basic facts were shared and gathered. For example, how these different professors define design thinking, what their course entails, and how it is taught, such as class structure and assignments. The information gathered is by no means complete, for reasons that have been discussed above. Despite the limitations presented by this framework, some general themes as well as a cumulative list of components in all these courses could still be found, observations could still be made, to help shed some light on this subject.

Professors of these courses include

1. Keith Rushton, Professor of "Design Process," Faculty of Design, Ontario College of Art and Design (http://www.ocad.ca/Page980.aspx);
2. Susan McCahan, Professor of "Engineering Strategies and Practice," Faculty of Applied Science and Engineering, University of Toronto (http://www.esp.engineering.utoronto.ca/Page4.aspx);
3. Heather Fraser, Professor of "Design Practicum: The New Product and Services Lab," currently offered under the course name "Design Practicum: Business Innovation Lab," Rotman School of Management, University of Toronto (http://www.rotman.utoronto.ca/mba/courses.htm);
4. Mary Ann Maruska, Professor of "Design Thinking: Creative and Critical Pathways," joint Bachelor of Design program between Sheridan College and York University (http://design.yorku.ca/bdes/course-info-second.php); and
5. Ann Donar (author of this thesis), Professor of "Design Thinking," currently

offered under the course name "Design Thinking I," joint CCIT (Communication, Culture, and Information Technology) program between Sheridan College and University of Toronto Mississauga (http://www.utm.utoronto.ca/index.php?id=2681).

Where joint programs are concerned, the courses are offered through the participating degree-granting universities, i.e. York University and University of Toronto Mississauga. Accordingly, policies and procedures of the respective universities are followed and enrollment and evaluations are administered through these institutions.

"Chapter 5: Implementing Ideas – *Practicum*" documents the implementation or testing of the selected ideas identified in Chapter 3 in the fall term of 2009. This portion of the project takes advantage of action research as a methodology. Action research is considered a departure from traditional research, and as such, bears some key advantages that stem from this distinction. While fundamental research (Linder & Gordon, 1974), formal research (Stringer, 2007) or traditional research (Mills, 2007) upholds positivism, regarding the world as a 'thing', and attempting to impose change from without, action research represents a new scholarship, an emergent interpretive tradition, that focuses on the 'person', attempting to "understand and improve the environment and human practices by changing them from within" (McNiff & Whitehead, 2006, p. 10). This new scholarship embodies newer holistic forms of enquiry, at the intellectual level, as well as social, cultural, political, and emotional levels (Stinger, p. 11). While traditional scholarships aim for certainty and closure, new scholarships aim for creativity and freedom. Likewise, while traditional scholarships consider uncertainty a sign of weakness, new scholarships consider it a sign of strength (McNiff & Whitehead, pp. 74-75). Action researchers also differ from traditional researchers because "they are committed to taking action and effecting positive educational change based on their findings, rather than being satisfied with reporting

their conclusions to others" (Mills, p. 3).

Since action research is implemented in professional and public life (Stringer, 2007, pp. 1-3) and is intended for "practitioners everywhere to investigate and evaluate their work" (McNiff & Whitehead, 2006, p. 7), an action researcher takes on the role as a practitioner-researcher (McNiff & Whitehead, p. 70), who is directly involved and invested in the situation at hand. Unlike traditional research, action research is "done by practitioners themselves rather than a professional researcher, who does research on practitioners" (McNiff & Whitehead, p. 8). Unlike traditional research, which is a kind of outsider or spectator research, action research is insider research, where the practitioner-researcher is closely associated with the needs at hand (Linder & Gordon, 1974, p. 9), focused on self-study, and is morally committed to making changes from within (McNiff & Whitehead, p. 10). In this respect, action research is powerful and transformative (McNiff & Whitehead, pp. 8-10), liberating and life enhancing (Stringer, 2007, p. 11).

Action research is not only a form of research methodology, it is also a form of professional learning. Through the action research interacting spirals of "look, think, act" (Stringer, 2007, pp. 8-9), or the action-reflection cycles of "observe, reflect, act, evaluate, modify" (McNiff & Whitehead, 2006, pp 8-9), action researchers become knowledge creators who develop learning and influence others' learning. Instead of being appliers of other people's theory, they are practitioner-theorists (McNiff & Whitehead, p. 69). Dick (1993) points out that "[w]hen practitioners use action research it has the potential to increase the amount they learn consciously from their experience… Schön (1983, 1987) argues strongly that systematic reflection is an effective way for practitioners to learn" (¶ 23). With the knowledge generated having direct relevance to the researcher's practice, "there need be no gap between theory, research and practice. The three can be integrated" (Dick, ¶ 28).

With action researchers being change agents, action research informs and improves social contexts, at the personal, organizational, and social levels. Action research aims at creating "good social orders by influencing the education of social formations" (McNiff & Whitehead, 2006, p. 32) and "is about developing social justice" (McNiff & Whitehead, p. 69). Action research is value-laden; action researchers focus on individual or collective values, and work collectively for sustainable personal and collective wellbeing (McNiff & Whitehead, pp. 10-11).

Action research offers a wealth of data-collection techniques, including archival sources, tools for capturing everyday life and tools for question, conventional sources such as surveys and questionnaires, inventive sources such as exhibits and portfolios, interviews, oral history and narrative stories, rating scales, inventories, observation, mapping, visual recordings, photography, and journals and diaries (Mills, 2007, p. 56). Among these tools, many have been used in the practicum, including surveys, discussion forums, assignments, tests, rating scales, but most importantly, observation and keeping of a journal.

In "Chapter 6: Learning from Students – *Analysis*," data collected from the pilot teaching project will be analyzed. This step further exemplifies the spiral "look, think, act" as information gathered is reviewed and reflected upon. An attempt in being objective will be made, such as in identifying trends and comparing marks, though some of the disadvantages of action research must also be recognized. For example, action researchers may experience a resistance to change and a reluctance to admit difficult truths (Mills, 2007, p. 152-153). It may be problematic to authenticate and validate evidence, for example, producing evidence of the researcher's influence on other people's learning (McNiff & Whitehead, 2006, p. 55), and to extract and differentiate evidence from data. Therefore, the nature of action research must be considered while viewing the analysis of data.

Finally, in "Chapter 7: Convergence – *Next Steps*," additional literature published since

the pilot teaching project will be reviewed and reflected upon, in a similar manner as that in Chapter 2. Perhaps it is important to note that since 2010, literature on the subject of design thinking has mushroomed, simultaneously published by authors from diverse disciplines, in a prolific fashion and pace that almost exceeded those of the relatively more dated literature combined. Additional new and not so new themes and trends will be added to the collective findings drawn from the previous chapters in this thesis. Thus, a final cycle of "look, think, act" will take place as all thoughts and realizations converge in an attempt to suggest the next steps in a field that I so love.

CHAPTER 2: LITERATURE REVIEW

WHAT IS DESIGN THINKING?

This chapter documents an examination and reflection of the key literature that directly address Design Thinking. The works examined are individually summarized first, each followed by my personal comments and observations, and then an attempt will be made after all the works have been reviewed to find any overall themes and/or issues that are of concern and relevance to my study. Due to the volume of the literature, only ideas related to this thesis are highlighted. The discipline, if there is one, in which these works are presented, will be temporarily subdued, put on the back burner, so to speak, as much as possible, while doing this review. The objective is to find an initial common ground whereby these themes and/or issues could be integrated and viewed in an interdisciplinary manner. The literature is examined chronologically by their publication dates, that is, from the oldest to the newest publications, to observe how some issues may have evolved over time and whether any significant trends and patterns may have emerged.

A similar procedure in surveying and reflecting on key literature that directly address Design Thinking will resume in Chapter 7, after the report on the teaching project conducted in the fall of 2009. The additional literature surveyed at that point represents significant literature that is published after the teaching project in 2009, i.e. 2010 onwards, and will be integrated in my concluding reflection and recommendations.

Design Thinking in the 1980s

1980: Current Design Thinking: A Symposium Organized by the Midlands Branch of the Institution of Chemical Engineers at Aston University, September 12-14, 1979 (The Institution of Chemical Engineers, Midlands Branch)

Current Design Thinking: A Symposium Organized by the Midlands Branch of the Institution of Chemical Engineers at Aston University, September 12-14, 1979 is a compilation of papers selected from a larger number presented during the course of Design ’79 in Birmingham. The selection of papers is published in two volumes: *Current Design Thinking* and *Design for Safety*. The program for Design ’79, which is called the “Technical Program,” encompasses a range of topics of interest and concern to the chemical engineering field. Presentations could be loosely categorized under the themes of economic, energy, and environmental evaluation and prospects, current and emerging technologies and methods, design and project management, safety and hazard assessment and control.

Of particular interest to me are the following topics published in this compilation of selected presentations:

1. “Future Organic Chemical Feedstocks: An Energy Perspective” by Andrew Stratton, Corporate Research & Technology Dept., I.C.I. Ltd.

2. “Evaluation of Future Processes” by K.J. Fergusson, Chief Engineer, RTZ Services Ltd.

3. “Environmental Impact Analysis: Foundation of Social Costs” by H. Rothman, Chemical Engineering Department, The University of Aston in Birmingham

4. “Design Strategies and Tactics” by S.A. Gregory, Chemical Engineering

Department, The University of Aston in Birmingham

5. "Design for Maintainability" by G.E.P. Constable, Head of Industrial Division, Design Council, London, and D. Parkes, National Technology Centre, Leatherhead

Each of the above presentations will be summarized first and then observations and comments will be made from an overall perspective.

In "Future Organic Chemical Feedstocks: An Energy Perspective," Stratton (1980), brings attention to the energy crisis of which today's readers are well familiar: "the near six fold increase, in real terms, of the price of oil from 1970 to 1977 brought an awareness that…primary energy resources to meet the bulk of an unconstrained energy demand is over" (p. 1/2:1). In light of the energy crisis, energy forecasting is essential. The availability of sufficient substitute oil, economic assessments and conversion efficiencies, along with technological methods, are important factors in considering future energy options. A lower energy usage is essential by a combination of technological change and influencing human values, including individual and organizational values. In terms of forecasting, a complex set or infrastructure of factors and values need to be considered and balanced, technologically, economically, environmentally, commercially, and politically.

In "Evaluation of Future Processes," Fergusson (1980) proposes a new way of producing an existing product based on a set of advantages at the conceptual stage. These advantages include lower capital, energy, labour, and raw material costs, and the ability to meet higher environmental standards. To this end, Fergusson reiterates the importance of cost as the measurement of advantage. In fact, monetary cost is the "one common factor by which quantitative comparisons can be made" (p. 2/1:1). Thus argued, Fergusson cautions against making predictions based on theoretical or bench-scaled work in environmental standards. If the

cost structure and initial evaluation are satisfactory, more detailed investigations would be conducted in areas of uncertainty. The series of progressively detailed evaluations would thus bring about possible improvements based on the originally stated principles of evaluation, that is, of cost.

In "Environmental Impact Analysis: Foundation of Social Costs," Rothman (1980) takes on a different position than Fergusson's, in that while Fergusson places significant weight on money as the measurement of advantage in a design activity, even if it means jeopardizing environmental standards, Rothman voices the urgency of implementing policies in preventing environmental damage. Such policies adopted by national environment ministries normally arise from environmental impact assessment that document possible changes to the environment. Environmental impact analysis thus forms the basis for environmental impact assessment, which, in the form of environmental impact statements (EIS), are required in some countries by law as part of the planning process. Environmental impact statements are an American innovation and are stipulated by the National Environmental Policy Act (NEPA) of 1970, requiring "Federal agencies to make 'a full and adequate analysis of all environmental effects of implementing its programs or actions.'" (p. 2/3:2). Rothman concludes by recommending that more research be done especially where potential conflicts of interest and subjective judgments may arise in the course of EIS preparation.

In "Design Strategies and Tactics," Gregory (1980) attempts to propose an organized and rational approach in the understanding and procedure of design, in particular, the design of processes and plants. The two areas targeted are strategies and associated procedures. Gregory defines "strategy" as "the general approach to the attainment of an objective or set of objectives" (p. 6/3:3). The systems approach is an example of strategy that scans and evaluates items against the objectives as it works its way down the task hierarchy. Two significant recommendations that Gregory makes in future strategy are (a) to routinely develop safety and environmental amenity,

and (b) to transition from "'optimisation' and incremental innovation to more novel and radical designs" (p. 6/3:11).

In "Design for Maintainability," Constable and Parkes (1980) examine the issue of maintainability, "measured in terms of time taken to diagnose and repair" (p. 7/3:1). Even though maintainability has nothing necessarily to do with how old the product is or when it is designed, since there are both old and new designs that could be either easy or difficult to maintain, Constable and Parkes point out that there are indeed some products that are designed from the outset for good maintainability. The presence of maintainability features is not coincidental; the designers' brief should include explicit maintainability requirements. The assumption is that there must be a demand from the product user or purchaser even if there is an increase in purchase price. The designer also has a moral or professional obligation to fulfill maintainability requirements along with market pressures, if not statutes for such enforcement. Thus, Constable and Parkes propose that design for maintainability be "part of a core curriculum in every type of design course" (p. 7/3:7).

Reflection

Looking at the five presentations above, "design thinking" comprises addressing current design issues and thinking of ways to resolve them. These issues may be directly related to general current issues, politically and environmentally, such as the energy crisis or environmental damage, and may include the authors' own recommendations for the future. A few personal and/or overall observations are made:

1. In anticipating and solving future problems, such as the energy crisis, it would be helpful to think ahead and come up with systematic forecasting and analysis methods, in order to better consider and assess available options.
2. Surely, problem-solving options need to be examined technologically, but one

must not underestimate other dynamic factors, such as time scales, and the interplay between individual and organizational values.

3. Actions need to be taken to bring about awareness, change and implementation, such as in energy, maintainability, and environmental issues. The following are some possible avenues: (a) policies, (b) statutes, (c) moral and professional obligations or responsibilities, (d) designers' briefs, and (e) demand from users and market pressures.
4. Since 1970, federal agencies are required to make a full and adequate analysis of all environmental effects before implementing its programs or actions, in the form of Environmental Impact Statements (EIS). However, it is not mentioned that such requirements are made on corporations, leaving a tremendous loophole allowing corporations to potentially cause environmental damage locally, nationally, or globally, in the name of trade secrets and profit.
5. There is a level of complexity in design activities. To better achieve objectives, explicit managerial procedure in the form of strategies and tactics need to be in place and shared, including "inside-out" and "outside-in" strategies.
6. Focus should not be placed predominantly on the design activity but also on overall approaches prior to embarking on the design activity, i.e. in the beginning of the design process or at the conceptual stage.
7. A shift from incremental innovation to more novel and radical designs is recommended, i.e. solutions that are outside the existing framework.
8. Express and routine attention is to be paid to maintainability, safety, and environmental amenity and assessment.
9. In balancing and resolving opposing positions, such as in environmental standards, not only qualitative but also quantitative terms and precise expressions are to be used, such as in terms of damage, cost, and estimating benefits.

10. Best aspects of current industrial custom and practice could be reduced and be part of a core design curriculum.

1980: How Designers Think (Lawson, B.)

How Designers Think by Bryan Lawson, an architect, introduces the book as "[not] a book about architecture, or indeed about any of the products of design. It is a book about design problems, and how to understand them, and about design processes and how to learn, develop and practise them" (Lawson, 1980, p. 2). In other words, shifting from the traditional emphasis of design on the end product rather than the process, Lawson hopes that the book would help the designer acquire his/her own flexible and productive design process.

There are several premises on which this book is written. Firstly, Lawson believes that not only do designers need to be competent in the technology and materials of their practice, they also need to be knowledgeable about aesthetic appreciation. Lawson (1980) states: "In environmental, product, or graphic design space, form, and line as well as colour and texture are the very tools of the trade…The designer must understand our aesthetic experience, particularly of the visual world, and in this sense his work may seem not unlike that of an artist" (p. 5). Secondly, designers need to have an understanding of the nature of their users, e.g. "ergonomics of chairs or the semiotics of graphics" (p. 5). Thirdly, design is a skill that can be acquired through practice; it is a "highly complex and sophisticated skill. It is not a mystical ability given only to those with recondite powers but a skill which, for many, must be learnt and practiced rather like the playing of a sport or a musical instrument" (p. 6).

Various design processes or maps are referenced, including The RIBA (Royal Institute of British Architects) processes and the Markus/Maver morphology. Though an awareness of design processes is helpful, Lawson (1980) argues that such theoretical, prescriptive, logical, and

systematic processes and "maps are probably much more use to the methodologist than to the designer" (p. 28) since "neither the RIBA Handbook nor Markus produce any evidence to show that designers actually behave as if they were reading such maps" (p. 29). More importantly, "it is what goes on in the designer's mind which really matters" (p. 24). Such subtleties in how designers actually think and work, which do not necessarily follow a logical sequence, is further demonstrated in the findings of a series of experiments that Lawson began to conduct in 1972. Between scientists and architects who participated in these experiments, it is found that while "the scientists focused their attention on discovering the rule, the architects were obsessed with achieving the desired result. The scientists adopted a generally problem-focused strategy and the architects a solution-focused strategy" (p. 32).

In the context of dynamic client-designer relationships, designers and clients contribute equally to the definition of design problems, often somewhat loosely defined and originated by the client, with the expectation that the designer would take on an artistic as well as interpretive role, such as in form, space, and style (Lawson, 1980, pp. 64-65). Constraints, both internal and external, establish the parameters within which the designer works, ranging from more rigid, mandatory constraints, such as legislations, to those set by users and clients, and finally more flexible and optional ones, such as the designer's own individualistic style (p. 68). Working within this model of design problems, designers often bring integrated solutions to realistic, multidimensional problems with multiple requirements (p. 43). In rare cases, such as in Peter Cook's *Plug-in-City* of 1964, does one see the designer's own vision only, a vision that is supposedly imaginary and never intended to be built, and which is done in a manner that is "more akin to the artistic than the design process": "[*Plug-in-City*] explored and expressed ideas, beliefs and values, and asked provocative questions about the future direction of city design and patterns of life" (p. 65).

Remarking that "what goes on inside the designer's head is by far the most difficult and yet the most interesting and vital" (Lawson, 1980, p. 94), the second half of Lawson's book is devoted to "Design Thinking": firstly, to the types and styles of thinking, followed by the categories of creative thinking, design philosophies, design strategies, design tactics and traps, designing with others, and lastly, designing with computers.

Firstly, in terms of theories of thinking, Lawson (1980) gives us some background in the realm of psychology, in the hopes of finding some relevancy to design thinking (pp. 95-99). Schools of psychology discussed include the behaviourists, associationists, Gestalt school, and information theorists. When addressing the types and styles of thinking, Lawson first brings attention to the major division used in psychology, that is, between "reasoning" and "imagining." While reasoning has to do with "logic, problem-solving and concept formation" and is "purposive and directed towards a particular conclusion" (p. 99), imagining "[combines] material in a relatively unstructured and perhaps aimless way" (p. 100), such as in artistic and creative thoughts as well as daydreaming. Even though reasoning and imagining may be considered separate categories in psychology, Lawson remarks that in many design situations, both types of thinking are combined and required, e.g. creativity in the logical field of engineering and logical structure in art.

Another type of thinking that Lawson finds relevant to design is what Guilford (1956) calls cognition factors. Of major importance here is the analytic ability of classification, such as in objects or ideas. As Lawson (1980) points out: "problems of figural and structural types abound in design and the ability to discriminate figural and structural classes is likely to be important to the designer" (p. 101). Further, productive thinking, a notion introduced by Wertheimer (1959), is also relevant. Lawson tells us that productive thinking is originally concerned with the directional quality of thought, with the assumption that the thinker has the ability to control the direction of his/her thinking, and that if an appropriate direction is followed,

that thinking is deemed productive. As Lawson observes, bipolarity, what Bartlett (1958) calls "thinking in closed systems" and "adventurous thinking," may be parallel to convergent and divergent thinking – convergent thinking is deductive and leads to one correct answer, while divergent thinking is more open-ended, leading to many possible answers. Lawson concludes that for the most part, design is a divergent task since there is rarely only one correct answer in design activities. However, Lawson reminds us that an appropriate balance between convergent and divergent abilities is required in design. Lawson compares this to Laxton's (1969) analogy of a hydro-electric plant, where one draws upon a reservoir of experience or ideas (reservoir), upon which one generates critical evaluations (generator), and finally from which one interprets and transforms ideas into appropriate forms and contexts (transformer).

Another type of thinking that is particularly relevant to design is creative thinking. To start with, Lawson states that creativity can be demonstrated not only through products, but also through processes and persons. The five, normally sequential stages of the creative process may be identified as (a) first insight, (b) preparation, (c) incubation, (d) illumination, and (e) verification. To counter the tendency to apply old solutions to new problems, two creativity techniques are recommended: brainstorming (Osborn 1957), intended to generate as many, albeit wild and superficial ideas as possible, and synectics (Gordon 1961), with its four types of analogy: (a) personal, (b) direct, (c) symbolic, and (d) fantasy. It is to fantasy analogy that Lawson brings special attention, as Lawson deems it central to many creativity techniques, since, with its temporary detachment from any reason or critical judgment, one is more able to make creative, albeit impractical breakthroughs.

Closely related to the study of design methods and techniques are design philosophies, which Lawson (1980) observes are significantly intertwined with the designer's "role in society and the function and reason for his work" (p. 119). Drawing from the articles published in the RIBA Journal, Lawson outlines the variety of design philosophies found in the architectural field

at the time. First and foremost in design philosophies is the importance of user needs. Secondly, the designer's view and philosophy about the future greatly influence his/her design process. In this regard, Lawson uses technology as an example as pro-technologists and anti-technologists hold different views as to how technology should influence the future and how progress is defined. Finally, one's design philosophy is also influenced by one's aesthetic style and needs, with one's designs ultimately demonstrating a set of principles and beliefs that are important to the designer. Recognizing the shifts in paradigms and philosophical attitudes not only in the design world but also in the whole of our culture, from a logical, rational theory of design to alternative, new attitudes, Lawson reminds us that ultimately, it is the designer's own philosophy that makes a difference.

The next two chapters in Lawson's book are dedicated to design strategies and tactics; in short, some of the specific ways or techniques in which designers approach complex design problems. Lawson tells us that observation studies show that most designers employ strategies that are heuristic and scanning in nature. In all instances, constraints are used to focus the attention, be it costs, sites, available technologies, methods, and materials. In some cases, constraints may lead to aesthetic revolutions or manifestations, e.g. the colour-coded pipes at the Pompidou Centre, the formal mathematical proportions of the Golden Section in Le Corbusier's Modulor, and the symbolic connotations of the Sydney Opera House. Summarizing the design strategies found in both empirical and anecdotal examples, Lawson points out that in the design process of analysis through synthesis, the designer may encounter both "evolutionary [(gradual modifications of the embryonic design)] and revolutionary [(new trains of thought)] modifications of early solutions" (1980, p. 147). Aside from design strategies, Lawson recommends that the designer adopt mental tactics to better organize and control the mind. An example is to avoid mental traps such as the category trap, puzzle trap, number trap, icon trap, and image trap.

It is worthy to note that Lawson's book has been updated a few times and reprinted even more times, with the most recent edition, the fourth edition, released in 2005. While the majority of the content and key principles remain, dated information such as the chapter, "Designing with Computers," has been deleted due to obvious irrelevance in terms of how information technology has evolved over the last few decades.

Reflection

There is a wealth of information in Lawson's book that could be translated into pedagogical approaches and strategies in design thinking. To begin with, Lawson's conviction that it is the mind of the designer that matters, is a signal that it is the potential of the student's mind that needs to be maximized and developed, as opposed to, for example, adhering to a rigid process in design. The theories and types of thinking, that, according to Lawson, are to a greater or lesser degree related to design thinking, may in fact suggest ways through which the student's mind could be developed. Compounded with Lawson's notion that design is a set of skills that needs to be learned and practiced, very much like learning to play a sport, one might make the assumption that there are capacities within the student's mind that, if developed and exercised diligently, could enable the student to become a better designer. These capacities potentially include

1. Physical skills, such as drawing, suggested by the behaviourist model of learning with stimuli and responses;
2. Problem-solving skills, suggested by the behaviourist model of learning through trial and error;
3. Imaginative skills, suggested by the associationist model of making choices with the strongest associationist links out of life experiences;
4. Organizational skills, suggested by the Gestalt model of perception and

organization to the end of finding a meaningful whole;

5. Both reasoning and imagining, convergent and divergent thinking skills;
6. Cognitive skills, in particular figural, structural, and conceptual classification;
7. Productive thinking skills, in controlling both directed and undirected thoughts;
8. Interpretive skills, e.g. using Laxton's model of building a reservoir, generator, and transformer of ideas;
9. Aesthetic and artistic skills (e.g. arrangements and ordering of things, shapes/colours), appreciation and development of aesthetic styles, aesthetic revolution, individual self-expression as well as expression for collective symbolic purposes;
10. Creative thinking skills, in unleashing uninhibited, albeit impractical ideas, making divergent leaps and creative breakthroughs;
11. Innovation (revolutionary vs. evolutionary);
12. Personal design philosophies, e.g. towards user understanding, visions about the future, views about technology and progress, principles, beliefs, and values;
13. Individuality beyond functional performance;
14. Design strategies, e.g. problem-focused vs. solution-focused, brainstorming, synectics (personal, direct, symbolic, fantasy analogies), heuristic, scanning strategies, constraints as strategies (internal, external, radical/fundamental, symbolic, formal, physical or practical constraints), mental tactics, and traps to avoid (category, puzzle, number, icon, image traps);
15. Awareness of the complexity of design activities, designers' briefs, which are multidimensional with multiple requirements;
16. Awareness of established design and creative processes, analysis through synthesis, while acquiring one's own flexible process; a shifting of angles and perspectives, which Lawson states is the centre of design thinking.

1987: Design Thinking (Rowe, P. G.)

Design Thinking by Peter G. Rowe, is the result of a series of seminars on methods of inquiry in the Ph.D. Program in Architecture at the University of Pennsylvania. The book is divided into four chapters: (a) Designers in Action, (b) Procedural Aspects of Design Thinking, (c) Normative Positions That Guide Design Thinking, and (d) Architectural Positions and Their Realms of Inquiry. Unlike Lawson, also an architect, who declares that his book *How Designers Think* (1980) is not necessarily about architecture, Rowe (1987) tells us that the context of his book, *Design Thinking*, is in fact about the world of architecture.

Making it clear that the book excludes aspects of administration or client-architect relationships, influences of specific audiences, or definitions of "good" design, Rowe (1987) tells us that "[his] subject is more narrowly defined. [He is] concerned with the interior situational logic and the decision-making processes of designers in action, as well as with theoretical dimensions that both account for and inform this kind of undertaking" (p. 2). In this respect, Rowe's statement calls to mind Lawson's reiteration that what matters is what goes on in the mind of the designer and what theories or types of thinking that are most related to design thinking.

Like Lawson, Rowe (1987) also observes that there is no one prescribed design process, but rather, an episodic process during which there are periods of speculation and contemplation; and in whatever decision-making process that the designer chooses, there are constraints, be it internal or external, that shape and direct the process. Perhaps more importantly, Rowe notes that there is a shifting of angles and perspectives in the designer's mind, "the 'to and fro' movement between areas of concern" (p. 34), which coincidentally is what Lawson states as the centre of design thinking. In other words, the design process is by no means rigid, but rather, flexible. Using three separate case studies as well as other examples, Rowe attempts to suggest the range

of styles of thinking or determinants that dominate the thinking processes, from the use of analogies and "orderly confrontation with the constraints" to "presuppositions and hunches about architecture" (p. 3).

It is this last point about "presuppositions and hunches" that is emphasized in Rowe's discussion more than once. When remarking on the case studies used, Rowe (1987) tells us that "designers will cling to major design ideas and themes in the face of what at times might seem insurmountable odds" (p. 32). This aspect appears to be a significant factor in the designer's decision-making process, as tenacity upholds a guiding vision despite difficult obstacles and challenges, transforming what Rowe calls "operational constraints" (p. 32). Again, like Lawson, Rowe brings up Utzon's Sydney Opera House and the Plateau Beaubourg or Centre Pompidou project in Paris, as examples of unusual and visionary appearance.

It is perhaps important to reiterate and clarify at this point that, even though like Lawson, Rowe believes that there are "to and fro" movements between areas of concern in the "flexible" design process, in the end, it is the designer's initial vision, or "hunches," that are of paramount influence in the decision-making process. To be specific, Rowe (1987) tells us that "[t]hese concepts or hunches [are] to provide insight and direction for further information processing" (p. 37) and that "[e]ven when severe problems are encountered, a considerable effort is made to make the initial idea work, rather than to stand back and adopt a fresh point of departure" (p. 36). In other words, the shifting of angles is subservient to the designer's individual idea or vision.

Rowe (1987) proceeds to describe some general characteristics of the procedural aspects of design thinking. The first category is that of design problems, of which there are three: (a) well-defined problems, (b) ill-defined problems, and (c) wicked problems. The second category of procedural aspects consists of "early theoretical positions," which, similar to Lawson's discussion of theories of thinking, are from schools of psychology, such as associationism,

behaviourism, information processing theory, the Würzburg school, and the Gestalt school. Of particular significance to the Gestalt school are the idea of *Schemata* or organizational frameworks and the concept of bisociation. Bisociation, the idea of two mutually incompatible contexts could perhaps explain creativity since "creating involves relating two normally independent frames of reference" (p. 46). The third category of procedural aspects of design thinking is what Rowe (1987) calls staged-process models of problem solving in design. These models stem from the phase or rigid-state models whereby logical structures of creative problem-solving activities, such as analysis, synthesis, and evaluation, are consciously marked out. The major models discussed are the Asimow's model, models of the Hochschule für Gestaltung at Ulm, Archer's, and Thornley's.

The next portions of discussion are similar to what Lawson calls design strategies, but which Rowe (1987) calls heuristics, rules and principles that facilitate planning and problem solving. *Heuristic reasoning* "refers to a problem-solving process in which it is unknown beforehand whether a particular sequence of steps will yield a solution or not" (p. 75). Thus, there is an open-ended aspect in heuristic reasoning. Within the operations of heuristics, Rowe brings attention to a few aspects of design behaviour that may add to the complexity of design thinking. Among them are two concepts that are relatively new in the literature review thus far: (a) modes of representation and (b) the concept of style. Firstly, in terms of modes of representation, Rowe (1987) tells us that there is a reciprocal movement between the act of drawing and the thinking that goes with it. This movement is significant because the act of drawing or symbolic modeling might enable the designer to discover things through which their expression may be a form of positive constraint. Some referential sketches have an idiosyncratic and notational quality, and representational techniques such as perspective drawings "have altered what we can represent, see, and therefore understand and imagine" (p. 99). Examples of such drawings include the eight

projections of a simple cubic object: (a) plan, (b) section, (c) elevation, (d) isometric, (e) diametric, (f) oblique, (g) plan oblique, and (h) perspective.

Secondly, the concept of style is a consistency in a designer's manner in how he/she handles the problem-solving process, which Rowe (1987) tells us normally surfaces towards the end of stylistic episodes in a designer's career. In other words, the consistency of a style would reach a level of fluency when a distinctive repertoire of techniques has been developed and consistently expressed. Rowe further points out that there may be a collective style adopted in the broader community, and "when dominant principles and forms no longer prove productive, they are replaced, and shifts in style…can be observed" (p. 110).

The next chapter in Rowe's (1987) book outlines the normative positions that guide design thinking, or "the perspectives that guide the choice of organizing principles and constraints" (p. 115). Perhaps it is pertinent to start with the premise that, according to Rowe, theoretical positions in architecture have traditionally been concerned about values and priorities about architecture, asking such questions as "What constitutes proper architecture?" (p. 115). Rowe further clarifies that even though this answer (or definition of architecture) has limitations, it does state the importance of aesthetic appeal as opposed to, say, utilitarianism. Thus, an assumption implied here is that traditionally, aesthetic considerations constitute a key component of design thinking in architecture. For example, Le Corbusier (1926), while de-emphasizing "aesthetic fantasies" and "fashionable effects," is concerned about "architectural facts that imply an entirely new kind of building" (p. 117). This sense of "newness" represents "new opportunities for building and ones that are more intrinsically appropriate to the conditions of the time" (p. 117). This declaration is significant, as its consciousness of newness can perhaps be understood as an aspiration for innovation.

Other normative positions sometimes stem from maxims, such as "form follows function" or "less is more"; these statements are part of *doctrinaire positions*, positions that define and prescribe "proper" architecture. Contrary to doctrinaire positions, categorical systems are less singular in viewpoint but they still aim at defining proper architecture. Vitruvius and Alberti are examples of these positions. Rowe reminds us that all positions are "ideological or biased to some degree" (p. 121). The assumption in the distinction between "good" and "right" is that positions are right if they maximize their concept of good, or that they produce the most good. Following this train of thought, Rowe suggests the necessity to find ways to substantiate how categorical priorities are assigned. To that end, Rowe suggests five methods: (a) intuition, insight, and discretion, (b) single-principle doctrine, (c) ordering of principles through a categorical system, (d) prudential judgment based on specific settings or contextual viewpoints, and (e) lexical ordering based on superordinate and subordinate principles.

Two final points to consider while substantiating and prioritizing decisions are what Rowe (1987) calls (a) the *centrality* of a position and (b) the *comprehensiveness* of a position, both of which point to the likelihood that "the most compelling positions, at a given moment, are the ones that seem to address the most important issues of that moment" (p. 147). Some architects in the Modern Movement, such as Gropius and Taut, define a paramount principle of the modern movement as the prohibition against all direct stylistic references (p. 157). Thus, this type of aesthetic direction is not simply an experiment in formalism per se but is very much influenced by the beliefs and philosophies held by the architects at the time within a world of social, political, and technological developments. It reflects one's inner systems of belief. In other words, it represents a Humanist view. In the end, Rowe warns us of the risk of "a 'scientific view' of man and his world…When such a view is inappropriate or ignores many dimensions of the situation at hand, the consequences can be dire indeed" (p. 199).

Reflection

As already mentioned, Rowe, like Lawson, places much importance on the designer's mind as integral to the heart of design thinking. While Lawson believes that it is the shifting of angles and perspectives in the designer's mind that is of essence in design thinking, Rowe is emphatic that it is the designer's tenacity in his/her hunches and vision that is of paramount impact on the design process. Rowe tells us that there is much power in the designer's tenacious individuality since it could potentially bring about innovation, or in Lawson's terms, aesthetic revolution. Another noteworthy dimension in this regard is the designer's inner systems of belief or values that are of significance in imbuing meaning into the designer's work, without which, Rowe postulates that architecture might be rendered value-free, overly scientific and objective, void of vision and social purpose, thus leading to possibly dire consequences. Even though Rowe's discussion is meant to address strictly the profession of architecture, one might be inspired to fashion a parallel argument in other realms of design.

One may ask, however, in the context of design education, how such things as tenacity, individuality, hunches, prowess, vision, innovation, and systems of belief and values can be taught? This may be especially challenging when educators attempt to foster these capacities in students while making sure that they are at the same time exploring options, maximizing their creative and analytical potential, and not simply, in worst case scenarios, holding onto some pre-conceived, mediocre idea out of stubbornness or laziness. Perhaps a well-rounded, balanced pedagogical approach would help achieve these goals. To that end, Rowe has given us a wealth of ideas:

1. As in Lawson's case, diverse skills could be encouraged through exercises developed based on the theories of thinking in psychology:
    a. Building of mental images, forming of thoughts, impressions, and mental

acts such as intending and focusing, as suggested by the associationist model;

b. Extended introspective methods as suggested by the Würzburg School;
c. Visual perception, holistic principles of organization, bisociation and forming of schemata, as suggested by the Gestalt School;
d. Phase or rigid-state models of creative problem-solving, as suggested by the behaviourist model, including professional staged-process models subsequently developed for product development (e.g. Asimow's model, models of Ulm and Archer), as well as other methods from the behaviourist model, such as puzzle-forms and synectics /analogies;
e. Thinking in terms of problem space, knowledge states, generative processes, and test procedures, as suggested by the information processing theorists;

2. Heuristics: open-ended, problem-structuring devices, use of organizing principles and logical structures, five analogies (anthropometric, literal, environmental, typological, and formal);
3. Aesthetics:
    a. Practicing diverse modes of representation, acts and types of drawing and modeling, understanding the symbolic value of what is important;
    b. Developing a concept of style, through subject matter, manner, and sequence of problem-solving, developing fluency and consistency in individual or collective expression, developing a sensitivity in the need in shifts in style
    c. Innovation or a new aesthetic, quoting Le Corbusier, not simply "aesthetic fantasies" or "fashionable effects," but recognizing new

opportunities that are intrinsically appropriate to the conditions of the time;

   d. Work on the language (how and what, formal and figural), bricolage (combining past components), type (idea of an element);
   e. Ensuring accessibility vs. privacy, and meaning vs. significance

4. Last but not least, fostering a sense of vision, sense of values, and social purpose, through
   a. Developing a sense of centrality and comprehensiveness of a problem (the most compelling positions address the most important issues of the time);
   b. Interpreting "man and his world" through behavioural science and the concept of models (descriptive, predictive, explorative, planning);
   c. Awareness of personal visions and what Rowe calls positive, enabling prejudices;
   d. Practicing strategies for prioritizing (intuition, single-principle doctrine, ordering of principles through a categorical system, prudential judgment based on specific settings or contextual viewpoints, and lexical ordering based on superordinate and subordinate principles);
   e. Developing doctrinaire positions, maxims;
   f. Developing orientation, critical stance and larger social purpose (e.g. functionalist, populist/contemporary, conventionist/historical, formalist);
   g. And finally, practicing substantiation and legitimation, validity, appropriateness, and merit.

Design Thinking in the 1990s

1992: Research in Design Thinking: Proceedings of a Workshop Meeting Held at the Faculty of Industrial Design Engineering, Delft University of Technology, The Netherlands, May 29-31, 1991 (Cross, N., Dorst, K., & Roozenburg, N.)

Research in Design Thinking: Proceedings of a Workshop Meeting Held at the Faculty of Industrial Design Engineering, Delft University of Technology, The Netherlands, May 29-31, 1991, as editors Cross, Dorst, and Roozenburg tell us in the Preface, aims at reviewing "the current state of knowledge in this research field and to identify ways and means of using this new knowledge in design education" (p. 1). "This research field" naturally refers to design thinking, which, according to the editors, is defined as "the cognitive processes that are manifested in design action" and which "has become recognised as a key area of research for understanding the development of design capability in individuals and for the improvement of design practice and design education" (p. 1).

The Faculty of Industrial Design at Delft University of Technology, having conducted non-experimental studies in design theory and methodology for twenty years, has established some prescriptive models of the product design and development process, on which its curriculum are built. Yet, Cross, Dorst, and Roozenburg (1992) tell us that "[t]here is a strong feeling that curriculum development within the context of design exercises should be based on a broader understanding of the nature of design ability" (p. 1). Participants and presenters in this workshop include not only engineers, but also scholars from other disciplines, such as architecture, psychology, and information science. Out of the 14 papers published, 4 are selected for a summarized look:

1. "Research in Design Thinking" by Nigel Cross, Faculty of Industrial Design Engineering, Delft University of Technology, the Netherlands, and Faculty of Technology, the Open University, Great Britain
2. "A Structure and Function Based Theory for Design Reasoning" by Ömer Akin, Department of Architecture, Carnegie Mellon University, U.S.A.
3. "Some Observations on Design Thinking" by Ken Wallace, Engineering Design Centre, Department of Engineering, University of Cambridge, U.K., and
4. "On the Logic of Innovative Design" by Norbert Roozenburg, Faculty of Industrial Design Engineering, Delft University of Technology, the Netherlands

In "Research in Design Thinking," Cross (1992) attempts to provide a background of the research done in design thinking for at least thirty years (prior to the Delft workshop), the pioneering paper, according to Cross, being Marple's (1960) "The Decisions of Engineering Design." Cross first defines design thinking simply as "how it is that people do design" (p. 3). Summarizing this past research, Cross observes three consistent patterns in the research results: (a) problem formulation, (b) solution generation, and (c) cognitive strategies. Even though simplified paradigms of design thinking have been attempted in the past, such as viewing it as problem-solving, information-processing, decision-making, or pattern-recognition, they fail to address the complexity in design thinking. Cross observes that an adequate, simplifying paradigm could help "the transfer of knowledge from research into practice and education." Thus, Cross concludes the paper by asking these questions: (a) what are the implications for design education of what we know about design thinking? (b) What further research is needed? (c) Do we just perpetuate how designers think now, or attempt to change it? Surely, these questions leave us with some fruit for thought.

In "A Structure and Function Based Theory for Design Reasoning," Akin (1992) recognizes design thinking as an emerging discipline, and yet the lack of theoretical approaches

dedicated to it in research necessitates a theory in design reasoning. As an introduction, Akin summarizes the studies in design thinking conducted to date as follows: (a) descriptive studies within the realm of information processing theory, and (b) prescriptive studies such as design methods and models.

Not unlike Cross, Akin (1992) observes some areas where research in design thinking could use more clarity, translating into these questions: (a) About what subject are the findings, e.g. building, design, designers, construction, or all of them? (b) Are there shared tools, methods, and theories between these fields? (c) Is there a common purpose between these studies; if so, what is it, e.g. are they to be used for purposes of education or practice, or to propose alternatives? Thus, in this paper, Akin aims at coming up with a theoretical framework that is more comprehensive and inclusive, "to find some common ground which can be applied towards generalizable underpinnings of the area of design thinking" (p. 39).

In *Design Thinking*, Rowe (1987) uses the term "hunch" in several instances as a key component of design thinking, although he does not exactly define it. On the contrary, Akin (1992) clearly differentiates the difference between "thinking," "intuition," and "reasoning":

> *Design thinking* connotes a comprehensive concept: the totality of the cognitive activities that occur during design. *Design reasoning*…distinguishes the conscious, predictable use of rules of inference for the purposes of manipulating design information…*Design intuition*…implies manipulations of a sub-conscious kind, where the rules of manipulation are not explicable. (p. 39)

The theoretical framework that Akin aims at coming up with in this paper lies only within the subset of design reasoning, as the title of his paper states. To that end, Akin attempts to use a protocol study to empirically illustrate the rules and theoretical constructs within design reasoning. Although no clear conclusion could be reached, it is found that representations such as

drawings and models have a role in design reasoning for purposes of communication between designers, contractors, and clients. As Akin concludes, "[a] new logic for design may have to be invented before the process of reasoning in design will become a viable research area" (p. 51).

In "Some Observations on Design Thinking," Wallace (1992) observes that since the structure and methods of systematic design have been "around for some time, there is a tendency to believe that they have been validated. A consequence is that their status changes subtly, from that of a descriptive guide to a prescriptive norm" (p. 75). This norm views the product creation process as a linear, chronological process (similar to Rowe's staged-process models). As an alternative, Wallace proposes that the design process be represented by the analogy of a fluid, free-flowing string of bubbles, moving from State 1 to State 2, with the designer's internal and external states floating around the design activity. The internal state comprises elements such as attitude, knowledge, information, methods, and skills, and the external state comprises elements such as knowledge, methods, information, skills, tools, materials, and energy. Also attached are "attitude and mood," which Wallace recognizes as significant in design thinking. In conclusion, Wallace emphasizes the importance of applying a systematic approach flexibly or softly.

"On the Logic of Innovative Design" by Norbert Roozenburg (1992) is an investigation into the background on the discourse about *abductive* reasoning, which Roozenburg views as the key mode of reasoning in design. Roozenburg acknowledges March (1976) as the original holder of this view but who refers to it as *productive* reasoning. Throughout this investigation, Roozenburg attempts to define what abductive reasoning is and compare it with *inductive* and *deductive* reasoning. Referencing Peirce (1891), Roozenburg explains the three kinds of reasoning: abduction, induction, and deduction, as three stages of inquiry: "Abduction invents or proposes an hypothesis…Deduction explicates hypotheses, deducing…the necessary consequences which may be tested. Induction [tests] hypotheses" (p. 130). Roozenburg suggests why abduction is the key mode of reasoning in design: (a) the significance of *ampliative*

inferences: “Because the conclusion amplifies rather than explicates” (p. 130); (b) the significance of *synthetic reasoning*: since abduction introduces new ideas, then “it is the only truly synthetic operation” (p. 131); (c) the significance of *innovative abduction*: “Starting from a surprising, not yet explainable, fact (the result), we try to conceive of a new rule (a principle, law, or theory) that allows us to infer the cause (the case) [(Habermas, 1968)]” (pp. 131-132). Lastly, Roozenburg stresses the importance of the phase of *conceptual* design in the design process, where synthesis leads to tentative solutions for design problems. Equally important is the concept of innovative design, which employs abductive reasoning and a close interplay with the form from scratch, as opposed to designing by precedents, which employs what Zen and Chen (1991) call *recursive reasoning*.

Reflection

The readings summarized above have allowed me to gain much knowledge and insight into how past scholars have attempted to research and define what design thinking is and what this emerging field of research entails. In particular, the cumulative discussions have clarified that, according to the authors, design thinking is a comprehensive concept that includes the totality of cognitive activities in design, encompassing two main categories of human thought processes: design intuition and design reasoning:

1. Design intuition – the ability to immediately know, instinctively feel, without having to reason or explain, and possibly involving the workings of the subconscious mind.
2. Design reasoning – including innovative abduction (as opposed to explanatory abduction, or inductive and deductive reasoning), ampliative inferences, as well as productive, synthetic, and recursive reasoning.

Generally, I agree with the definition above and am especially inspired by the concept of innovative abduction. As Habermas explains, innovative abduction is about discovery, the process of which starts with a not yet explainable fact (the result), which encourages the thinker or designer to conceive a new rule, principle, law, or theory, and which in turn helps infer the cause (the case). The condition is that the rule is not assumed to be true, but that hypotheses are to be formed. In the design context, I find this exciting not only because, as Peirce states, it [innovative abduction] is the only logical operation which introduces new ideas, but also because it is a theory that could be applied to the scenario of designing for the future. In other words, the scenario or design activity might run as follows: (a) the designer has a vision, for example, about a future that is more equitable for all citizens of this world (the result), (b) the designer is encouraged to conceive a new rule, principle, law, or theory, for example, the principle of altruism, which (c) in turn helps infer the cause, for example, a design that makes zero monetary profit but would benefit mankind (the case). The concept of forming a myriad of hypotheses in this instance prompts numerous design opportunities.

However, although I agree that innovative abduction is an important aspect of design reasoning, I do not agree that it is the only key mode of design reasoning. Deductive reasoning, the ability to logically analyze available facts, is a much required skill in the design process in particular the research phase, the absence of which might render an otherwise innovative design ineffective or wasted. Further, I find that the scholars may have put too much attention on the role of reasoning in design, when intuition may in fact be an important ingredient in design thinking. For example, Cross mentions that research results show that experienced designers rely strongly on intuition and creativity, and Wallace mentions that attitude and mood are two important aspects in the designer's internal state. These are indications that a successful curriculum in design thinking ought not to neglect these components but rather, cultivate them.

There is another aspect of design thinking that I find may have implications on design education, and that is the importance of innovation at the conceptual design phase. In their discussion on recursive reasoning, Zen and Chen emphasize the difference between innovative design as opposed to designing by precedents. They claim that in order for innovative design to take place, the conception between the purpose and the form of the designed object ought to start from scratch; that is, the synthesis between the two needs to take place from the initial phase of the design process. With Akin reminding us of the communicative value of representations for the designed object, and Wallace's recommendation of a soft, flexible design process, one of the ways synthesis could occur is perhaps through the conduit of sketching, through which the oscillating movements between the designer's mind and the drawings, the visualization and rendering of the intuitive mind could be brought to the surface.

Finally, the questions asked by Cross and Akin remain to be answered:

1. What are the implications for design education of what we know about design thinking?
2. What further research is needed?
3. Do we just perpetuate how designers think now, or attempt to change it?
4. About what subject is design thinking?
5. Are there any shared tools, methods, and theories between these fields?
6. Is there a common purpose between these studies, and if so, what is it?

1996: New Thinking in Design: Conversations on Theory and Practice (Mitchell, T.)

New Thinking in Design: Conversations on Theory and Practice, by C. Thomas Mitchell (1996), is a compilation of synopses of the author's interviews with "thirteen leading people from a range of design or design-related fields, each of whom has developed ways of making designing

more encompassing and more responsive to those who interact with it" (p. xi). These thirteen leading people include design professionals from a range of disciplines, such as industrial design, architecture, engineering, and strategic design planning. In most cases, these individuals are not only academics, but also involved practitioners and/or consultants in their respective fields.

In *Design Thinking*, Rowe (1987) tells us that theoretical positions in architecture have traditionally been concerned about values and priorities about architecture, asking such questions as "What constitutes proper architecture?" Similarly, Mitchell (1996) tells us that one of the most discussed and contentious issues among designers is the definition of good design. Although there is a divergence of opinions on this topic, the assumption made in *New Thinking in Design: Conversations on Theory and Practice* is that, those "included [in the interviews] had rejected some 'bad' aspects of mainstream design practice and that they had each developed more responsive ('good') alternatives" (p. xi). Mitchell organizes these "good alternatives" as the chapter headings in his book, namely: (a) infusing meaning, (b) increasing scope, (c) involving users, (d) enhancing perception, (e) considering context, (f) thinking strategically, and (g) re-viewing design. In turn, a few shared themes can be found.

Firstly, the importance of how users interact with designed objects is manifested from several angles. For example, Donald Norman looks at design primarily in terms of how easily understandable the designed object is supposed to be used, that is, the cognitive aspects of design. Norman refers to his approach as cognitive engineering, "the applied side of cognitive science" (Mitchell, 1996, p. 92). Norman's major design principles include (a) *Visibility*: cues to indicate intended functions; (b) *Affordance*: cues to indicate intended interactions; (c) *Mapping*: cues to indicate causal relationships; and (d) *Feedback*: cues to indicate intended performance.

While Donald Norman is concerned with the functionality of designed objects, Michael McCoy is concerned with what he calls *product semantics* or *interpretive design*, both of which

focus on how meaning is interpreted or embodied in form. In some cases of interpretive design, obvious, direct similes and analogies such as wave forms are used. Yet, interpretive design primarily entails the role of the object (ritual or routine) in the user's life. McCoy describes the evolution of his work from the manifestation of early, semiotic, structuralist, analogous work, to more symbolic work that is more open to personal interpretation on the part of the user. McCoy uses what he calls a poststructuralist term *conceal and reveal*, whereby meaning is discovered by the user over time.

From a similar angle, user experience and perception are two other important aspects. At a basic level, Mitchell (1996) makes the assumption that aesthetically pleasing arrangements have a positive effect on those who interact with them (p. 61). For example, Daniel Weil, Professor and Course Director of Industrial Design at London's Royal College of Art and Partner in the London office of Pentagram Design Ltd. explores "the relationship of art and industry as mediated through design" (p. 14). Weil's designs resemble more Cubist-influenced sculpture than conventional daily objects. Some functional are named like artwork, such as a vase named *Walter* and a fruit bowl named *Claire*.

Castelli Design Milano, founded by Clino Trini Castelli, focuses also on user experience and perception. Castelli stresses the term *qualistic*, which he states is now in the mainstream Italian vocabulary, distinguishing it from the quantitative connotation of quality: "[qualistic] is concerned with the perception of quality connected with the subjective evaluation" (Mitchell, 1996, p. 65). Castelli distinguishes "qualistic" from objective human factors, such as ergonomics. Rather, it is subjective, such as one's preference in colour, that may not be shared by others. Other than being qualistic, Castelli's designs also have another important trait, and that is to humanize the impact of technology – "inclusion of immaterial quality, complexity, and multiple stimulation is a good strategy to balance the aspects of high technology" (p. 67).

This humanizing aspect is also mentioned by Michael McCoy, who states that the teaching philosophy at Cranbrook is to develop the student's individual voice along with the ability to humanize objects. Along a similar train of thought, Kiyoshi Sakashita, Executive Director and Group General Manager of the Corporate Design Center and a member of Sharp Corporation's Board of Directors, emphasizes not only the role and quality of the object, but also its potential in the user's life. In this regard, there is a change in orientation in design from the object to systems, which Sakashita calls *humanware* design, that highlights essential values and a new lifestyle, focusing on humanity and well-balanced design.

At another level, the importance of users is not restricted to designed objects themselves. Involving users does not simply mean asking users about what they prefer, it also means having them involved in the actual design process from the outset. Lucien Kroll is one such architect who actively collaborates with users by studying ethnologists' reports and engaging in a participatory design process. As Mitchell observes, users' participation in the design process is a precursor to democratic architecture.

The second theme found in Mitchell's interviews is that of rejecting modernism. Michael McCoy and Daniel Weill are "concerned with overcoming the modernist legacy of anonymous, 'universal' design" (Mitchell, 1996, p. 14). Lucien Kroll's work "is motivated by a strong dislike of the legacy of modern architecture" (p. 42). In particular, Kroll's criticisms are especially targeted at the rationalistic and mechanical approach adopted by Gropius, Breuer, and others at the Bauhaus as well as many architects who still "design buildings that are square, white, cubic, and without any complexity" (p. 44). Kroll criticizes the rationalist, problem solving approach advocated by some Modernists such as Gropius – "I think designing is about touching people…Otherwise it's purely problem solving, and engineers are much better at that for sure" (pp. 24-25).

The third major theme found in Mitchell's interviews is that of the concept of *metadesign* – "one that addresses the broader context in which design takes place" (Mitchell, 1996, p. 13). A broader context consists of not just one discipline, it is "about the whole picture" (p. 24). For example, Francis Duffy, Cofounder and Chairman of DEGW International Ltd., states that other related design disciplines are incorporated into the architectural design process, such as information technology or programming, and organizational structures. Castelli and Weil also mention projects that encompass logos, corporate identity, strategy, and thinking about communications. Not only does metadesign transcend a single discipline, it also transcends the design of the single object. This resonates with what Sakashita refers to as the shifting of design from the object to systems. As John Chris Jones, a pioneer of the British design methods movement and the author of the textbook *Design Methods*, observes: "[W]hat needs changing is the design process itself, and with it the way of life" (p. 157).

Just as metadesign transcends the design of a single discipline or object, it also involves intangible design, which John Chris Jones states is an emerging concept and which Mitchell states as the emerging presence of immaterial phenomena. For example, "Castelli explicitly addresses the immaterial phenomena involved in the design experience – light, color, texture, aroma, microclimate, sound – in his work" (Mitchell, 1996, p. 66). Castelli models upon the complexity and immaterial quality of nature in his designs: "Nature is complex, and so subtle… and multiple stimulation is a good strategy to balance the aspects of high technology" (p. 67).

One final major theme found in Mitchell's interviews is that of the relationship of design with the organizational, strategic, and business aspects of corporations. The effectiveness of design does not stop at the design of the product, it also involves the support of organizations and strategic design planning. When asked what methods are instrumental to strategic design planning, Larry Keeley, the President of Doblin states that design briefs are very important. Peter Schwartz, President of the Global Business Network (GBN), Emeryville, California, is a futurist,

business strategist, and a strong believer in scenarios as tools for perceiving alternative future environments. Some approaches suggested are (a) multiple scenarios, (b) sensitivity analysis, and (c) alternative interpretations of the past – multiple pasts. Schwartz goes so far as to say that "[t]he failure to foresee the implications of design decisions is one of the leading causes of design failures" (p. 147).

In the end, nothing is more important than fail-safe designs. As Mitchell (1996) points out, it is fairly obvious when designs fail: e.g. the collapses of the Tacoma Narrows Bridge in 1940 and the roof of the Kemper Arena in Kansas City in 1979. John Chris Jones, who focuses much of his work and conference presentations on fail-safe designs, explains, "[t]he principle which these devises have in common is that they cease to function at all as soon as something goes wrong" (p. 150), which are particularly imperative "in the case of nuclear power, genetic manipulation, agrochemicals, new therapies, and drugs" (p. 151). In such cases, the incorporation of *systemic*s, or checks and balances in designs, is absolutely necessary.

Reflection

Rather than focusing on discovering or developing theoretical approaches on design thinking, the interviews conducted by Mitchell reveal glimpses into the individual philosophies and preferred styles of those featured. These glimpses are invaluable as I find them inspiring, and in all cases, in agreement with my own understanding and rising beliefs about design. Therefore, the details indicated by those interviewed, such as the methods and terms used, have furthered my knowledge and insight in this regard. In terms of design education, the information I have gathered from these interviews could be adapted to pedagogic approaches in design thinking, tentatively organized in these realms:

1. Cognitive: In the footsteps of Norman's cognitive engineering, a basic understanding of his principles is necessary to make a functional object work.

This has to do with the functionality and ease of use of designed objects, a most basic requirement, as nothing is more frustrating and wasteful than creating products that cannot be used.

2. Ethnographic: Observations on the routines and customs of different peoples or users would enhance user understanding and open up a wide range of new design opportunities.
3. Artistic: This realm has to do with the execution of form, in the following aspects:
    a. Arrangement: Based on the assumption that aesthetically pleasing arrangements would enhance user perception, the use of design elements such as colour, line, shape, and texture could be practiced and explored.
    b. Semantics: How meaning is infused into form needs to be considered, in varying degrees, such as in the use of direct analogies, symbolisms or other means of allowing multiple interpretations, such as the "conceal and reveal" method.
    c. Complexity: Inspired by Castelli's observation that nature is complex, multiple stimulation in the material and immaterial realms could be incorporated into designs.
    d. Representation: Based on the term "qualistic," soft-oriented, subjective diagrams or drawings could be explored in addition to other traditional forms of drawing such as technical drawing.
    e. Language: Languages of communication used could include both languages traditionally used in art and design.
4. Humanizing: Evidence of the human mind and the human hand, the designer's individual voice, democratic, participatory aspects could be considered in the design process. I am particularly inspired by Sakashita's sentiment, that is, the

transition from "substance to sensibility, from concentration to decentralization…from economic to cultural values…. our attention on humanity…happiness for every being on earth" (Mitchell, 1996, pp. 82-87).

5. Systemic: Design has transcended the single discipline and the single object, becoming metadesign. The shift from objects to systems, including the tangible and intangible realms, demands a new thinking process.
6. Visionary: Design has also transcended problem solving, especially as a rational, objective, mechanical activity. However, it does involve strategic design planning such as scenario planning. Developing foresight and visions into the future and learning related methods, such as briefs, could be a beneficial approach.

There are a couple of final observations worth mentioning. The first one has to do with what is implied in one of Weil's statements. When commenting that design is beyond problem solving and that engineers are better at that, I sensed a slight disdain on engineering as a discipline. This disdain is perhaps an indication of the increasing rift between the professions of engineering and design, professions such as architecture or interior design. This rift is ironic since engineering has traditionally been considered design, and much of the earlier research conducted in design thinking was conducted by engineers. This rift may have to do with the fact or the perception that design has to do with aesthetics, and engineering does not. I think that it is time this dichotomy is addressed, so that there is some common ground and collective efforts taken by all designers, self-proclaimed or otherwise, through which future design activities take place.

Secondly, as Jones and Mitchell state, it is obvious when designs fail, that is, when collapses literally happen. With the recent events in oil spills (e.g. BP, Enbridge, and Shell), such physical and environmental catastrophes should be prevented where humanly possible. Negligence and shoddiness at the expense of human lives and environmental damage cannot be

tolerated. To that end, safety measures and environmental considerations must therefore be made mandatory and built into all standard design processes, in both government as well as corporate projects.

1998: Thinking Design (Balaram, S.)

Thinking Design, by Singanapalli Balaram (1998), is a selection of earlier writings and conference papers of the author, an industrial designer, senior faculty and former Chairman of Education at the National Institute of Design (NID) in India. The writings are organized into three sections (a) Design: Nature and Power, (b) Design: Human Perspectives and Concerns, and (c) Design: New Dimensions and the Future, followed by a number of case studies. Topics range from semiotics, training, policies and politics, to alternative approaches; topics that are meaningful in the context of India. In other words, references to Indian history, philosophy, religion, customs, political leaders (e.g. Gandhi), and way of life are made.

Within the diverse and rich discourse throughout the book, a few issues particularly stand out that complement some of the issues that are of concern in the western world. As Balaram (1998) states: "The articles chosen are varied in their themes and each represents a different dimension of Design Thinking. Although these are based on the Indian and Asian Design situation, their arguments are universal" (p. xx). A summary of these arguments follows.

Firstly, in the discussion on product semantics, Balaram (1998) hails the power of semantics over function. In this regard, Balaram relates the embodiment of semantics in artifacts to the philosophy of Gandhi, that is, of a holistic approach. Balaram states: "Gandhi's semantic use of objects was simultaneously multifarious and integrative in nature" (p. 34). Some examples are his simple, round glasses, his traditional Indian slippers (*chappal*), his lower garment (half-*dhoti*), and his simple staff. In this respect, they symbolize the "complex principles of self-

reliance, active employment, and productivity" (p. 41). As well, the surface or design elements selected by Gandhi, such as natural colours, forms, textures, and materials, enhance the semantics intended. As Balaram states: "appearance is not aesthetics alone" (p. 42).

Secondly, Balaram (1998) criticizes that "the present design training approaches are so generalized that they ignore the 'personal and individual' factors of the learner completely" (p. 50). This criticism calls to mind Cranbrook's philosophy of the importance of nurturing the individual voice of students. The personal and individual voice nurtured should be geared "to suit the individual country's needs as well as its future demands" (p. 52).

Thirdly, Balaram observes that there is an emerging global vision whereby the design model where "more" is better is being challenged. As Balaram (1998) states: "One…hopes that private profit would eventually give way to collective benefits and further promote democratic values…**What is now required…is not a skilled designer …but a broad based, socially well integrated, humane designer with a broad global vision**" (p. 61).

Finally, one point found in Balaram's book that has not yet been encountered thus far in this literature review is what Balaram calls "the barefoot designer." Balaram (1998) states: "A problem most countries, particularly developing ones, face is not the lack of design talent but sustaining and directing their best talent towards areas where it is required most" (p. 77). These conditions could be promoted through policies, such as direct, indirect, and lateral policies. In the barefoot designer model, design is provided as a service to rural people – "this changing ideological base is seen by the world design community as the beginning of a paradigm-shift…in the social, moral, and economic values guided by…technology" (p. 103). Balarem suggests that a workable barefoot designer approach would be to establish more design institutions in the country and to train students to train others – "being a seed farm" (p. 112).

Reflection

Balarem's *Thinking Design* (1998), like Mitchell's *New Thinking in Design* (1996), is not concerned about coming up with a theory about thinking or reasoning, nor even a shared design process, but rather, presents some emerging, "universal" arguments that represent a paradigm shift in design. Like Mitchell's interviewees, who propose and are already practicing alternative, non-mainstream design approaches, Balaram has proposed some new views that I personally find inspiring. These views have in turn given me some ideas in the context of design education.

First of all, product semantics are to work in conjunction with aesthetics. In other words, aesthetics are to serve the purpose of bringing about or clarifying product semantics. Using the example of Gandhi's chosen objects, the use of colour, texture, shape, and material are purposely and intentionally made to enhance the visual metaphors and symbols embodied in these objects. In this regard, Balaram's view is that the use of design elements should not be an experiment in itself, but rather, to enhance the meaning of the object. This is a particularly important lesson for design students to learn, as they become more sensitive to how variations in the use of different design elements could affect, make or break a message, so to speak. Especially in the field of communication, Balaram's view is particularly relevant.

Secondly, once again, the significance of the individual voice and the training of the mind are recognized, especially in terms of forming professing visions about the future. In this regard, Balaram's personal global vision of a future where there will be a shift in the design of single products to total environments or identities, from designing for private profit to collective benefits and democratic values, designing for society, and designing to liberate rather than captivate users, all of which I personally identify with and find inspiring. However, the challenge in an educational context is that, as the educator helps the student to find his/her individual voice and vision, how can the educator avoid imposing his/her own personal visions on students? This is an

issue that still needs to be resolved. However, as Balaram (1998) states: "**What is now required more and more is not a skilled designer (by skill I mean knowledge and aesthetic sense included) but a broad based, socially well integrated, humane designer with a broad global vision** [for the betterment of life]" (p. 61), this statement could be part of my personal teaching philosophy, which could then be translated into a pedagogical approach; for example, by incorporating not only knowledge and aesthetic skills but also broad, social, human, global issues into the curriculum as points of departure.

Finally, I find Balaram's point about the barefoot designer a most uplifting one. The significance is threefold:

1. The barefoot designer model points to the concept of sustainability, not in terms of raw materials but definitely in terms of resources and talents.
2. This model points to the importance and potential of developing a national conscientiousness and identity, that could be applied not only in India, but also in Canada, for example.
3. Balaram's proposed barefoot designer approach in training the student to train others is especially significant in a design educational context.

Design Thinking in the New Millennium

2009: The Design of Business: Why Design Thinking is the Next Competitive Advantage (Martin, R.)

The Design of Business: Why Design Thinking is the Next Competitive Advantage, by Roger Martin, Dean of the Rotman School of Management at the University of Toronto and a professor of strategic management at the school, offers a look at how thinking like a designer could transform business thinking and management with an advantageous edge.

Before attempting to investigate what design thinking is and how it could be a competitive advantage, Martin (2009) explains the fundamental concept of the *knowledge funnel*. There are three stages in the knowledge funnel: (a) *Mystery*: where questions are asked, e.g. why do objects fall? (b) *Heuristic*: A rule of thumb, e.g. some objects fall quickly, some fall slowly; (c) *Algorithm*: A fixed formula, e.g. Newton's rule of gravity – "an object dropped from any height will accelerate at a constant rate of 32 feet per second squared" (p. 12). The premise of Martin's argument is that, if knowledge and insights are applied correctly and moved to the last stage of Algorithm, the knowledge funnel guarantees success. Similarly, Moldoveanu (2009) calls these three stages hunches or *prelinguistic intuitions*, heuristics or *open-ended prompts*, and algorithms or *certified production processes* (pp. 10-11). Moving knowledge through successfully to the Algorithm stage is the key to establishing the advantageous edge over competitors. In business, such quest for reliability and refinement in algorithms are reflected in tools and systems such as CRM (Customer Relationship Management), TQM (Total Quality Management), KM (Knowledge Management), and techniques such as Six Sigma and linear regression.

As discussed by the management theorist James March, Martin (2009) explains that creating value using the knowledge funnel requires two activities: (a) *exploration* and (b) *exploitation* – "the maximization of payoff from existing knowledge" (p. 18). Exploration can be generally associated with the invention of business, while exploitation can be generally associated with the steady administration of business. From a business perspective, companies that are solely dedicated to exploration tend to be unstable business and companies that are solely dedicated to exploitation will eventually exhaust the use of the same initial invention. Thus, both exploration and exploitation independently have their own drawback but companies very rarely dedicate themselves to these two activities simultaneously. The key to success then, according to Martin, is in striking a balance or reconciliation between the two prevailing approaches: exploration and

exploitation, in a "steadily cycling process" (p. 23). Companies need not only be on the defensive but the offensive in order to stay ahead of the competition.

It is in addressing the reconciliation between these two modes of thinking that Martin (2009) defines the term *design thinking*: "Neither analysis nor intuition alone is enough…The most successful businesses…will balance analytical mastery and intuitive originality in a dynamic interplay that I call *design thinking*…From these firms will emerge the breakthroughs that move the world forward" (pp. 6-7). In another instance, Martin asks: "What is design thinking anyway?" (p. 62): "Design thinking…has been slowly evolving…over the past decade. One popular definition is that design thinking means thinking as a designer would…a fruitful balance between reliability and validity, between art and science, between intuition and analytics, and between exploration and exploitation" (p. 62). Like Roozenburg (1992), Martin states that the tool is *abductive reasoning*, while the two scientific modes of reasoning that businesspeople traditionally use are *deductive reasoning* and *inductive reasoning*.

In the section "Roadblocks en Route to Design Thinking," Martin further explains why this predominant mindset adopted by business leaders might pose concrete difficulties. Firstly, instead of delving into the mystery, companies tend to declare them unsolvable, creating coping mechanisms without the ability to plan ahead. Secondly, to corporate executives or specialists, design thinking might well be seen as a threat, as they are not willing to hand the information monopoly to a less costly employee. Thirdly, algorithms are not settled and refined to code, such as by using software to push clerical algorithms to code. By not refining algorithms to code, efficiency is not as easily achieved. Fourthly, traditional corporate financial planning and reward systems are built to satisfy short-term gains and not to encourage design thinking.

To overcome the above-mentioned roadblocks, cultural norms that reinforce design thinking should be instilled in a corporate environment, such as viewing constraints as

opportunities. Companies could also be run where "one half [of the organization] functions like an accounting firm and the other collaborates like a design shop" (Martin, 2009, pp. 121-122). Finally, a "hybrid leader" (p. 147) could be trained by adopting the *personal knowledge system*, which helps one build one's design-thinking skills. The personal knowledge system consists of three components: (a) stance, (b) tools, and (c) experiences, within which sensitivity and skill could be nurtured to bring about mastery. According to Martin, the stance of the design thinker is that of a balance between validity and reliability, and the tools used are "observation, imagination, and configuration" (p. 160). In particular, "deep, user-centered understanding, using the techniques of the ethnographer, is an essential tool of the design thinker" (p. 161). As Martin observes, for many business people, imagination is underdeveloped, which could otherwise be turned into a powerful tool, supported by an inference and testing loop. In this regard, Martin introduces the term, *"[C]onfiguration* – translating the idea into an activity system that will produce the desired business outcome…that will bring the abductively created insight to fruition. Without that, all the observation and imagination will have no meaningful payoff" (p. 163).

Referring to a previously published book by Martin *The Opposable Mind*, Martin (2009) compares design thinking with *integrative thinking*: "Integrative thinking is the metaskill of being able to face two (or more) opposing ideas… to generate a creative resolution…Design thinking is the application of integrative thinking to the task of resolving the conflict between analytical thinking and intuitive thinking" (pp. 165-166).

Recognizing that the business design thinker has to work with colleagues who are most likely reliability-oriented, Martin (2009) offers five suggestions to be more effective:

1. Reframe extreme views as a creative challenge;
2. Empathize with your colleagues on the extremes;
3. Learn to speak the languages of both reliability and validity;

4. Put unfamiliar concepts in familiar terms;
5. When it comes to proof, use size to your advantage.

Perhaps one of the most memorable statements that Martin has made in the entire book is this:

> [D]esigners care profoundly about impact. Their ethos is to do meaningful work…Design thinkers want their ideas to make a difference in the world. Their stance takes for granted that the world can change, and that they, as individuals, can bring about that change. It is a wonderfully open and optimistic way of being. (pp. 153-154)

Reflection

There are a few ideas that Martin puts forth that I find helpful or even illuminating in teaching design thinking. First of all, the concept of the Knowledge Funnel, with its three stages of Mystery, Heuristic, and Algorithm, deserves attention as each individual stage has its own merit and potential contribution. The stage of Mystery, which Martin identifies as a stage where exploration takes place and questions are asked, opens up a wealth of possibilities in terms of idea-finding and problem-finding. Students could be inspired to delve into their surroundings, look into their psyche, being aware of current issues and asking exploratory questions, such as "How come the tsunami in Japan claimed so many lives? Is it possible that such casualties be prevented?" or "What if houses are more sustainable?" or "What would be the future of computing devices?" Such questions could mark the beginning of the research and conceptual stages of the design process thus opening up a wealth of worthwhile design avenues. The stage of Heuristic, according to Martin, focuses on rules of thumb and ways of thinking; perhaps one could call them patterns or phenomena, and perhaps one could associate them with trends, such as "Some houses are already more sustainable by using solar energy," or "Computing devices are becoming lighter, more powerful, and the batteries last longer." Martin remarks that new

heuristics often reflect what consumers want; in fact, these phenomena and trends are extremely significant in pointing designers to the next step in the future, helping them to expand on the possibilities and develop more options to fulfill these needs. Perhaps in business terms, one could say that such opportunities could be capitalized on. Lastly, the stage of Algorithm, is particularly critical in the business world, according to Martin, because algorithms enable efficiency, something that is valued in the business world. In another instance, Martin (2009) proposes the use of the tools: "observation, imagination, and configuration" (p. 160). It appears that mystery could be matched with observation (according to Martin, deep user-understanding in particular), heuristic with imagination (according to Martin, consisting of an inference and testing loop), and algorithm with configuration, that is, using those tools respectively in those stages of the Knowledge Funnel could help the designer refine the knowledge explored in those stages in more concrete forms, be they statements, ideas, concepts, or prototypes. As Martin states, configuration means "translating the idea into an activity system that will produce the desired business outcome…that will bring the abductively created insight to fruition. Without that, all the observation and imagination will have no meaningful payoff" (p. 163). I tend to agree with Martin, in the sense that, even though the stages of Mystery and Heuristic both have merit in themselves as parts of the design process, it is in the stage of Algorithm or the activity of configuration that brings the design to fruition. In other words, if one were to relate the three stages of the Knowledge Funnel with the design process, the stage of Algorithm is the last stage of the design process, in which a product surfaces, and it is this product that would more concretely make a difference in the world. However, my understanding is that Martin, representing the business world, values algorithm not so much as the designed product, but more so as a kind of code, if you will, a system of delivery, that would push the product systematically into the market, thus moving ahead of one's competitors. In this regard, it reminds me of some of the products designed in the Bauhaus, in which the prototype itself would have no "value," in the business sense, unless it is standardized, mass produced, and pushed into the market. In this

respect, there seems to be an implication that design only has value, if it could reach the largest number of people possible, making the largest market impact, creating the largest ROI (return on investment). Even though at first glance, it seems to be a mercenary concept, on second thought, it is quite positive in a way, if it means accessibility to more people and better efficacy of the design. It appears then that both the traditionally valued aspects of craftsmanship in design as well as standardization are both important.

It is important to note that even Martin (2009) admits that not everything in this world can be reduced to algorithms. For example, he states: "[t]here is still nothing close to a formula for producing consistent success in the music business. Yet" (p. 15). If it is true that not everything in this world could be reduced to workable algorithms, which I agree with, then what else could be added to his thesis to make it more complete? To me, this is a very interesting question that deserves further inquiry.

Another idea brought up by Martin, that I find useful is the Personal Knowledge System, comprising of stance, tools, and experiences. To recap, stance is when one asks questions such as "Who am I in this world?" and "What do I want to accomplish?" These are very meaningful questions and empower students to connect their work with a personal purpose. Having a stance means having opinions; taken further, it enables students to exercise critical thinking in taking positions, establishing philosophies, visions. Therefore, I believe that developing one's stance is essential in design education, as it enables design students to make design choices that are in keeping with their beliefs and visions. Stance, therefore, is something that designers ought to explore and establish. Tools, according to Martin, are frameworks, rules, principles, theories, and processes. In other words, they encompass a repertoire of knowledge that is relevant to the designer's realm of practice. In this regard, I believe that "tools," as Martin calls it, could be the scope of knowledge that the design educator could identify, that design students ought to learn. Experiences, according to Martin, consist of sensitivity and skills, which requires practice, which

in turn deepens one's experiences and sharpens one's abilities to differentiate between levels of quality. In my opinion, in the context of design education, it appears to resemble the studio environment, where design students do sketches, learns various software programs, creates iterations of designs, and do critiques of each other's work. Martin's Personal Knowledge System, can therefore be translated into a rich pedagogical approach in a design thinking curriculum.

It is undoubtable that one major central theme in Martin's book is that of striking a balance between exploitation and exploration, reliability and validity, analytical mastery and originality, deductive/inductive reasoning and abductive thinking, as well as how a hybrid leader needs to learn to speak both the languages of business and design. In fact, design thinking, according to Martin, means striking such a balance and turning it into what he calls "the next competitive advantage," as stated in the title of the book. Design thinking is also related to integrative thinking, which is the metaskill of generating a creative resolution between two or more opposing ideas. It appears to me that a main objective of Martin's book is to educate the business audience, the majority of whom are traditionally trained heavily, if not entirely, in the realm of deductive and inductive reasoning, of the other opposite approach, that is, of exploration, intuition, imagination, and originality. I think that this objective has been achieved in that his book has introduced this audience to the idea of what he believes to be design thinking; however, it has not dealt with the crux of how one goes about achieving it, that is, what creativity is and how one goes about acquiring creativity and originality. The closest point in the book, in which I believe this is achieved, is when he mentions how Buckminster Fuller uses constraint to redesign a house, implying that constraint could be a creativity method. In other words, it talks about the importance of making the logical leap but does not actually provide ideas or methods as to how it could be done. In this regard, Martin's book is not as thorough and systematic in educating the

reader of such methods, as Lawson's or Rowe's (e.g. Rowe's categories of heuristics, in terms of analogies).

One final thought that came to mind in retrospect is that, though Martin has not made it a major theme or proposition, it has been implied that there is an importance in what the future might bring, or rather in my opinion, what the designer could bring to the future. A statement in Martin's book that has made a deep impression on my mind is one made by Moldoveanu (2009), that "the *real* empiricist is a first-rate noticer of anomalies" (p. 56). Perhaps noticing anomalies could be made a required component in a curriculum in design thinking, since, without anomalies, the world is not likely to have any movement or room in allowing for creativity.

Reflection – Literature Review

Having combed through the literature reviewed in this chapter a couple of times, I find that one of the most dominant themes that recur regardless of the discipline associated with the authors is that of the question: "What is design thinking?" Other than the Institution of Chemical Engineers at Aston University (1980), Mitchell (1996), and Balaram (1998), all other publications reviewed include a discussion on what types or styles of thinking are involved in design thinking. Cross, Dorst, and Roozenburg (1992) are unique in encompassing the study of design thinking to not only the cognitive processes of the designer (natural intelligence), but also its application in simulating design thinking in computers (artificial intelligence). Lawson (1980) draws attention to the importance of developing the mind of the design student, as opposed to, for example, adhering to a rigid design process; he states: "it is what goes on in the designer's mind which really matters" (p. 24). Lawson is also the first author in this pool of literature to dissect the schools of psychology in an attempt to find types of thinking that are relevant to what he views is design thinking. For example, the Gestalt school of psychology, in their premise of thinking involving processes, patterns, schema, structured relationships, perception, and organizations, and

the information theorists, in their study of discrimination, pattern perception, concept formation, purpose and insight, are pertinent to what design thinking entails. Similarly, Akin (1992) attributes the characterization of the design process in its most general form, formulation of design problems, and representations for designed objects to the information processing theorists.

A number of authors further associate design thinking with various forms of logic. As Rowe (1987) phrases it, it is "the interior situational logic and the decision-making processes of designers in action, as well as with theoretical dimensions that both account for and inform this kind of undertaking" (p. 2). Specifically, Lawson references Wertheimer's (1959) theory of *productive thinking*, concerned with the directional quality of thought, with the assumption that if an appropriate direction is followed, that thinking is deemed productive. Lawson also references Bartlett (1958), whose definition of productive thinking includes two types of thinking – *thinking in closed systems* and *adventurous thinking*, which could be analogized to convergent and divergent thinking respectively.

Rowe (1987), on the other hand, brings up the notion of *heuristic reasoning*, which "refers to a problem-solving process in which it is unknown beforehand whether a particular sequence of steps will yield a solution or not" (p. 75). In heuristic reasoning, an open-ended, episodic process, that is neither entirely objective nor subjective, involves the designer's mind going back and forth between what Rowe calls the designer's hunches and a set of guiding, organizing principles and logical structure. Cross (1992) picks up on this idea by referencing March (1976) in a particular form of reasoning that is called *design reasoning*, which is different from inductive and deductive reasoning, and which Cross observes is essentially abductive, because the speculative design cannot be determined logically. Roozenburg (1992) also acknowledges March (1976) as the original holder of this view but refers to it as *productive reasoning*. Roozenburg reminds us that Peirce's (1891) original theory on abduction states: "[a]bduction invents or proposes an hypothesis; it is the initial proposal of a hypothesis on

probation to account for the facts." (p. 130). Roozenburg also tells us that Peirce saw abduction as the only logical operation that introduces any new ideas and references Habermas (1968), in suggesting the significance of *innovative abduction*. Martin (2009) picks up on this idea by differentiating between deductive and inductive reasoning from abductive reasoning. Like Roozenburg, Martin also attributes to Peirce the concept that new ideas come into being by logical leaps of the mind. Martin states: "[t]he design-thinking organization applies the designer's most crucial tool to the problems of business. That tool is *abductive reasoning*" (p. 62). As Breen (2005) points out, "Martin defines [abductive thinking] as 'suggesting that something may be and reaching out to explore it.'" (p. 69).

Abduction, abductive reasoning, innovative abduction, or abductive thinking, regardless which term is used, appears to be a key component of design thinking. Its credit for generating new ideas is correspondingly critical to design thinking. As Cross (1992) states: "[d]esign initiates novel forms" (p. 8). In the literature reviewed, a particular kind of newness or innovation is emphasized. Specifically, Gregory (1980) recommends transitioning from incremental innovation to more novel and radical designs. Referencing Kuhn (1962), Lawson (1980) points out the essential element of a divergent leap, that is, a revolutionary conflict between tradition and innovation (p. 115). Lawson calls this revolutionary vs. evolutionary. Similarly, Martin (2009) calls on innovative, imaginative breakthroughs, which are attributed to such business successes as Apple, Proctor and Gamble, and Google, to name a few. Fraser (2006) also uses the term *breakthrough thinking*, which embraces risk-taking and 'outside the dots' concepts, and which I believe is similar to *blue-sky thinking*. Blue-sky thinking is the type of thinking that is used in brainstorming, when the sky is the limit, with unlimited possibilities (Briggs, 2003). Rowe (1987) mentions a special kind of innovation, i.e. individualistic innovation, stemming from designers' hunches and guiding visions, and turning constraints into positive elements.

Examples include Sydney Opera House and Centre Pompidou. Rowe also asserts that the to and fro movements in design thinking are often subservient to the designer's idea or vision.

A concurrent theme is that logic and reason are balanced, or ought to be balanced by intuition and creativity. Lawson (1980) points out the difference between reasoning and imagining, where reasoning generally involves external needs, external constraints, and design, and imagining generally involves internal needs, internal constraints, and art. Lawson clarifies that both reasoning and imagining are required in design situations in different degrees. Akin (1992) clearly differentiates intuition from reasoning: "*Design thinking* connotes a comprehensive concept...*Design reasoning*…distinguishes the conscious, predictable use of rules of inference for the purposes of manipulating design information, from intuition. *Design intuition*…implies manipulations of a sub-conscious kind, where the rules of manipulation are not explicable" (p. 39). These manipulations of a sub-conscious kind are perhaps similar to what Rowe calls hunches. Cross (1992) also emphasizes that research results show that experienced designers rely strongly on intuition and creativity. The theme of balance is picked up on later by Martin (2009), who stresses the need to balance exploitation (quantitative, analytical reasoning based on deductive and inductive reasoning) with exploration (instinctive, unanalyzed, intuitive, creative, innovative flash of insight), thus empowering what he calls a hybrid leader. Martin calls this type of balance *integrative thinking*, which calls on the metaskill to face two (or more) opposing ideas or models. Another way to describe or define this type of thinking may be what David Kelley, the chairman of IDEO and founder of Stanford's d.school, calls *T-shaped thinking*, "'that means combining analytical thinking–the vertical leg of the T–with horizontal thinking: intuitive, experimental, and empathetic'" (Breen, 2005, p. 69). Likewise, Professor Mary Ann Maruska, who teaches in the Bachelor of Design program at Sheridan Institute of Technology and Advanced Learning and York University, defines design thinking as creative and critical pathways, combining *divergent thinking* with *convergent thinking* (interview, April 10, 2007).

As stated above, Martin (2009)'s proposal of integrative thinking calls for the ability to resolve two (or more) opposing ideas or models, transforming them into a creative resolution. My observation is that this concept actually stems from Koestler's idea of bisociation (1964). Rowe (1987) points out the concept of the bisociation of two mutually incompatible contexts, or bisociation of matrices, which could explain creativity. Rowe states: "[C]reating involves relating two normally independent frames of reference" (p. 46). Rowe further explains that, [in 1987] information processing theory was the dominant school of thought about creative problem solving, which involve the creation of new knowledge states through generative processes. Alternatively, Zen and Chen claim that in order for innovative design to take place, the conception between the purpose and the form of the designed object ought to start from scratch (Roozenburg, 1992).

It appears quite clearly that innovation and creativity are intertwined, and though creativity methods are not extensively explored or proposed in the literature reviewed, there are some concepts that could potentially be turned into creativity methods. For example, Lawson (1980) brings up creative thinking as a process consisting of the five stages of first insight, preparation, incubation, illumination and verification. Brainstorming, as an activity to counter the mechanical habit of applying old solutions to new problems, and synectics, with its four types of analogy, are suggested. According to Lawson, the four types of analogy: personal, direct, symbolic, and fantasy analogies, but especially fantasy analogy (applying fantastic and seemingly impossible ideas), are central to creativity techniques.

Closely related to creativity but is a skill and sensibility in its own right is a sense of aesthetics or artistry. As Lawson (1980) points out, a designer would "take on an artistic as well as interpretive role, such as in form, space, and style" (pp. 64-65). To this end, there is potential in using Guilford's cognition factors (1956), especially the three types of classification as artistic exercises: figural, structural, and conceptual classification. In design, artistry could be effectively

and appropriately rendered to communicate the intended message. For example, aesthetic styles could be reflections of one's principles and beliefs; such as in the architectural works in the Modern Movement. As Rowe illustrates, works by Gropius, for example, demonstrate an aesthetic direction that is not simply an experiment in formalism per se but is very much influenced by the beliefs and philosophies held by his contemporary architects. It reflects the Modernist principle of rejecting all direct historical and stylistic references and the search of a new spirit for a new community. In other words, aesthetics are not to be taken at face value, but are reflections of inner systems of belief. By the same token, aesthetics could serve the purpose of bringing about or clarifying product semantics. In graphic communication, variations in the use of different design elements could affect the meaning of a message. As Green (1980) points out, "the shapes, colours and arrangements of things that make up the environment speak of the ideas, values and dreams of their designers in a way that nearly every one can grow to understand" (Lawson, p. 172). Green asserts that the "grey uniformity of 'good design' strip[s] of any individuality, quirks of personal expression or appeal to…users who themselves are looking for an expressive environment" (Lawson, p. 175). This expression applies to a language that is not exclusively relevant to the designer, but to the client as well as the user. Similarly, Rowe (1987) raises the issues of modes of representation and concept of style: "Some referential sketches have an idiosyncratic and notational quality, and representational techniques such as perspective drawings 'have altered what we can represent, see, and therefore understand and imagine'" (p. 99). Weil's Cubist-influenced works, for example, the series *100 Objects* clocks and the *Still Life* series, draw on the language in art (Mitchell, 1992). Balaram (1998) points out the symbolisms used in Gandhi's objects. Hence, the use of aesthetics is a rich, effective means to express and communicate one's values and beliefs, sometimes individualistic, other times collective. The use of the design language is a skill to foster, requiring practice. Lawson uses the analogy of sports, and Martin (2009) emphasizes experience as one of the key components in the personal

knowledge system, that would help one sharpen one's abilities to differentiate between levels of quality.

In executing the language of design, user needs must be considered. In as early as 1971, Maguire states that user needs should be formulated in the designer's brief and explored in depth in the design process. Around the same time, Hertzberger suggests that elements or forms of the product could be purposely designed to be more flexible and open-ended to suit long-term users' needs (Lawson, 1980). Donald Norman looks at design primarily in terms of how easy the user understands how the designed object is to be used, a discipline referred to as cognitive engineering, "the applied side of cognitive science" (Mitchell, 1996, p. 92). Michael McCoy is concerned with what he calls product semantics or interpretive design, both of which focus on how meaning is interpreted (by the user) or embodied in form, as well as the manifestation of the human hand and the human mind in the form of the products. Clino Trini Castelli, on the other hand, focuses on user experience and perception by stressing the term *qualistic.* Castelli recommends multiple stimulation as a means to humanize products, while Kiyoshi Sakashita states *humanware* design, lifestyle products, and essential design is a means to improve the condition of life. Further, users' participation in the design process is a precursor to democratic design (Mitchell, 1996).

The idea of metadesign is brought up by Mitchell (1996) and is one that I believe is a key concept and phenomenon in the world of design today. Metadesign represents a paradigm shift in design from independent objects and isolated disciplines to the design of interdisciplinary or multidisciplinary complex systems. Mitchell states: "To combat the increasing fragmentation of the design disciplines, a *metadesign* approach is needed, one that addresses the broader context in which design takes place" (p. 13). Sakashita refers to it as the orientation of design shifting from the object to systems. Castelli also brings up examples of highly complex, system-like products.

Metadesign could include intangible design, which John Chris Jones states is an emerging concept (Mitchell, 1996).

A major theme that is directly or indirectly addressed throughout the literature surveyed is that of a design process. Lawson (1980) states that his book is about how to understand design problems and practice design processes, and he hopes that the book would help the designer acquire his/her own flexible and productive design process. Like Lawson, Rowe (1987) also observes that there is no one prescribed design process, but rather, an episodic process during which there are periods of speculation and contemplation. Rowe notes that there is a shifting of angles and perspectives in the designer's mind, "the 'to and fro' movement between areas of concern" (p. 34). This to and fro movement coincides with what Lawson states as the centre of design thinking. Both Lawson and Rowe state that the design process is by no means rigid, but rather, flexible, during which the designer may backtrack to a previous, more advantageous position, while systematically working out issues within an established framework (Rowe, p. 35). At play in this to and fro movement are the designer's guiding vision and the constraints that exist in the design project. Some early constraints mentioned include costs (Stratton, Fergusson, 1980). They can be internal (e.g. in the mind of the designer), external, fundamental, symbolic, formal, physical, or practical, all of which might affect design decisions in costs, sites, available technologies, methods, and materials. In a positive light, constraints are used to focus the attention and direction of the design process, and may even lead to aesthetic revolutions or manifestations, e.g. the colour-coded pipes at the Pompidou Centre, the formal mathematical proportions of the Golden Section in Le Corbusier's Modulor, and the symbolic connotations of the Sydney Opera House, and as Martin (2009) points out, Buckminster Fuller's lighter version of a house in the geodesic dome. Rowe (1987) reiterates that the aspect of hunches is a significant factor in the design process, as it remains a guiding vision for the designer despite operational constraints (p. 32). Significantly, Rowe mentions that the designer's vision can outweigh what

might seem to be insurmountable odds. The design process can therefore be seen as a creative problem-solving process in resolving the goals, visions, limitations, and context of the design project.

Despite both Lawson's and Rowe's recommendation of a somewhat flexible design process, a number of phase models are brought up in literature. Some examples are from the Royal Institute of British Architects' Plan of Work (RIBA), Asimow's, Archer's, Thornley's, and Keeley's models. Most of these processes are made up of rigid phases, concentrating on the designer's activities, with the exception of Wallace (1992), who includes the internal state of the designer in the process, with a special note about the presence of attitude and mood, which Wallace recognizes as significant in design thinking.

There is an assumption that the definition of design problems is often loosely defined and originated by the client at the beginning of the design process (Lawson, 1980), but that problems could either be well-defined, ill-defined, or wicked problems as well (Rowe, 1987). Constable and Parkes (1980) point out that the brief is a key document, clarifying design problems, and aspects such as safety and maintainability should be stated right off the bat, with precision in wording. Martin's (2009) model of the knowledge funnel shows that algorithms are capable of enabling efficiency, reliability, and uniformity in the design process. Taking an idea to the algorithm stage, in Martin's opinion, is essential to establishing the advantageous edge over competitors. However, Martin observes that not everything, e.g. music, could be reduced to algorithms, yet. Similarly, Akin (1992) finds from his experiments that mathematic algorithms do not appear to be sufficient enough to propose a theoretical framework and to address the freedom and full range of variables and possibilities demanded in design. Additionally, while reflecting on his own experience as a designer, Gregory (1980) cannot recall any emphasis placed on the exploration of alternative overall approaches in the design process. The key word here, in my opinion, is "overall," as, focus should not be placed predominantly on the design activity but also

on overall approaches prior to embarking on the design activity, i.e. in the beginning of the design process or at the conceptual stage. This may involve a revision of the design process to give more thought to problem finding and identification, as well as a broader consideration of overall approaches and possibilities. Perhaps more succinctly, as John Chris Jones observes, "what needs changing is the design process itself, and with it the way of life" (Mitchell, 1996, p. 157).

One observation that I have made from following the evolution of the literature reviewed that worries me somewhat is in the realm of environmental, energy, and safety issues. At the chemical engineering conference, Design '79, significant attention was paid to these issues. As seen in articles such as "Future Organic Chemical Feedstocks: An Energy Perspective" (Stratton, 1980), "Evaluation of Future Processes" (Fergusson, 1980), "Environmental Impact Analysis: Foundation of Social Costs" (Rothman, 1980), and "Design for Maintainability" (Constable and Parkes, 1980), the authors have raised concerns, questions, as well as practical suggestions in addressing these issues. Energy inflation and forecasting, future energy alternatives, environmental impact, safety considerations, maintainability, waste disposal, hazard assessment and control are among the topics covered. For example, Rothman (1980) voices the urgency of implementing policies to prevent environmental damage. Gregory (1980) recommends routinely developing safety and environmental amenity. Fergusson (1980) warns that the costs of containing the precipitation of toxic content would likely be greater than originally predicted at the conceptual stage. Constable and Parkes (1980) raise the assumption that designers have professional and ethical obligations. Rothman (1980) suggests that qualitative advantages, such as environmental benefits, must be measurable and justifiable in objective and paradoxically, quantifiable ways, e.g. in terms of damage, cost, and estimating benefits. Mitchell (1996) urges the incorporation of systemics, or checks and balances in designs, to ensure fail-safe designs; while reminding us of the dire consequences with the collapses of the Tacoma Narrows Bridge in 1940 and the roof of the Kemper Arena in Kansas City in 1979. What I find sad and perplexing is

that, even though environmental, energy, and safety issues were of obvious concern in 1979 and have been addressed, in my opinion, quite soundly at the time, some thirty years later, our world is still facing the same problems today. Indeed, the same issues appear to be becoming even more severe, with rising energy costs and crises, global environmental damages, and alarming physical and environmental catastrophes (e.g. BP, Enbridge, and Shell oil spills).

So how can these urgent issues be addressed? Can they be incorporated in the teaching and practice of design thinking? For example, an awareness, advocacy, and system of control could perhaps be built into industry standards through a code of ethics, modified design process, public policies such as environmental impact analysis (EIS), and greater obligations from the corporate sector. Design must be conducted through modified design thinking to prevent further environmental damage and minimize catastrophes on a global scale, where humanly possible and as much as possible.

A powerful tool that could be used to help address the issues stated above is systematic forecasting. For example, the designer's view and philosophy about the future could greatly influence how the future is shaped. In this regard, Lawson (1980) uses technology as an example as pro-technologists and anti-technologists hold different views as to how technology should influence the future and how progress is defined. Balaram (1998) recommends the training of the student to develop professing visions, such as visions about the future. Jain et al. (Rothman, 1980) recommend a set of practical and systematic methodologies for conducting environmental impact analysis, e.g. using a checklist that systematizes categories such as human activity, infrastructure, services, and existing environmental pollution; using matrices, where points of interaction between two axes represent areas of possible, significant environmental impact; and using networks, such as diagrams and maps to allow for unforeseen elements. Mitchell (1996) also brings up the example of Peter Schwartz, President of the Global Business Network (GBN), who is a futurist, and whose company focuses on corporate scenario planning and research into

the future of the business environment. In predicting alternative future environments, Schwartz recommends using the methodology of scenarios, such as multiple scenarios, sensitivity analysis, and multiple pasts. Such systematic forecasting methodologies could be built into the design process as a standard and required stage.

An important aspect of design thinking that must be acknowledged and perhaps emphasized intentionally is the inspiration and expression of one's values and beliefs. These could be at the individual (e.g. designer, client) or collective level (e.g. users, society). Even if such expressions are not materialized as finished designs in the end, practicing such expressions could be invaluable creative and imaginative exercises for the design student. For example, Lawson (1980) brings up Peter Cook's architectural drawing, *Plug-in-City* of 1964. As Lawson states, this piece "did not solve any immediate problems, nor was it intended to be built. Rather it explored and expressed ideas, beliefs and values, and asked provocative questions about the future direction of city design and patterns of life" (p. 65). In fact, Rowe (1987) cautions against creating designs that are value-free, overly scientific and objective, and that are void of vision and social purpose. In this respect, Rowe draws attention to two positions: (a) the centrality of a position and (b) the comprehensiveness of a position, both of which point to the likelihood that "the most compelling positions, at a given moment, are the ones that seem to address the most important issues of that moment" (p. 147). The awareness of and identification with these positions are powerful stimuli for design thinking. From an interview with Michael McCoy, Mitchell (1996) states that Cranbrook Academy of Art stresses the mission of nurturing the individual voice of students. Alternatively, Balaram (1998) observes that there is an emerging global vision whereby the design model where "more" is better is being challenged. Balaram states: "What is now required more and more is not a skilled designer (by skill I mean knowledge and aesthetic sense included) but a broad based, socially well integrated, humane designer with a broad global vision" (p. 61). Additionally, Balaram recommends the fostering of "the barefoot

designer," to sustain and direct design talents where it is most needed, to be complemented and supported by policies, subsidies, grants, agreements, as well as other sectors of the society, e.g. culture, health, and education. As Balaram points out, "this changing ideological base is seen by the world design community as the beginning of a paradigm-shift in design…a shift in the aims of modern technology and in the social, moral, and economic values guided by that technology" (p. 103).

Personally, I find Balaram's vision very inspiring and one that I identify with. It is a global vision of a future where there will be some paradigm shifts in the world of design: from designing single products to total environments or identities, from designing for private profit to designing for collective benefits and democratic values, designing for society, designing to liberate rather than captivate users, and training designers to sustain talents where they are most needed; in short, to use design for the betterment of humankind. Martin (2009) states:

> [D]esigners care profoundly about impact. Their ethos is to do meaningful work…Design thinkers want their ideas to make a difference in the world. Their stance takes for granted that the world can change, and that they, as individuals, can bring about that change. (pp. 153-154)

Such sentiment represents the crux of what I believe design thinking should entail.

Finally, I cannot help but think of Martin's (2009) Personal Knowledge System, consisting of stance, tools, and experiences. To recap, my interpretation of stance includes one's values and beliefs. It enables students to exercise critical thinking in taking positions and developing visions. Tools, according to Martin, are frameworks, rules, principles, theories, and processes. My interpretation of tools consists of a repertoire of knowledge that is relevant to the designer's realm of practice. Tools could be the scope of knowledge that the design educator could identify, that design students ought to learn. Experiences, according to Martin, consist of

sensitivity and skills, which requires practice, enabling the designer to differentiate between levels of quality. Martin's Personal Knowledge System indeed encompasses a scope of potential pedagogical approaches in a Design Thinking curriculum.

In "A Structure and Function Based Theory for Design Reasoning," Akin (1992) aims at coming up with a theoretical framework that is comprehensive and inclusive, that is, "to find some common ground which can be applied towards generalizable underpinnings of the area of design thinking" (p. 39). By the same token, my aim in this leg of my reflective journey is to come up with some key, potential components, regardless of disciplines, to be incorporated in an interdisciiplinary Design Thinking curriculum.

CHAPTER 3: DEVELOPING A VOICE

SELECTED IDEAS

Introducing Design Thinking as a Holistic Approach

Design, as a branch of study, is actually compiled of many separate and individual disciplines today. They include the more commonly recognized design disciplines such as graphic design, interior design, industrial design, and fashion design, as well as other disciplines that are inherently design-oriented but are not normally considered design, such as architecture, engineering, business, and urban planning. As Buchanan (1992) notes: "[t]o gain some idea of how extensively design affects contemporary life, consider the four broad areas in which design is explored throughout the world by professional designers and by many others who may not regard themselves as designers" (p. 7). These four broad areas are 1) symbolic and visual communications; 2) material objects; 3) activities and organized services; and 4) complex systems or environments for living, working, playing, and learning.

While the compartmentalization of these disciplines emphasizes specialization of skills, it may also jeopardize the quality of the design holistically. Some scholars associate this holistic dimension of design as part of the humanist tradition (Buchanan, 2004, p. 5). Zaccai (1996) sums up this concept succinctly:

> If we consider the consumer psyche as an extension of the individual psyche... the 'superego' defines emotional requirements, the 'ego' defines rational requirements, and the 'id' defines sensory requirements... these are not distinct and independent components of an individual, but highly interactive and interdependent forces which constitute the whole person. They must be simultaneously balanced and satisfied. The failure to find a proper balance among the three means that all are compromised to

> some degree. In other words, if the real focus of design is not the object, but the human user of that object, then the entire psyche of the individual must be satisfied. If we, as designers, focus most of our energy on only one aspect of the psyche, the id, for example, then we are doomed to fail. (p. 8)

In other words, the way products are developed nowadays by an assembly line of technical specialists (or engineers) to solve complex technical problems, marketing specialists to promote the product, and design specialists to touch up the aesthetics, would only produce mediocre products. They are not able to "develop a deeper understanding of what might be called a humanistic aesthetic, which encompasses the intellect, the soul, and all of the senses" (Zaccai, 1996, p. 8). "The designer must feel equally responsible for all aspects of the total product" and "must be able to develop a clearer understanding of where the natural balance point is among the forces of the id, the ego, and the superego for any specific human need," with the actual process of design taking place "as a collaborative effort among the appropriate specialists" (Zaccai, pp. 9-10).

Engineering as a discipline, for example, fundamentally does not design the look and feel of a product; industrial design does. It does not design graphics; graphic design does. Similarly, it does not do fashion design but do textile manufacturing in the realm of chemical engineering. In short, engineering is concerned about the functionality but not the aesthetic part of a design; functionality being successful only if a design works for the user. Engineering as a discipline by nature excludes the consideration of aesthetics, look and feel, and graphics, although there is a creative aspect in engineering, which distinguishes engineers from technicians (Susan McCahan, interview, April 27, 2007).

In the introduction of the essay "Rethinking Design Education for the 21st Century: Theoretical, Methodological, and Ethical Discussion," Findeli (2001) references a statement

made by Boekraad and Smiers (1998) in "The New Academy[1]: Uniting Visual Intelligence with Ethics and Research": "'the disturbing effect of product engineering and marketing on design and the visual arts' [is] the main issue to be addressed currently" (p. 5). Some of these "disturbing effects" include (a) the economic factor as exclusive evaluation criterion, (b) narrow philosophical anthropology of user as the customer, (c) outdated (19th century) epistemology of design practice and intelligence, (d) overemphasis on the material product, (e) aesthetics based on material shapes and qualities, (f) code of ethics based on business contracts and agreements, (g) cosmology restricted to the marketplace, (h) the concept of material progress, and (i) the cycles of fashion or technological innovations/obsolescence. It appears that the legacy of product engineering is so inherent in our society, that it is deemed an issue severe enough for design educators, such as Findeli, to find ways to address it.

Indeed, Boekraad and Smiers (1998) state: "[d]esign engineering appears to be gaining the upper hand…Designing for industrial-scale production is confined in practice to an unending chain of redesign. Designers are degenerating into specialists in form, line and colour" (p. 1). The problems indicated in this statement are, therefore, twofold: (a) that designers are preoccupied with constantly improving a flawed product, and (b) that designers are only preoccupied with the physical appearance of products.

I believe that these two problems are significant. Firstly, designers are placed in a mode of operation and thinking that is passive and reactionary. Instead of proactively initiating innovative designs, they are continuously making amends to existing, flawed designs. In fact, Fraser (2006) distinguishes this type of thinking, which she calls *incremental thinking*, from *breakthrough thinking*. Incremental thinking is traditionally adopted by well-established companies based on their existing business model, with minimal investment risk and largely

[1] "The New Academy" was presented at the European League of Institutes of the Arts (ELIA) conference in Lisbon in 1996.

incremental results. On the other hand, breakthrough thinking embraces risk-taking, is innovative, and reflects "'outside the dots' concepts – exploring many new and even seemingly crazy ways to deliver bigger, broader user value" (p. 26). Gregory (1980), Lawson (1980), and Martin (2009) have also made references to this concept. If designers are trapped in the mode of incremental thinking, they are less likely to maximize their creative potential by thinking outside of the box in developing innovative designs.

Secondly, if designers are degenerating into specialists in form, line and colour, the impact of their designs is superficial (though one may argue that if the form, line and colour of a product is pleasing, the psychological and emotive realms of the user are also naturally enhanced). Surely, the design of strictly the form, line and colour, that is, the physical appearance of an object, does not tap into what Findeli (2001) identifies as the invisible realm of existence. At best, the designer taps into the inner world of cognitive psychology of the user, but hardly, the inner, invisible world of "human consciousness (thoughts, motivations, purpose, fear, needs, aspirations, etc.)" (p. 11). Such an approach may neglect to consider the user as a whole person, lacking what Fraser calls "a deep user understanding" (2006, p. 26).

In "The New Academy," Boekraad and Smiers (1998) also state:

> Design is being absorbed into communication processes which are *geared* to stimulating consumption, it is increasingly driven by the will to achieve short-term commercial success. In the marketing process, the role of the general public is chiefly that of consumer and thus we are losing sight of the public interest. (p. 2)

The point of "public interest," in my opinion, deserves attention, and is one that perhaps Findeli considers in the "ethical" realm: "To which meta-project…does a design project and a design curriculum contribute? For what end is design a means…How autonomous can design be?" In other words, does design serve the interests of corporations or does design serve the

interests of the public? What is the overall purpose of design education and practice? These questions need to be asked and answered if one was to devise a theoretical and methodological model for design education and practice. The content and emphasis of such a model would certainly vary depending on whether or how much the interests of corporations and the public are to be served.

Lastly, Boekraad and Smiers (1998) observe:

> Thinking about design is in danger of confining itself to reacting to signals from the marketplace…design has become far more closely intertwined with strategic communication, so that what threatens to disappear is a specific objective based on design thinking, whether or not it is nourished by a critical and humane picture of culture and society. (p. 4)

The "specific objective based on design thinking" further upholds Findeli's proposition that an overall purpose of design education and practice, albeit a contentious one, needs to be present, fairly considered, and adequately articulated in a humane culture and society.

Findeli (2001) traces and critiques the evolution of the Bauhaus tradition, which results in the current model of design education today. According to Findeli, the ideal model as embodied in the Bauhaus tradition is one of a tripolar model, consisting of art, technology, and science. When this model is optimally actualized, the three poles of art, technology, and science would have relatively equal weight and adequate articulation. However, the models actually implemented at Bauhaus (both the Weimar and Dessau locations) and the New Bauhaus in Chicago (both of which where design was taught as applied esthetic), and the Hochschule für Gestaltung (HfG) in Ulm (where design was taught as applied human and social science), failed to actualize the "ideal" model due to issues with the relative weight of the three poles, as well as the articulations thereof. Findeli's critique is based on the assumptions that the tripolar model is

indeed the ideal model, as intended by the Bauhaus tradition, and that, "[t]oday, everybody tends to agree upon the necessity of including art, science, and technology in a design curriculum" (p. 8) with relatively equal weight of the three dimensions of art, science, and technology.

Currently, design thinking is taught as a foundations course in diverse programs in higher education, preparing design students for higher levels of studies in their chosen major. A survey of five different courses in design thinking reveals a broad spectrum of components currently taught in this subject (Chapter 4). Though these components are not totally, commonly shared by all five courses, the majority of these components, such as the use of design elements and principles, belong to the arena of practical, functional skills and techniques, equipping the student designer with a repertoire of experiential knowledge that is often considered invaluable before entering the professional industry. In fact, the tradition of teaching practical, functional skills in a foundations course goes back to the Bauhaus. The preliminary course or *Vorkurs*, which was compulsory, was meant to ensure that students had a "shared, basic understanding of design as a foundation for the instruction on form and work that would follow" (Wick, 2000, p. 68). In other words, the instruction on form was considered of prime importance before any meaningful design activity could happen. Indeed, the emphasis on form is definitely not part of an engineering curriculum, but the tradition and philosophy of the Bauhaus in teaching functional skills in a preliminary course have certainly been passed down to the majority of design schools and are still being practiced widely in North America and Europe today.

Likewise, a significant number of post-secondary design programs still embrace the Bauhaus tradition of design as a craft. The Royal College of Art, formerly the Government School of Design, for example, has experienced a revival of teaching the graphic crafts. Subjects such as drawing, calligraphy, letterpress printing, and stonecutting are taught, in hopes of developing the student's sensibility towards the relationship between form and the material. Even in the context of industrialization, digital media, and new technologies, the Royal College of Art

still finds it relevant to train the student in handwork, in hopes of encouraging a more sensitive response to the opportunities of new media. In this context, the crafts act as the pivot between the fine arts and industrial design (McAlhone, 1982, pp. 36-37).

Although the curriculum in the Bauhaus tradition described above has been implemented for decades, and has even been introduced in some design courses at the high school level, some new ideas of design thinking have emerged in recent years, as seen in the previous chapter. Instead of introducing design thinking as a set of functional skills and principles, and addressed as isolated disciplines, as has been taught in most design curricula for decades, my philosophy is that this instruction be introduced as a holistic and interdisciplinary approach, with the commitment to shape the future. Instead of continuously redesigning existing products incrementally, design thinking could start with and be inspired or motivated by some collective values. A modified design process will be proposed in hopes of encouraging breakthrough thinking, redefining design as systems in the visible and invisible realms, exercising creativity, applying a holistic set of integrated design principles, and addressing some contemporary issues or problems that we face today. The guiding values could be brought to the surface by personal introspection and/or discussion with others, and establishing one's stance individually or collectively. Examples of such values may include sustainability, universality, holism, diversity, accessibility, innovation, progress (technological, artistic, cultural, spiritual, social, economic, and/or ethical), humanitarianism, and last but not least, the betterment of mankind at the personal, national, and global levels. These values, rather than functional skills, should be at the forefront of all design activities, conditions and prerequisites that guide and shape the design process at the initial stage rather than as an afterthought. In this chapter, I will outline and elaborate on a few selected ideas that I have extracted based on my reflection from the previous chapter. Additional literature will be incorporated to further refine and complement the ideas, in hopes of clarifying the directions that are to be taken when implemented in the pilot teaching project.

Values-Based Design

As seen from my reflection in the previous chapter, the ability to express one's values and beliefs, and to establish one's stance is a potentially significant aspect of design thinking and component in a Design Thinking curriculum. The awareness of and identification with one's values and those of others, and the opportunity to display the expressions thereof creatively, are potentially invaluable. Other than Lawson, Rowe, Mitchell, and Balaram, other authors have also voiced similar sentiments in this regard.

In "Culture-Based Knowledge Towards New Design Thinking and Practice – A dialogue," Leong (2003) proposes a paradigm shift in the emphasis of product design from its functional aspect to its ability and potential in fostering cultural values. Drawing from the design philosophy of Ming dynasty furniture and basic Chinese thinking and reasoning with roots in Confucian and Taoist literature, Leong relates his guiding set of values, consisting of what he calls a new subjectivity, objectivity, and acculturation. Leong explains: "The choice of a new design strategy is not about aggressive 'progression,' and spiritual 'transcendence,' but about strength-gathering and harmonization, to counter the issues that are byproducts of the speeding techno-economic machine of the world" (p. 54). The three related areas of investigation are defined by Leong as "'value' in design – …value systems of the given culture; 'Macro-relations' – a combination of the collective behavior of users, the interaction of users and objects, and the relationship of users, objects, and environments; and 'Micro-relations" – of design interfaces or ergonomics…" (p. 54).

The *spatial perspective* of culture is a significant point in Leong's discussion, consisting of the three levels: (a) outer tangible level, (b) mid behavioral level, and (c) inner intangible level. Likewise, one can look at a matrix consisting of the four dimensions: (a) material, (b) immaterial, (c) thoughts (static), and (d) behavior (living); or the four quadrants of (a) material design, or

style/form, (b) behavior, (c) institutions/customs, and (d) philosophy or ideology. Intersections of these four dimensions constitute what Leong calls the spatial structure of culture. Different angles of investigation or application in integrating different aspects of these dimensions could produce culturally integrated or hybridized designs. A particular methodology that is based on this idea, that Leong suggests, consists of the acculturation of different (e.g. two) cultures. Assuming that each culture has three layers of culture: material/style/form, behavior/rites, and ideology/ways of thinking, one could take an aspect from one or two layers from the first culture, and then integrate it/them with an aspect from the other layer/layers from the second culture, to create a culturally hybridized design. An example that Leong uses is the design of the Double Happiness condiment set, taking the material/style/form of Chinese paper cutting and acculturating it with the Western behavior/rite of using the salt and pepper shakers, to create a new design, which is a combined salt and pepper condiment set with a Chinese paper cutting motif.

In the Things East West exhibition, Leong showcases a series of products that are designed to explore the quadrant of philosophy in the structure of culture and designed intentionally to foster non-commercial values. These values include sharing, bonding between family members, and bringing nature back into one's environment, in the designs: Story-Telling Device, Timed-Words, and Nature Radio respectively. In other words, by initiating the design process with the goal of promoting certain values, novel designs are created, rather than redesigning existing products incrementally.

In "Altruism as Design Methodology," Stairs (2005) attempts to provide a critical review of the emergence of design as a non-commercial, counter-cultural activity against consumerism. Stairs argues that "[i]n successive waves, designers and design theorists have embraced social and environmental causes with the growing awareness of slightly guilty affluent urbanites" and proposes that this change in design from conventional design practice be framed "in terms of one

of humanity's oldest collective instincts: mutual support, or altruism" (p. 3). Stairs positions his argument by referencing and critiquing several eminent protagonists with comparable ideologies.

The first protagonist cited by Stairs (2005) is Victor Margolin, who wrote *The Politics of the Artificial*, published by the University of Chicago in 2002. In it, Margolin calls for a systemic reform, remarking that "[d]esign must disengage itself from consumer culture...and participate in projects for the welfare of humankind both inside and outside the market economy" (p. 3). Having read the writings of anthropologists and sociologists such as Mary Douglas and Daniel Miller, Margolin calls for a "look at economic and social development from a global perspective, [to] address the gross inequities of consumption between people in the industrialized countries and those in the developing world" (p. 4). Stairs observes that Margolin is "at odds with mechanization," who proposes "spirituality as an anodyne [to mechanization]… [s]pirituality, in Margolin's metaphor, is another term for environmental justice" (p. 5). In his own defense, Stairs asserts that "while spirituality might enhance society's general well-being, so too could simple charity or, for the sake of my thesis, social altruism" (p. 5). In Stairs' opinion, despite Margolin's "creative solutions," he "stops short of providing a full-bodied prescription for the needed paradigm shift" (p. 3) and "takes a rather timid approach to addressing the problems at hand" (p. 4). Interestingly, Margolin himself critiques Kenji Ekuan's "Design for the World" concept in a similar fashion, that it is "not yet well enough defined to lead to viable strategies of practice" (p. 8).

Margolin's reaction to the "colonization of the natural" by mechanization is not a new phenomenon. Stairs points out that Ralph Waldo Emerson of the nineteenth century transcendentalist movement, and William Morris's Arts and Crafts movement, were also responses to the expanding industrialization of the world.

Another protagonist cited by Stairs (2005) is David Korten, economist and development theoretician, who in the 1990s, equates capitalism with cancer. In his proposals for democratic and economic reform, Korten "advocates what he calls 'people-centered development,' the effort to attain sustainable improvements in the quality of life for individuals and communities" (p. 6). Stairs observes that Korten's "rallying cry is especially pertinent for designers who, as often as not, act as handmaidens to the corporate bottom line" (p. 6). Unlike Margolin, who, according to Stairs, has not proposed any concrete prescriptions, Korten proposes the creation of "a global system that is biased toward the small, the local, the cooperative, the resource-conserving, and the long-term…In other words, think globally and design locally" (p. 7).

Other theoreticians cited by Stairs (2005) include Nigel Whiteley, who opposes consumer-led design and advocates socially-conscious design, philosopher James R. Ozinga and ecologist Garrett Hardin, both of whom suggest "the deep genetic underpinnings of altruistic behaviour…Ozinga even refers to altruism as 'natural law'" (pp. 7-8), and self-described utilitarian Peter Singer, who acknowledges that "the readiness to cooperate is a true universal among humans…and other long-lived intelligent social animals" (p. 8). Using these stances, Stairs strengthens his own argument of proposing altruism as not merely a principle but a design methodology, not merely an ideal but a physical condition.

In addition, Stairs (2005) draws attention to a few organizations that embrace design as a social responsibility; they are Design for Social Impact, Architecture for Humanity, the Society of Graphic Designers of Canada, ICOGRADA, AIGA, and Designers Without Borders. Stairs also manages to wrap up his discussion with a tone of optimism: "The late-twentieth century explosion in 'dot orgs' online, in almost inverse proportion to the collapse of 'dot coms,' suggests that the kinder, gentler *fin de siecle* angst of the '90s was not completely in vain" (p. 10), that "designers are rising to the occasion, developing socially active nonprofits at an unprecedented rate. This is good" (p. 12).

In “Design, the Future and the Human Spirit,” Margolin (2007) also investigates the role designers could play in shaping social change for a better future. While recognizing the unique potential and abilities designers have in impacting every aspect of the world of design, both material and immaterial, Margolin observes and laments that designers rarely become vocal where social policies and plans are concerned, failing to generate “profession-wide visions of how [the world’s] energies might be harnessed for social ends” (p. 4). Yet “[d]esigners, like everyone else on the planet, have good reason to be concerned about the future” (p. 4).

With a backdrop of increasingly imminent threats “from global warming, poor nutrition, disease, terrorism, and nuclear weapons” (p. 4), and like Stairs, Margolin (2007) also attempts to trace the efforts made by designers in the past, to redress the prevailing social and economic situations of their times, and to think about the future. For example, Tomás Maldonado, in *Design, Nature and Revolution: Toward a Critical Ecology*, uses a systems theory model, to suggest the capacity humans have in making “‘substantial – that is irreversible – disturbances in the equilibrium of other subsystems’”; designers, he states, are “complicit in this process” and must therefore play a substantial part in the process of social change (p. 5). William Morris in *News from Nowhere*, on the other hand, elicits a Utopian vision of the future; his critical response to the negative effects of the Industrial Revolution “was a recreation of the [medieval] past” (p. 6).

The examples of Maldonado and Morris may infer some difficulties to designers: firstly, autonomy, or what Margolin (2007) calls the “ability to set [an] agenda” (p. 4), is a “difficult state to achieve” (p. 5); secondly, it is difficult for designers to negotiate with the “harsh realities” of the present (p. 6). Maldonado raised the question of how the designer’s role could change, recognizing that “autonomous design action is difficult in any social system” (p. 5), and Morris, in his Utopian vision, retreated to a nostalgic, bygone setting, not having to negotiate with the harsh realities of the Industrial Revolution.

To help resolve these difficulties and to plan effectively in the present, Margolin (2007) suggests using two approaches of future studies, which "emerged after World War II as an attempt to apply sophisticated modeling techniques to the creation of future scenarios" (p. 5). After all, as Margolin argues, in order for a designer to "formulate a role as a change agent and determine a course of action, [one needs to] consider both the past and the present" (p. 5). These two approaches are (a) a *predictive* model, which tends to be pragmatic, recognizes that events are "too complex to control by fiat" and that there could be more than one future (p. 6); (b) a *prescriptive* model, which tends to be idealistic, embodies "strongly articulated visions of what should happen" (p. 6).

Although these scenarios range widely, Margolin (2007) summarizes that the predictive model is most used by geopolitical theorists to make forecasts on international relations. Examples include Francis Fukuyama's "Enlightenment-based optimism involving worldwide democracy" (p. 6), and Samuel P. Huntington's view of a "clash of civilizations" based on "culturally compatible nations," but whose opposing groups often have "difficulties in reconciling their differences" (p. 7). Margolin asserts that "[g]eopolitical theories and their implications for the future are also relevant to design" (p. 7), as design could be included in national strategic plans. The predictive model is also popular with studies involving technology, which could be "highly speculative" (p. 9). The prescriptive model, on the other hand, for example, is employed in the environmental movement, asserting that sustainability for the future should be a collective human responsibility.

According to Margolin, there are three factors that might potentially complicate the study of future scenarios: (a) technology, (b) ethics, which are sometimes correlated, and (c) rhetorical incompatibility. Firstly, despite the many streams of technology, ranging from robotics, genetic engineering, to nanotechnology, technological speculations could sometimes "ignore the complexities of the world, substituting instead reductive predictions that lack sociological,

psychological, or political credibility" (p. 10). Secondly, the endless scenarios made possible by technology could also raise serious ethical issues, such as implanting RFID chips in human beings, smart dust, and space tourism, which ignores the spirit of the 1967 and 1979 United Nations treaties, "which state explicitly that the resources of outer space are the heritage of all mankind" (p. 14). The accelerated pace and "democratic" implementation of these technologies could put designers in a difficult situation as employees in a capitalist society. As Margolin (2007) states, "[e]thics, like technology, has also entered a gray area where the moral implications of certain actions are unclear" (p. 14). Thirdly, the study of future scenarios could sometimes be rhetorically incompatible and tainted by research agenda and the context of sponsors. For example, the Hudson Institute, who sponsored Kahn and Wiener's study, one of the most comprehensive forecasting exercises in Margolin's opinion, works mostly for large corporations and governments.

Nonetheless, Margolin commends Jaime Lerner, mayor of Curatiba, in transforming the city into "a low-tech laboratory for sustainable urbanism" (p. 11) and the project, *Massive Change*, organized by the Institute Without Boundaries and Bruce Mau. *Massive Change*, which, according to Margolin, is prescriptive rather than predictive, presents a "liberal, global agenda," emphasizing the "most positive side of capitalism – its ability to innovate in a socially-responsible way– while identifying the multifarious actors in civil society…." (p. 11). Margolin compares Mau's project with the writings of Victor Papanek, Buckminster Fuller, Gui Bonsiepe, and Tomas Maldonado, in its attempt to turn a Utopian ambition of improving the welfare of humankind to a practical objective through design. As Margolin (2007) observes, "*Massive Change* is about action rather than policy, and is effective in providing an avenue of hope for designers who are concerned about the state of the world" (p. 11). At the same time, Margolin critiques the project as

> [failing] to confront the many ways that designers are implicated in producing a world that runs counter to the values the exhibition espouses, nor [suggesting] the kinds of political changes that must occur in order for designers to undertake the good work it advocates. (pp. 11-12)

In my opinion, Margolin (2007) in this article successfully conveys a sense of urgency in his call to designers for change in their attitude, collective vision, and commitment to take a more active, critical, and participatory role in shaping the future. This urgency is achieved by framing the discussion against a backdrop of "the rapid degradation of the environment" (p. 5), with global, social, and environmental threats, compounded by the accelerated pace of technological change. Margolin duly warns designers the difficult situation that they may already be in, of possibly being employed in organizations where ethics and values are questionable. Even though Margolin critiques designers such as Morris and Mau for not having made any concrete, practical suggestions for political change, he himself also falls short in doing so. Stairs, in "Altruism as Design Methodology" (2005) makes a similar remark about Margolin's approach as "timid and inconclusive" (p. 4). Nonetheless, I find Margolin's discussion poignant in picking up the subtleties in rhetorical incompatibilities (p. 10) amidst the social, political, and technological complexities of our world and the ethical issues therein.

Similarly, I totally agree with Stairs (2005) in his passion for design as an agent for social change, problem solving from a social perspective. Equally I admire his multidisciplinary investigation of design as a critical response to industrialization, consumerism, capitalism, and environmental and social detriment and injustice. I appreciate his recommendation of promoting altruism as design methodology, his attempts to reconcile design with philanthropy, and his call for other designers and design studios to do the same. However, as he himself realizes, it is not easy to change the system (p. 8); design altruism, may seem like a "'tempest in a teacup' when compared to the ocean of for-profit design" (p. 10). As Korten points out, "in a corporate

libertarian dominated system, altruism is not considered good business" (Stairs, p. 12). Stairs admits that his is not a competitive model, "dependent upon grants, donations, and lots of imagination," and may not seem possible outside academia (p. 10). Is it sufficient then that we have designers work overseas as volunteers and design studios voluntarily donate a percentage of their profit to charity? These are undoubtedly good, albeit small steps towards social change, but how effective are they in the long run amidst the bigger ocean of deeply entrenched, capitalist, global system? To this end, I do not believe that Stairs has proposed any concrete, strategic, systematic solutions. As Stairs himself critiques Margolin's approach as timid and inconclusive, so too are his own suggestions.

How then can this model thrive and succeed? I do not claim that I have all the answers, but I do believe that there needs be a better networked, more aggressive, systematic and strategic plan in place. As Stairs (2005) himself points out, Richard Dawkins states, "If there is a human moral to be drawn, it is that we must *teach* our children altruism, for we cannot expect it to be part of their biological nature" (p. 12). As a design educator, I believe that one of the most effective ways to impact the future is through design education, as a new generation of designers are trained, inspired, and empowered to use design as an agent for social change. Therefore, it is only reasonable that environmental and social justice, or what Stairs calls altruism as well as other worthy humanitarian and compassionate values, be integrated in the design curriculum as part of a transformative, design methodology. In my opinion, this calls for a revision of a fundamentals course in design thinking, one that has prioritized functional skills for the benefit of the design and corporate industries for decades, to one that emphasizes humanitarian and compassionate, ecologically and socially conscious values at the forefront of all design activities. The "One Laptop Per Child" project and Benny Ding Leong's artifacts in the "Things East West" exhibition are good examples of this type of values-based design approach. In fact, design does not need to be in isolation or opposition with corporations, as Stairs's model implies, it may be

exponentially more effective should there be collaboration and cooperation between designers and corporations, a sense of goodwill and commitment that is potentially more culture-changing in the long run.

In conclusion, these three scholars, Stairs, Leong, and Margolin, all acknowledge the fact that values, such as altruism and sharing, are significant and needed paradigm shifts from functional skills in the conception, implementation, and use of design. Stairs, Leong, and Margolin, in different rhetoric, are all envisioning and working towards a future in design that embraces such values.

In other words, if guiding values are to initiate and motivate all design activities, conditions and prerequisites that guide and shape the design process at the initial stage rather than as an afterthought, it would be reasonable to introduce a modified Design Thinking course with this concept. To that end, potential components could include:

- Case studies of designs that are guided by different values, encompassing elements of graphic design, material objects, businesses, services, architecture, and environments. Examples would show how different values are embodied in different designs and how they may have evolved over time, e.g. values of efficiency and convenience vs. values of philanthropy. Attention would also be given to broad, interdisciplinary projects that are shaped by specific guiding values, affecting the core values and philosophy of the operation/project, which in turn are manifested in the various aspects of design. An example would be the One Laptop Per Child project, whose humanitarian values shaped the context and audience (children in the third world), business model (matching donations), hardware (ability to withstand the elements), software and interface (basic, child-oriented), and aesthetics (fun, child-friendly) of the project.

- Role models of design visionaries whose designs are uniquely shaped by their values. Examples could include Buckminster Fuller, whose values of compassion, affordability, and efficiency inspired designs such as the 4D House and the Dymaxion Deployment Unit. Other examples may include Amory Lovins, Paolo Soleri, and Bruce Mau.
- Values-based design methods will be introduced, e.g. method of cultural integration or acculturation (Leong, 2003, p. 57).
- Students could also be encouraged to be introspective and reflective of their own values as well as to be aware of those of others, e.g. classmates, community groups.

Integrated Design Principles

In the previous chapter, I have attempted to synthesize the literature to extract themes and ideas shared across the disciplines. While acknowledging the disciplines from which the authors of the literature originate, their respective disciplines were also temporarily placed on the back burner, so to speak, in hopes of gaining a new perspective holistically. For example, some scholars share similar investigations in schools of psychology, forms of logic, or modes of thinking. Most share their conviction in the importance of innovation, creativity, and/or artistry. Equally, most share their attention to user considerations and product semantics. A few of them raise the issue of designing as systems, across disciplines. Most of them include some sort of a design process in their discussions. Some draw attention to environmental and safety issues and some point to the potential significance of being able to think about the future and express one's values and beliefs. One approach that could help address these shared themes and ideas, to help bond them within design thinking, in my opinion, is to apply a shared set of integrated design elements and principles.

For the years prior to the pilot teaching project conducted in the fall of 2009, I have been addressing design elements and principles in an isolated manner. For example, when teaching the module on visual and symbolic communication, I would present the design elements and principles associated with graphic design. When teaching the module on the design of material objects, I would present design elements and principles associated with engineering and industrial design. When teaching the module on the design of environments, I would present design elements and principles associated with environmental and interior design, though they share essentially the same design elements and principles as graphic design, with greater emphasis on the elements of light and space. When teaching the module on the design of services and activities, I would present principles in operations management. Although I have also encouraged students to cross-apply these elements and principles; for example, try applying the principles traditionally used in engineering to the realm of services and activities, this idea is only marginally introduced. With the development of my new thoughts and ideas in teaching design thinking, I have come to see the potential in consciously shifting the paradigm of looking at design elements and principles, that is, to develop a set of integrated principles that could be applied across the disciplines and that could be taught to students from all disciplines as recognized, current principles, intended to address the broad issues that we face today. In other words, regardless which program the students are in, be it graphic or interior design, engineering, architecture, or business, they could be taught at least a shared set of integrated design principles.

Hence, instead of introducing design elements and principles in the contexts of disparate and isolated disciplines, as they are currently practiced, I will attempt to present the design elements, principles, strategies, design paradigms, process, and tools in a more integrated manner that may be applied across the disciplines. For example, traditionally, some of the principles used in graphic design are balance, emphasis, hierarchy, unity with variety; some of the principles used in engineering are visibility, mapping, constraint, and feedback; some of the principles used in

business are deep user understanding, collaboration, visualization, and multiple prototyping. Now, I will attempt to synthesize these principles in categories that would encourage students to think holistically, across all disciplines.

Examples:

- *Principle of aesthetic*, which in turn includes principles such as visibility, legibility, order (within chaos), unity (with variety), balance, emphasis and hierarchy (also possibly introduced is what Zaccai calls a humanistic aesthetic, which encompasses the intellect, the soul, and all of the senses)
    - Importance of creativity, which transcends the mere realm of aesthetics
    - Importance of semiotics in communication and design
- *Principle of sustainability*, which in turn includes principles such as zero waste, zero toxin, zero carbon footprint, ecology, nature, collaboration, recyclability, maintainability, and longevity
- *Principle of functionality* (meaning that the design should work), which in turn includes principles such as mapping, feedback, constraint, bridging the gulfs of execution and evaluation, and multiple testing and prototyping
- *Principle of user signification*, which in turn includes principles such as empathy and deep user understanding, value, emotional bonding, and wholeness of the human psyche
- *Principle of progress*, which in turn includes principles such as innovation and abductive thinking – "Progress...in its cultural use, is not just movement forward, but movement toward something: a goal or endpoint" (Slack & Wise, 2005, p. 10)

In "Turning Design Thinking into Design Doing," Fraser (2006) examines how *design thinking* can be turned into design doing, from inspiration to implementation, from a business administrative perspective. According to Fraser, design, being one of the hottest topics in the business world today, is the new driver behind innovation and breakthrough ideas, a new competitive edge that precipitates breakthrough results and business successes in any field. Fraser introduces design thinking as something distinctly different from design – design being the physical manifestation of form and function in spatial terms, and design thinking being a set of problem-solving principles and practices through which opportunities are reframed strategically. Without necessarily establishing a rigid formula or a new set of rules, Fraser states that design thinking is more about an attitude or a mindset that designers have and that the average person finds inspiring, a mindset that in turn creates or defines the emotional and psychological conditions for success. This mindset entails three traits: (a) open-minded collaboration, (b) courage, and (c) conviction, requiring a shift in culture and behaviour to acknowledge new ideas, risk-taking, trust, integrity, and perseverance (pp. 25-26).

Fraser states that design thinking also differs from creativity, in that creativity is about the ability to create something new whereas design is about doing something new. In this respect, the methodology suggested by Fraser, comprises three main gears, in sequential order as well as levels of importance: (a) a deep user understanding, (b) multiple prototyping, and (c) strategic business design. A deep user understanding, vs. product usage or usability, is critical, as it taps into unlimited possibilities in a broader context of users' lives and activities, possibilities from which design solutions can blossom, solutions that may fill needs and opportunities that were never before realized or articulated. Multiple or iterative prototyping reflects a flexible and efficient design process through which multiple concepts can be realized and evaluated faster and earlier, without limiting the possibilities at an early stage. Lastly, strategic business design reflects *breakthrough thinking* vs. *incremental thinking*, which is traditionally adopted by well-

established companies based on their existing business model, with minimal investment risk and largely incremental results. Strategic business design, on the other hand, embraces risk-taking, is innovative, and reflects "'outside the dots' concepts – exploring many new and even seemingly crazy ways to deliver bigger, broader user value" (p. 26). Fraser substantiates this innovative business model by illustrating with the success stories of Adidas, Apple, Xerox, and Viagra, to name a few. Fraser then summarizes the key to successful design-doing in seven steps: (a) long-term commitment, (b) corporate/organizational strategy, (c) involving and inspiring everyone in the organization, (d) external and internal collaboration, (e) cultural shift toward fewer rules, deeper values, and stronger principles, (f) cultural development program and reward system, and (g) immediate implementation.

Fraser has succinctly described the core values, principles, and methodology of design thinking as taught at the Rotman School of Management. As such, her stance is geared towards educating and adjusting the business community to a new culture, that is, a designer's culture and the supposed mindset of the designer. While I appreciate the traits of the designer's mindset as depicted: open-minded collaboration, courage, and conviction, they could be complemented with a set of integrated design principles, to put the designs in the right place. As well, contrary to Fraser's view that design thinking differs from creativity, I believe that a large component of design thinking is *creative thinking*; open-mindedness, courage, and conviction themselves would not induce innovation without dynamic, systematic or intuitive creative thinking to begin with, supported by a strong set of integrated design principles. From an art or design educator's point of view, I believe that creative thinking is essentially what drives innovation, whereas Fraser, asserts that design-doing is what drives innovation.

In terms of methodology, I do agree with Fraser that a deep user understanding in broader contexts and activities is significant in suggesting possibly creative and innovative opportunities. This type of exploration and understanding considers the user's life in a holistic sense, a

philosophy and approach that I embrace and advocate in an interdisciplinary format. For example, engineering as a discipline has operated thus far in isolation, focusing on the physical and psychological aspects of design while leaving the emotional, spiritual, and cultural aspects untouched, and addressing the aesthetic or artistic aspect only as an afterthought, by graphic or industrial designers. I believe that this type of segregated design operation, without considering all the connections, the complex system and world in which design exists, needs to be remedied through a revised, universal, design thinking process.

Lastly, one important aspect that I believe is central to design thinking, that is not addressed in Fraser's article at all, is the motivation behind doing design. Perhaps the motivation has been implied, in that the reason for adopting design thinking as a competitive weapon in the business arena is to ultimately generate business success. My personal philosophy in teaching design thinking, on the other hand, is to encourage students to be visionaries, to foster innovative design thinking that is for the good of mankind, the betterment of the world at a personal, national, and global level. In other words, betterment at all three levels is a condition or prerequisite in design thinking, and values such as compassion, universality, accessibility, sustainability, and progress (without jeopardizing any one country) are at the forefront of design thinking, guiding all design efforts. Hopefully, this will be achievable as a collective and collaborative endeavour, involving all disciplines, including business.

Foresighting / Futures-Thinking

As seen in the previous chapter, scholars such as Lawson and Balaram have brought up the potential contributions in training students to profess their visions about the future. Jain et al. and Schwartz have suggested methods in monitoring future environmental impact and forecasting the future of the business environment respectively. To better include the component of foresighting or exploring how the future could be shaped in a Design Thinking curriculum, more

concrete methodologies or understanding in this area would be beneficial. To that end, a few additional scholars have enriched my appreciation in this respect.

In "Visioning Sustainability through Design," Dewberry and Sherwin (2002) present three case studies – two joint projects between Cranfield University and Electrolux Industrial Design and Philips Design, respectively, and SusHouse, to illustrate the changing characteristics of the techniques, strategies, and processes that can be used in realizing the future of innovative, sustainable development. The two main premises of the article are that (a) the initiatives and ideas of sustainable development, traditionally formed by corporate functions such as business and policy making, are now becoming more "design-led," that is, such ideas are embodied in the innovative concepts of design and are embraced by the design community, and that (b) the definition or ideal of sustainable development itself, is also changing. This changing ideal points to a future that will likely be positive, resulting in a significant reduction in energy and material throughput, a redistribution of wealth, and an adjustment of the global, governing system. A conduit through which these changes may occur is in the form of *foresighting* or forecasting techniques, which Dewberry and Sherwin discuss in the context of design thinking and design activities. Some statistics are provided in support of the authors' argument. For example, "decisions made at the design stage of the product's development influence up to 80% of its environmental impacts over its life cycle," and yet only 2% of all design activity is used in a strategic way towards sustainability (p. 127). As well, for each of the three case studies, conclusions or outcomes are presented consistently in a positive light, showing the benefits of the projects and the promising future of the recommended foresighting, design-based approach.

In another article, "A Design for Life: Futures Thinking in the Design Curriculum," Evans and Sommerville (2007) also examine what they call *futures thinking* as a powerful, systematic methodology that needs to be integrated in the design curriculum. The authors introduce the discussion with a preamble on the multifaceted nature of design, as an activity,

process, and outcome, comprising a range of practices in diverse disciplines, and with a breadth and scope that include design as problem solving, creativity, family of professions, industry, and planning. With an emphasis on design as a process, particularly in the context of product development design, the authors propose that futures thinking be utilized to "provide meaningful direction to future solutions" and to "develop long-term strategies that enable designers to not only be aware of, but also play a major participatory role in shaping change" (p. 5). Evans and Sommerville argue that even though considering the future is an intrinsic part of the design process, and that designers are constantly faced with the challenges of changing technologies, user expectations, and consumer wants and desires, the aspect of considering the future is still often overlooked by design education. This oversight, vis-à-vis the technological and economic shifts, needs to be recognized. Evans and Sommerville conclude with two case studies from the U.K., proposing that futures thinking be used as a framework for not only product design practice but also design education.

So what is foresighting or futures thinking? Dewberry and Sherwin (2002) link foresighting to some of "the key attributes of the design process: forward-looking, reflective, creative, process-oriented and diverse" (p. 126). To them, foresighting is an "active approach to the future and reflects the belief that the future can be created through the actions we take today" (p. 126). Foresighting is also one of the visionary, future-thinking design methodologies that "help organizations map, plan and prepare for the uncertainties of the future and, where possible, shape it towards desirable economic, social and environmental goals" (p. 126). According to Dewberry and Sherwin, foresighting in the context of design thinking requires a broader definition of design that shapes the human-made world and influences the future, as opposed to the traditional or more commonly understood definition of design, that entails the conception and styling of industrial products to stimulate economic activity. In other words, the focus is more on design as "a way of thinking, planning or viewing the world" (p. 127) as opposed to design as a

product or a profession. Thus, this broader definition of design calls for a number of paradigm shifts: from the design of a product to the design of the systems of delivery, or what Von Weizsäcker et al. calls "system innovation" (p. 127), from technological innovation to business innovation, from traditional, incremental innovation to "'step-change' responses" (p. 127), from the design of individual parts to the design of entire systems. These ideas are similar to that of metadesign brought up by Mitchell, Sakashita, and Castelli, and that of revolutionary, radical innovation brought up by Gregory, Lawson, and Martin. These ideas also resonate with what Fraser calls breakthrough thinking vs. incremental thinking, what Gregory calls radical designs, what Lawson calls revolutionary vs. evolutionary thinking, or making a divergent leap. Foresighting and breakthrough thinking thus appear to be complementary to each other. According to Dewberry and Sherwin, these paradigm shifts have already happened but are yet to be fully exploited.

On the other hand, Evans and Sommerville (2007) present futures thinking as a "systematic study of the future…a semi-structured approach to consider potential futures," and/or a "relatively new field of social inquiry [that] provides a framework of concepts and methodologies [to] allow a structured consideration of the future," so that "today's changes [can] become tomorrow's reality" (p. 8). Their reference to Philips' Vision of the Future project in 1995 acknowledges the impact of new technologies have on many aspects of life and society, as well as the opportunities for product development that may follow. To Evans and Sommerville, futures thinking could thus be a powerful tool to envision and tap into future opportunities, and to "interpret social, cultural, technological, and economic futures" (p. 12).

In terms of methodology, both Dewberry and Sherwin (2002) and Evans and Sommerville (2007) have made concrete suggestions in concepts and methods that could be used in forecasting or futures thinking. Dewberry and Sherwin suggest methods such as brainstorming, mapping, concept modeling, and scenario-building. Evans and Sommerville, on the other hand,

outline the key concepts of futures thinking, of relevance to design, as horizon scanning, trends, scenarios, forecasting, and backcasting (pp. 9-11). Evans and Sommerville acknowledge that these concepts are broad and that they are not necessarily readily implemented into design practice. However, they can facilitate knowledge acquisition and the understanding of "developmental patterns regarding a more significant extrapolation of a possible solution" (p. 13). To that end, Evans and Sommerville also recommend a list of futures thinking methods, namely (a) trend extrapolation, (b) analogy analysis, (c) predict next year's headlines, (d) impact analysis, (e) content analysis, (f) morphological analysis, and (g) nominal group analysis.

The approach recommended by Dewberry and Sherwin is a relatively unique one, in the sense that the majority of articles written on sustainability and design revolve around the use of green materials, e.g. (Jen, 2008) (Ferenc, 2008) (Stevens, 2008), whereas Dewberry and Sherwin advocate the broadening of the definition or perspectives of sustainability in the context of foresighting and design as the guiding concepts for sustainable development.

While the tone of Dewberry and Sherwin's article is less of a commercial nature, it is implied in Evans and Sommerville's (2007) that design, using futures thinking, is in the primary interest of businesses and manufacturers. In fact, the premise of their whole article is made in the context of consumerism. The following statements are examples of this implication: "With an ever-changing landscape of technology, user expectations, and consumer wants and desires, designers face a growing challenge to provide meaningful direction to future solutions" (p. 5); futures thinking should be used to "provide meaningful, timely and efficiently produced consumer insight, and inform design activity" (p. 8); "[d]esign may be considered the decision-making process that deals with manifestation of objects with consideration to economy and technical function and in answer to various consumer demands" (p. 7); product design is a professional service that "optimize[s] the function, value and appearance of products and systems for the mutual benefit of both user and manufacturer" (p. 7); "specifications through collection,

analysis and synthesis of data [are] guided by the special requirements of the client or manufacturer" (p.6); "Predict Next Year's Headlines: Headlines –[p]rojects a company into the future, identifying how they want to sustain and develop customer relationships" (p. 11). As the above statements in Evans and Sommerville's article imply, the primary interest of all design activities seems to lie in the mechanism of a consumer-oriented society.

My goal, on the other hand, of using futures thinking in design and teaching it, is to help foster a paradigm shift in design, including the design of products, systems, services, and/or environments, for the overall good of mankind. In other words, design could be used as a form of social or even global intervention. Even though Evans and Sommerville (2007) have described futures thinking as a "relatively new field of social inquiry" (p. 8), it is not evident that they have addressed the subject as such; rather, their proposition appears to be in the economic interest of corporations or manufacturers, the key drivers of a capitalist society. However, there is one aspect of Evans and Sommerville's article that I can relate to – they are advocates of incorporating futures thinking into the design curriculum, to "enable designers to not only be aware of, but also play a major participatory role in shaping change" (p. 5). Likewise, the foresighting methodology in the context of redefining sustainability proposed by Dewberry and Sherwin, is also one of the concrete ways to instill the value of social change through design education in partnership with the industry.

Nonetheless, the tone of Evans and Sommerville's article is reactive rather than proactive, implying that designers play a secondary role in shaping the future. For example, they state:

> Designers play a key role in providing the raw materials to assist decision-makers to explore alternative futures. Their task is to invent, discover and communicate ways to

advance the collective understanding of what to do next. Design education must recognize and react to this" (2007, p. 6).

In other words, what is implied is that, not only do/should designers assume a reactive role, so do/should design educators. On the contrary, I believe that designers and design educators could and should be encouraged to take a more proactive approach in shaping the future. They should not be reduced to positions of assistants in decision-making, but should be empowered to play a leadership role in initiating changes through their designs. Dewberry and Sherwin (2002) make reference to redefining sustainability as "design-led" initiatives (p. 37). In "Turning Design Thinking into Design Doing," Fraser (2006) also acknowledges this shift in roles.

> **Assign a leader, but don't limit it to a function.** Innovation through 'design doing' involves everyone. It is not just the 'design department' or the 'innovation team' or the 'marketing function' – it should inspire and impact every corner of the organization. (p. 28)

In fact, Fraser goes further to include everyone, not just the design department, to be proactive in being innovative, through design. Despite the merits of proposing a structured, systematic approach in teaching futures thinking in design, this empowering, democratic spirit is perhaps one that is lacking in Evans and Sommerville's article.

On the other hand, the views expressed by Dewberry and Sherwin are precisely the ones that I share, in particular the belief that design or design thinking is a powerful, yet unexploited tool to shape the future. The difference in our stances is that the Dewberry and Sherwin focus primarily on sustainability, be it in terms of energy, resources, human behaviour or community-building, and my focus is on using design or design thinking in innovative ways for the overall good of mankind, to promote technological, artistic, cultural, spiritual, social, economic, and/or

ethical progress, and to be used for humanitarian purposes. Foresighting is indeed one of the methodologies that can be used to shape this future, albeit idealistic future, through design.

As an advocate of futures thinking, I totally agree with both Dewberry and Sherwin's and Evans and Sommerville's proposal that futures thinking be integrated into the design curriculum. Like Evans and Sommerville (2007), I also advocate that long-term strategies be developed to "enable designers to not only be aware of, but also play a major participatory role in shaping change" (p. 5). Despite their commercial orientation, I believe that Evans and Sommerville have made some solid contributions by describing some key concepts of futures thinking as well as by proposing a number of concrete techniques or methods that could be readily integrated in a design curriculum, more so than any other scholars that I have come across thus far. I believe that concrete techniques or methods are indispensible in the pedagogy of a design curriculum. For example, Evans and Sommerville mention that these methods "can augment design practice, rather than be in addition to it" (p. 11). This statement implies that futures thinking should be an integral part of design thinking, an approach that designers should take at all times, not as an alternative. I particularly appreciate this sentiment as I share a similar one, in that I believe that design thinking should consider the future first, a future that embraces collective values that a society shares, hopefully in bestowing benefits to mankind at the personal, national, and global levels. To that end, design, by method of futures thinking, can help shape this future.

Lastly, Dewberry and Sherwin (2002) point out that "transformative learning, (required for a paradigm shift towards sustainability) is more liable to be achieved when a problem is viewed from many perspectives involving unique combinations of knowledge and skills" (p. 127) and that foresighting "help[s] organizations map, plan and prepare for the uncertainties of the future and, where possible, shape it towards desirable economic, social and environmental goals" (p. 126). These views are in accordance with what Miller and Seller (1990) call the transformation position in education. In this mode of learning, students are taught skills that

"promote personal and social transformation," and that "schools must be on the cutting edge of social and political change" (p. 8). This sentiment perhaps sums up the spirit and essence of Dewberry and Sherwin's article.

As mentioned earlier in this chapter, Margolin (2007) has also brought up two approaches of future studies. His differentiation between the predictive and prescriptive models is enlightening. Even without a detailed description of techniques involved, I find such a differentiation quite adequate in introducing the designer or researcher to the concepts of future studies or futures thinking. None of the other scholars that I have encountered thus far, including Stairs (2005), Dewberry and Sherwin (2002), and Evans and Sommerville (2007), has made such a clarification of these key, basic concepts.

In conclusion, I would like to accord with one particular statement that Margolin (2007) makes, that is, "there is little in the typical design curriculum that prepares students to imagine such [future] scenarios" (p. 10). As a design educator, I believe that one of the most powerful means of effecting change is to sow the seeds of education, to inform, inspire, and empower students to take critical, transformative, actions today, so that a better future would be brought to fruition. I believe that Margolin, as well as Dewberry and Sherwin, Evans and Sommerville, have adequately and appropriately informed and inspired me in the context of futures thinking, as well as impressed me with the sense of urgency, to effect changes in any design curriculum that I will have the privilege of planning and implementing in the near future.

Essentially, foresighting or futures thinking calls for a visionary attitude, which I believe should be an indispensable component of design thinking. I propose that, once students are familiar with the concept of values-based design and integrated design elements, principles, and strategies, foresighting may be introduced:

- Concepts, including horizon scanning, trends, scenarios, forecasting, and

backcasting (Evans & Sommerville, 2007, pp. 10-11)

- Methods, including trend extrapolation, analogy analysis, predict next year's headlines, impact analysis, content analysis, morphological analysis, and nominal group analysis (Evans & Sommerville, 2007, pp. 11-12)
- Approaches, including predictive and prescriptive (Margolin, 2007, p. 5)

Foresighting or futures thinking is invaluable especially when it is used to enhance the concept of problem-finding or problem-identifying, a much more proactive and preventive approach that utilizes breakthrough thinking, than problem-solving, which, albeit important, focuses on damage control and utilizes incremental thinking.

Integrated Design Process

At this stage, I will propose an *integrated design process* that starts with foresighting and values, focuses on integrated design elements, principles, and strategies, and asks the following questions:

1. What values are to be promoted?
2. How can these values be promoted through designs?
3. What is the thing that needs designing or redesigning?
4. What impact does this thing (or the lack thereof) have on our world presently?
5. What would the world be like with (or without) this thing in 50 years?
6. What options are there in designing or redesigning this thing?
7. How can the *integrated design elements, principles, and strategies* be applied in the design or redesign of this thing?
8. How effective does this design function as a collaborative system in the visible and invisible realms?

9. What are the prototypes?
10. How will this design be tested to ensure that the integrated design principles are met?
11. How will this design be delivered?
12. What post-delivery services will there be and what post-delivery actions will be taken?
13. How will this design be evaluated in the long-term, especially in leaving minimum waste, toxins and carbon footprint?

There are different design processes that are being followed by individual designers, such as a linear, lateral, pip, or circular process (Rushton, interview, May 11, 2007). There are also a number of different phase models that have been proposed and/or used, as discussed in the previous chapter. However, there is one design process that is commonly used in the industry, and that is a linear process, corresponding to the project's critical path or timeline. The stages in this process may have minor variations and may be called by different names, but they are essentially the same stages in this sequence: 1) problem, 2) research, 3) initial concepts, 4) refined concept, 5) prototype, 6) delivery, and 7) evaluation. This linear process has been used and taught for decades and it is time that it be modified to more consistently and urgently address the evolution and needs of design and those of the world today. Hopefully, such a revised process would provoke introspection and a sense of collective responsibility, while shifting the paradigm of how different sectors of the society, profit and non-profit, could partner together to create a better world.

Another way to look at the revised process suggested above is to apply some of the concepts found in the cultural studies approach to technology, as presented by Slack and Wise.

Firstly, when discussing the polysemic nature of technology, Slack and Wise (2005) point out that it is amazing "how little agreement there is about what is at stake, that is, about what really matters" in conversations involving technology. Examples include Kevorkian's suicide machine, SUVs, and other things at the most mundane level. It seems as if when these products are designed, attention is only paid to the object itself, that is, how it works (responsibility of the engineer) or how it looks (responsibility of the industrial designer); but the question of "what is at stake," "what really matters" is not an issue or part of the design process. In other words, it demonstrates the concept of *simple causality*: "*effects are inherent in the technology and that precise effects are inevitable*" (p. 105). I would propose that the question "what is at stake?" be asked at the initial stage of the design process. This shift in focus is represented by the first five questions in my proposed, modified design process:

1. What values are to be promoted?
2. How can these values be promoted through designs?
3. What is the thing that needs designing or redesigning?
4. What impact does this thing (or the lack thereof) have on our world presently?
5. What would the world be like with (or without) this thing in 50 years?

Secondly, the concept of *symptomatic causality* could be applied to the "initial concepts" or the brainstorming of initial concepts stage. From a symptomatic perspective, it is assumed that "*a range of effects* is inherent in the technology" (Slack & Wise, 2005, p. 106). For example, when designing the computer, the range of effects should have been considered in foresight, "we might develop educational programs for retraining people to work with computers in new jobs or to take up new kinds of non-computer-related jobs" (p. 107). Such considerations are not currently part of the design process used in the industry, which focuses only on the object itself. For example, in the Honda's "Problem Playground" ad

(http://www.guardian.co.uk/media/video/2008/feb/01/honda.rubiks.cube), the initial concepts or brainstorming stage is acted out, where Honda's engineers and designers get together to come up with different ideas for a hybrid car. It is true that the question of "what is at stake?" has been asked, and therefore a hybrid car needs to be designed, but how about the other options, e.g. rearticulating, reconfiguring, or redefining the concept of public transport. The consideration of this range of other effects, which is outside of the jurisdiction of engineering and industrial design, but in the realms of economics, politics, or education, is not integrated and therefore implemented in the current design process. I would propose that the range of effects and options in partnering with other sectors of the society, that is, a cultural studies approach, be considered earlier on in the proposed, modified design process:

6. What options are there in designing or redesigning this thing?
7. How can the *integrated design elements, principles, and strategies* be applied in the design or redesign of this thing?
8. How effective does this design function as a collaborative system in the visible and invisible realms?

Thirdly, currently, there is usually only one selected concept to be implemented in the "refined concept" stage, which is the final product itself. I would propose that there be possibly more than one "thing" in the final selected concept, that is, other "things," services, or programs in the package, so to speak, in partnering with other sectors of the society as needed. This package may also include steps taken in the post-delivery stage, where more responsibilities are taken collectively as a society to address long-term scenarios:

9. What are the prototypes?
10. How will this design be tested to ensure that the integrated design principles are met?

11. How will this design be delivered?
12. What post-delivery services will there be and what post-delivery actions will be taken?
13. How will this design be evaluated in the long-term, especially in leaving minimum waste, toxins and carbon footprint?

These are some of the thoughts that I have thus far in changing our current, yet dated, design process, and hopefully in the long run, it will also change our culture and our world.

Complex Visible and Invisible Systems

Findeli (2001), in his essay, "Rethinking Design Education for the 21st Century: Theoretical, Methodological, and Ethical discussion" brings up a few points that, I believe, are worth integrating into a revised Design Thinking curriculum. Of prime importance to Findeli are three recommendations: (a) that the "intelligence" of the invisible, human or social, complex system/s of design be taught (p. 12); (b) that the ethical aspect of design be addressed (p. 14); and (c) that the concept of the vanishing product be advocated, by emphasizing the importance of sustainability, the design of the invisible world, comprising of services (vs. products), and design as acting (such as acts of altruism), rather than making. Findeli's recommendations are exactly in sync with the train of thought that has been developing in my reflection. These new ways of looking at design education could definitely be incorporated in a revised Design Thinking curriculum.

Essentially, the gist of the shift is that, instead of designing isolated, single objects, we could consider designing entire systems, both in the visible and invisible realm, considering not just the immediate but also a more distant future. This concept is similar to that of metadesign brought up by Mitchell, as presented in the previous chapter. It is intentionally and consciously

addressed in the proposed, modified design process stated above in the previous section; to be considered quite early on in the process during brainstorming as well as in the selected, refined prototype/s.

These systems may encompass and cross broad areas of design in the *visible realm*, such as:

- Graphic design and aesthetics
- Engineering and industrial design
- Interior and exterior environments

And the *invisible realm*, such as:

- Business and services (from private and public sectors)
- Design as actions
- Culture

Referencing complexity theories, Findeli (2001) proposes a paradigm shift from "applied science," inherited from the tradition of applied science from the Bauhaus/New Bauhaus/HfG lineage, to "involved," "situated," or "embedded" science (p. 10). Such a proposal is based on the assumption that the design model based on both applied art and applied science is outdated (p. 9), and that systems and complexity theories are more relevant and capable of radically transforming this outdated, mechanistic model to service the future. Findeli's suggestion is to "open up the scope of inquiry…and push back the boundaries of our system in order to include other important aspects of the world in which design is practiced" (p. 11). Such a new model of involved science transforms the "outdated" model, which is based on

a) objectivity, tangibility, materiality, visibility, and rationality,
b) a theory/practice relationship,
c) a logical, linear, problem-solving design process with a final solution,

d) a methodological realm based on cognitive science, and

e) the user's outer world,

to one that encourages

a) subjectivity, intangibility, invisibility, and dynamics,

b) a non-theory/practice relationship,

c) a dynamic, complex, morphological, problem-setting design process with transitory and evolving solutions,

d) an epistemological realm ranging between anthropology and cosmology, and

e) the user's, designer's, and/or client's inner and outer world, values, and learning dimensions.

In this new model, Findeli (2001) states that "designers should be interested – in the origin and destination of their projects, and…the complexification of the **impact** of the project" (p. 12). In other words, such a model calls for significantly more proactive, involved, concerned initiatives from the designer, thinking and acting originally in a dynamic, visible and invisible, transdisciplinary sphere. Findeli provides a fair idea of what a "meta-project" in design entails when he asks the question: "To which meta-project (anthropological, social, cosmological, etc.) does a design project and a design curriculum contribute?" (p. 8). Without answering the question, Findeli implies that a meta-project in design can fall under any broad discipline of study or philosophical perspective, such as anthropological, social, or cosmological.

In response to the question: "How will this intelligence of the invisible be taught?" (2001, p. 12), Findeli suggests that "[b]asic design, if properly reconsidered, will be the best pedagogical tool for teaching such an approach…aesthetic education will be the best way…." (p. 12). His remark: "the appreciation of the relative stability of a system, and of the instability induced by the action of a designer within a system also are the concern of aesthetics" (p. 12), is inadequate as an

explanation of "aesthetic education." His subsequent statement: "a logic based on aesthetics" (p. 16) equally demands a more precise definition. I find that Findeli has introduced a potentially powerful argument, in the role of aesthetic education, but at the same time, a broad area that is somewhat vague. I could only gather that, when design principles such as unity and balance are taught, one can assume that students would have a better feel of whether the system is dynamic yet stable enough. Nonetheless, if Findeli could offer a much clearer and detailed description of what basic design education and aesthetic education entail, it would be helpful, especially if this is supposed to be the basis of his recommendation of an alternative, theoretical model of design education.

Likewise, if design intelligence is to be cultivated in a design curriculum, one needs to know what it entails in order for it to be taught. Following Findeli's thesis, one may gather that design intelligence embodies a proactive attitude that considers the ethical realm, to propose "'new scenarios for the future'" (2001, p. 17), in a world of complex systems. This differs slightly from "visual intelligence," which, traditionally when referencing perception and action, means "the psychology of visual perception" (p. 10). Interestingly, "visual intelligence" can also be invisible, as Findeli claims that "the kind of visual intelligence needed in such a case [invisible relationships] is of a different quality" (p. 11). I find this a very interesting, albeit intriguing concept, as it would be quite challenging to teach.

In the previous section, the cultural studies approach adopted by Slack and Wise (2005) is referenced in the modification of my proposed design process. Similarly, the idea of designing as systems, holistically in the visible and invisible realms, could also be viewed or situated in this framework. For example, when explaining the *nonmechanistic* perspective of *articulation* and *assemblage*, Slack and Wise provide this summation: "Articulation draws attention to the contingent relations among practices, representations, and experiences that make up the world. Assemblage draws attention to the structured and affective nature and work of these articulations"

(p. 126). Therefore, articulation and assemblage could be understood as complex systems made up of visible and invisible relationships or networks of components. Slack and Wise further explain that articulations and assemblages exist in a culture that consists of "corresponding, noncorresponding, and even contradictory practices, representations, experiences, and affects" (p. 127). Such is the world and culture in which we live. To be a contemporary designer, one must be able to understand, define, visualize, dream, and hone such practices, representations, experiences, effects, and relationships thereof, to tenaciously express and promote the values that are of importance, individually and/or collectively.

As an example, I will use the PC vs. Mac technologies to illustrate the concept of articulation and assemblage.

Slack and Wise (2005) state that "*Articulation can be understood as the contingent connection of different elements that, when connected in a particular way, form a specific unity*." Elements in this context are not necessarily things. They can be "made up of words, concepts, institutions, practices, and affects, as well as material things" (p. 127). In other words, the PC technology and the Mac technology respectively embodies its own elements, connected in its own particular way, to form its own specific unity, and may I add, its own specific identity and sub-culture. These elements, or *forms of content* and *forms of expression* (p. 130), may include: its own operating system, interface, hardware, look and feel, type of users or fans, corporate culture and practices, vision and philosophy, and advertising (http://www.apple.com/getamac/ads/).

As intentionally portrayed in the "Get a Mac" ads, the PC technology is associated with a cumbersome look and feel, obtuse and intrusive interface, virus-prone environment, and "nerdy" users. The Mac technology, on the other hand, is portrayed as more intuitive, more sleek, more "cool," more innovative, and used by a more design-savvy crowd. For this reason, the PC may sometimes be perceived as being designed by engineers and the Mac, designers. Corresponding

representations, experiences, and affects are found in corresponding services, stores, and peripheral devices, such as the iPod, the iPod Touch, and the iPhone.

As Slack and Wise (2005) point out, "a cultural studies approach draws attention to the movement and the flows of relationships" (p. 127). In the example of PCs vs. Macs, the movement and the flows occur in the relationship between the functionality and the look and feel of the product, the ads, the users, the changing preferences and trends of the market, and the corporate culture and practices that got the product to where it is in the first place. May I add the speculation that, if the movement and flows of relationships are slowed down or stagnated, or worse, redundant, it could potentially create a dire business situation, where the advantageous edge would be lost to the more fluid competitor.

The movement and flows of this kind of relationship is not only of interest to cultural theorists, they are also of interest to Microsoft's chief researcher, Bill Buxton. As Qixing Zheng, Microsoft UX advisor (position formerly called Microsoft UX evangelist) discloses, there has been a cultural shift within Microsoft, where there is now a greater emphasis on designers and the seamless collaboration between engineers and designers. Studies conducted by Microsoft reveal that the public's perception of the Microsoft Office Suite is associated with such words as "hard to use, unintuitive, confusing, ugly, and designed by engineers" (Zheng, 2008, p. 11). Such findings have therefore resulted in a mandate of "culture shift," including the hiring of more designers (as opposed to engineers and developers), and the development of products, such as Microsoft Expression Suite, a new workflow model integrating the work of the engineer and designer, and the creation of the position of Microsoft UX evangelist.

Today, Microsoft has the assumption that the design future lies in academia (Zheng, 2008, p. 33). To this end, Zheng is busily on the road "evangelizing" to the design community, most importantly, design schools, such as Sheridan, and their faculty and students in the design

disciplines. Efforts and strategies to harness the acceptance, or hopefully commitments of, and the partnership with this community include the creation of the Designer Academic Alliance Membership, and Imagine Cup, which is an annual global student technology competition, with categories including Short Film, Photography, and Interface Design.

The recent phenomenon transpiring at Microsoft is an example of technology as assemblage, where "the ways that these practices, representations, experiences, and affects articulate to take a particular dynamic form" (Slack & Wise, 2005, p. 129).

Further, as philosophers Gilles Deleuze and Felix Guattari describe in their book *A Thousand Plateaus*, assemblages do not remain static; they are constantly undergoing some form of transformation. If compared to constellations, they go through *territorialization*, *reterritorialization*, and *deterritorialization*. "Once drawn into this form, the constellation exhibits some tenacity... a particular constellation of articulations that selects, draws together, stakes out and envelops a territory that exhibits some tenacity and effectivity" (Slack & Wise, 2005, p. 129). Surely, the constellations which are the PC and Mac technologies are tenaciously territorializing and reterritorializing, because "the pleasure of the 'cool', [is] not likely to go away any time soon" (p. 128).

CHAPTER 4: LEARNING FROM COLLEAGUES

HOW IS DESIGN THINKING TAUGHT CURRENTLY?

This chapter surveys five courses offered in a number of different post-secondary curricula found in the Greater Toronto Area, that are either entitled "Design Thinking" or have titles or course content similar to it. Professors of these courses were interviewed, in an attempt to investigate how different educators define design thinking, what such a course entails, and how it is taught, such as in terms of class structure and assignments. In so doing, perhaps some general themes and/or a cumulative list of components could be found, some questions asked and other observations made, to help take this subject to the next level. The five courses surveyed are "Design Process" offered by the Faculty of Design at the Ontario College of Art and Design, "Engineering Strategies and Practice" offered by the Faculty of Applied Science and Engineering at the University of Toronto, "Design Practicum: The New Product and Services Lab" offered by the MBA program at the Rotman School of Management at the University of Toronto, "Design Thinking" offered by the joint Bachelor of Design program between Sheridan College and York University, and "Design Thinking" offered by the joint program of Communication, Culture and Information Technology between Sheridan College and the University of Toronto Mississauga.

Ontario College of Art and Design – "Design Process" (Undergraduate, First-Year)

Of the five programs surveyed, the Ontario College of Art and Design (OCAD) is the only one that does not teach design thinking per se. In fact, Professor Keith Rushton (interview, May 11, 2007) does not believe that design thinking can be taught. Instead, he believes that design processes can be formalized and taught. Rushton states that good design thinking is sequential thinking and is full of breadth and depth; that design is so complex that one must speak to its processes. Hence, in the course "Design Process," various design processes are explored. They are (a) linear process – working methodologically from problem to solution, (b) stepping up

or down process – moving forward and backward alternatively from problem to solution, (c) lateral process – moving sideways considering different approaches, (d) pip process – having to clear an obstacle before being able to move forward, and (e) circular process – going around in circles while moving forward. These processes are in turn explored under the premises of (a) problem concept, (b) task concept, and (c) self-directed concept, with the understanding that not all design processes are related to problem solving. The design process undertaken can be design-oriented or client-oriented, with the process revolving around the relationship between the design, the client, and the product.

"Design Process" is a first-year hybrid course, in which 300 students from all design disciplines, such as graphic design or industrial design, in sections of no more than 28 students each, are enrolled. Due to the multi-disciplinary background of the student body, the curriculum is equally appropriate to two-dimensional, three-dimensional, and four-dimensional, that is, time-based disciplines. While the course is not studio-based, it does involve the creative aspect of front-end design. For example, students are not required to do finished designs but would do assignments such as essays. Topics could range from analyses of product features, statistical patterning of spaces, to sustainable designs. The main goal of this course is to prepare students for more advanced critical thinking in Second Year.

One particular concept emphasized in the course is that of educating the "visually illiterate." As Rushton points out, the job of the designer, the "visually literate," is to reach out to the consumer, the "visually illiterate." The investigative and experimental nature of the task of designing is therefore to explore what the threshold level is before the consumer rejects what the designer does.

Finally, Rushton points out that there is one challenge in teaching this course, that it is impossible to define a single, universal methodology that could effectively reach all types of learners. With the multiplicity of learning styles, even within the same student, any universality attempted might be rendered ineffective.

University of Toronto – "Engineering Strategies and Practice" (Undergraduate, First-Year)

The second course surveyed is "Engineering Strategies and Practice" offered by the Faculty of Applied Science and Engineering at the University of Toronto. Even though the title of the course does not really suggest design thinking, Professor Susan McCahan (interview, April 27, 2007) states that design thinking is a major component of the course. In her opinion, design thinking is a term that is referred to in engineering as design methodology, which has been formally taught in mechanical engineering for about 20 years and implicitly taught in other engineering disciplines. In fact, design thinking in engineering, as a subject of research, appears quite frequently in literature, especially in human factors engineering (e.g., Lewis, 1999; Luescher & Kutz, 2005; Nagai & Noguchi, 2003; Papantonopoulos, 2004). Some of the earliest published books on design thinking are also from this discipline (e.g. The Institution of Chemical Engineers, Midlands Branch, 1980; Cross, Dorst, & Roozenburg, 1992).

According to McCahan, engineering is about the design of interfaces for physical and psychological use, in other words, human factors design. Engineering uses natural science in designing systems for people in the environment, encompassing an immensely wide range of projects, such as buildings, manufacturing systems with tools and processes to produce products, food products, cosmetics, shapes of caplets, water systems, ATM machines, and financial products such as derivatives. To better understand what design thinking does and does not entail in engineering, one must understand what engineering does and does not do. Fundamentally, engineering does not design the look and feel of a product; industrial design does. It does not

design graphics; graphic design does. Similarly, it does not do fashion design but do textile manufacturing in the realm of chemical engineering. In short, engineering is concerned about the functionality but not the aesthetic part of a design; functionality being successful only if a design works for the user. In other words, engineering as a discipline by nature excludes the consideration of aesthetics, look and feel, and graphics, although engineers do need to work with designers as a team. Although engineers are not concerned about aesthetics, there is a creative aspect, which distinguishes engineers from technicians.

"Engineering Strategies and Practice" is a first-year course, with 800 engineering students enrolled from all engineering disciplines, such as mechanical, chemical, and electrical engineering. Currently, the course is only offered to engineering students, but McCahan states that in future, it will be opened up to arts and sciences students as well. Classes are structured with a weekly lecture component and a tutorial component offered in 30 sections. Assignments and tutorial activities are organized around a large inquiry-based design project with a real client and marked by a professional project manager. Students work on this project throughout the term in groups of five; each group working on a different project totaling 160 individual projects for the whole class. The three primary thrusts of this course are exploring design methods, building team skills, and promoting effective use of written, oral, and graphic communication required in the engineering profession. In other words, students are expected to make credible statements supported with evidence. Realistic industry standards and practices create a natural backdrop for this course.

After examining the course material particularly the textbook by Dieter, the most remarkable attribute that stands out in this course is the extremely thorough, organized, and systematic approach in which design methodology is explored. To start with, a formal product design process is introduced, a process updated and modified from the one Morris Asimow called the morphology of design in 1962 (Dieter, 2004, p. 15). This product design process is divided

into three phases: (1) the conceptual design phase, with the activities of (a) problem definition, (b) information gathering, (c) concept generation, and (d) evaluation of concepts; (2) the embodiment design phase, with the tasks of (a) product architecture, (b) configuration design of parts and components, and (c) parametric design of parts and components; and lastly (3) the detail design phase (Dieter, 2004, pp. 15-17). It is along this design process that design thinking arises and takes shape.

As outlined above, each phase of the product design process entails some specific activities or tasks that are commonly practiced in the engineering industry today. Throughout the exploration of these phases, students are exposed to an impressively thorough array of methods to assist them in going through the design thinking process in order to accomplish the tasks. For example, in the conceptual design phase, a myriad of problem-solving tools are available to facilitate problem definition, cause finding, and solution planning and implementation. These tools mostly make use of analytical and logical diagrams, but may include other techniques and methods, such as interviews, focus groups, surveys, check sheet, brainstorming or brainwriting (each person writes four ideas on a piece of paper) (Dieter, 2004, p. 93). Where applicable, principles and/or generalized questions are set forth to guide the process. For example, there are four fundamental principles for brainstorming: (a) criticism is not allowed; (b) ideas brought forth should be picked up by the other people present; (c) participants should divulge all ideas entering their minds without any constraints; and (d) a key objective is to provide as many ideas as possible within a relatively short time. Generalized questions may also be asked to maximize the flow of ideas during brainstorming. For example, by following the SCAMPER checklist, one can focus on how a product can be changed by methods of substitution (S), combination (C), adaptation (A), modification/magnification/minification (M), putting to other uses (P), elimination (E), and rearrangement (R) of features and/or functions of the product in question (Dieter, 2004, pp. 94, 159).

This thorough and systematic approach is not only applied to the analytical aspect of design thinking but equally and consistently applied to creativity as well. Dieter (2004) covers a wide range of creativity methods to be used for concept generation and evaluation. Some examples include the four stages of the creative problem-solving process (preparation, incubation, inspiration, and verification), the four factors that improve a person's creativity (sensitivity, fluency, flexibility, and originality), an awareness of different types of mental blocks (perceptual, emotional, cultural, environmental, or intellectual blocks), applying different types of analogies (direct, personal, symbolic, and fantasy), force-fitting methods (e.g. asking "what if…"), and mind maps and concept maps (pp. 157-172).

In the latter part of the product design process culminating to the fruition of the final assignment, students have to complete the written Concept Design Specification, which they work on as a group. Documentation of the proposed design may include drawings, a bill of materials (a parts list), and cost evaluation tables justifying any economic decisions made. Such documentation is an integral part of the final phases of the product design and design thinking process. Other considerations emphasized in this course that may be characteristic of the engineering discipline include designing to codes and standards, technological innovation, product and process cycles, societal and environmental impacts, and designing for robustness.

Rotman School of Management, University of Toronto – "Design Practicum: The New Product and Services Lab" (Postgraduate, Second-Year)

The third course surveyed is "Design Practicum: The New Product and Services Lab" offered by the MBA program at the Rotman School of Management at the University of Toronto. This course is currently offered under the name "Design Practicum: Business Innovation Lab." It is a second-year Marketing elective for MBA students (The Rotman School of Management, 2006, ¶1). Similar to "Engineering Strategies and Practice," the course is organized around a

large design project overseen by real organizations, with nine students working in two collaborative teams on two separate projects. The program is spearheaded by designworks™, a centre at Rotman School of Management, to focus on design-based innovation and education to train business students to think and become more like designers. As Roger Martin, dean of the Rotman School of Management states, "'Businesspeople don't just need to understand designers better – they need to become designers.'" (Breen, 2005, p. 69). To that end, students in this course are paired with graduate students of Industrial Design from the Ontario College of Art and Design (OCAD) as they go through this project-based course together.

While "Design Process" at OCAD teaches multiple processes and "Engineering Strategies and Practice" advocates a singular industry-practiced design process, the Rotman School of Management advocates a somewhat more flexible design process. On the one hand, there is a design process followed, in the stages of (1) contextualization and knowledge, (2) orientation and insight, (3) ideation, (4) prototyping, (5) business design, (6) making a case, and (7) refine and report (H. Fraser, interview, April 30, 2007). On the other hand, there is also a conscious awareness that it is more important to focus "on a few core components rather than a litany of rules, process maps and formulas" (Fraser, 2006, p. 25). Students are therefore encouraged to experiment and modify their ideas using "multiple prototyping in the concept development process with user feedback and reconfiguration" along the way (Fraser, 2006, p. 25).

So what is design thinking according to business educators? As Martin (2009) states:

> Design thinking, as a concept, has been slowly evolving and coalescing over the past decade. One popular definition is that design thinking means thinking as a designer would, which is about as circular as a definition can be. More concretely, Tim Brown of IDEO has written that design thinking is "a discipline that uses the designer's sensibility

> and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity." A person or organization instilled with that discipline is constantly seeking a fruitful balance between reliability and validity, between art and science, between intuition and analytics, and between exploration and exploitation. The design-thinking organization applies the designer's most crucial tool to the problems of business. That tool is abductive reasoning. (p. 62)

Abductive reasoning differs from the two scientific modes of reasoning that businesspeople traditionally use: deductive reasoning and inductive reasoning. Both types of reasoning enable the thinker to answer if a statement is true or false at the end of the reasoning process. However, abductive reasoning entails logical, experiential leaps of the mind that cannot be proven. Another way to describe or define this type of thinking may be what David Kelley, the chairman of IDEO and founder of Stanford's d.school, calls T-shaped thinking, "'that means combining analytical thinking–the vertical leg of the T–with horizontal thinking: intuitive, experimental, and empathetic'" (Breen, 2005, p. 69).

As Professor Heather Fraser, director of designworks™ and the Business Design Initiative at Rotman, explains, the mindsets that are nurtured in this program are open-minded collaboration, courage, and conviction. The three gears of design emphasized in the course are deep user understanding, multiple prototyping, and strategic business design (H. Fraser, interview, April 30, 2007). Perhaps the most notable signs of passion found in the aforesaid beliefs are a sense of relentlessness or perseverance, a sense of fluidity or flexibility, and a particularly deep sense of user understanding during the process of conceptualization and prototyping. Generating ideas from deep user understanding, applying abductive thinking to those ideas while experimenting, multiple prototyping, and constantly modifying may be the way to achieve innovative breakthroughs. To that end, ethnographic tools and methods, as well as the

psychological and emotional aspects of design are also integrated into the curriculum.

Being a business school, one unmistakable characteristic of how the Rotman School of Management approaches design thinking is the consideration of the return on investment (ROI) by using strategy in a viable and sustainable way. This is partly what Fraser defines as design thinking: "the reframing of opportunities in a strategic sense. This is what is often referred to as 'design thinking' " (Fraser, 2006, p. 25).

York University | Sheridan College – "Design Thinking: Creative and Critical Pathways" (Undergraduate, Second-Year)

The fourth course surveyed is "Design Thinking" offered by the joint Bachelor of Design program between York University and Sheridan College. It is a 2000-level course, offered on the Trafalgar campus of Sheridan College, and is open to 50 students, who may be in their first to fourth year of study in this undergraduate program. Unlike the other courses surveyed, it is a course that is only offered every other year.

Professor Mary Ann Maruska (interview, April 10, 2007) states that the definition of design thinking is, in her opinion, as the subtitle of the course suggests: a combination of both creative and critical pathways. Both creative thinking activities, which are divergent and/or imaginative, as well as critical thinking activities, which are convergent, logical, and analytical, are required by each project that a designer undertakes. This definition is not unlike that of Martin, where design thinking involves a balance between reliability and validity, between art and science, between intuition and analytics, and between exploration and exploitation. Maruska, who is of the opinion that both thinking and creativity can be coached, hopes to help students to overcome their frustrations or creative blocks, especially when working under pressure.

Similar to "Engineering Strategies and Practice," this course is equally impressive in its systematic and thorough provision of tools and techniques. To exercise a designer's mind, a "toolbox" of design thinking skills and strategies may be assembled. Classes are structured with a weekly theme, with themes ranging from metacognition, analytical thinking, visual thinking, intuition, intention, imagination, the concept, detouring around creative blocks, Open Space Meeting, evaluating and persuading, brain basics, design as an expression of cosmic forces, to extending the boundaries or comfort zones of a designer. Corresponding to each weekly theme is a set of weekly tools, to help actively and thoroughly explore the theme in question. Examples of this impressive array of tools include brainstorming, Myers Briggs Type Indicator, paraphrase, zoom, Other Points of View (OPV), 180°, comparison matrix, Six Thinking Hats (or the de Bono Hats system), ideamapping, mindmapping, diagramming, storyboarding, using the non-dominant hand, visual triggers, metaphors, visual rhetoric, Strengths / Weaknesses / Opportunities / Threats (SWOT), decision matrix, rationale focus formula, and others. Along with the weekly themes and weekly tools, weekly "coaches" are also assigned; some examples are Leonardo da Vinci, Carl Jung, Edward De Bono, Edward Tufte, Betty Edwards, Shigeo Fukada, Joseph Campbell, and others.

When compared to the other courses surveyed, a few major differences are noted in this course. Firstly, there is a significant component in this course on the study of the anatomy of the brain and how it works, which lends a scientific and cognitive angle to this course, and which the other courses lack. Secondly, while design thinking involves a process, e.g. modifying Von Oech's stages of the Explorer, Artist, Judge, and Warrior, it also focuses on the present, which is a moment when the designer needs help in breaking free from his or her creative block. Thirdly, technology is not emphasized or encouraged in this course. On the contrary, hand-printing (in uppercase) and hand-sketching, keeping of a scrapbook and a journal, are mandatory as part of the exercises. This approach is perhaps indicative of an artist's tradition, almost of an arts and

crafts tradition, of working introspectively, reflectively, and with great craftsmanship. Fourthly, this course focuses more on the self, which is the designer, working internally, as opposed to collaboratively with others, with the exception of the Open Space Meeting, which involves the sharing of passionate ideas in a group setting.

One last observation about this course that makes it unique lies in the assignments. In one assignment entitled The Hero's Journey: A Risk Challenge, students are asked to document a three-hour-activity, which students make a decision to take on, that is psychologically challenging to them. The objective of this activity is to build mental strength by doing something that is uncomfortable, thereby extending the designer's boundaries. In another assignment entitled Reflecting on the Designer's Mind, students are asked to assemble all the tools learned in this course, in three creative options: (1) an owner's manual, complete with features, basic operating systems, performance, maintenance, and emergency service, (2) a tool kit, toy box, or a game, or (3) alternative framework with the instructor's permission. Undoubtedly, these assignments are the most designer-oriented, unique assignments of all the courses surveyed.

University of Toronto Mississauga | Sheridan College – "Design Thinking" (Undergraduate, Second-Year)

The final course introduced in this chapter is the one that is taught by the author: "Design Thinking," offered by the joint program of Communication, Culture and Information Technology (CCIT) between UTM and Sheridan. It is a second-year course with a lecture component as well as a studio/lab component, offered on the Trafalgar Campus of Sheridan College. There are 160 students attending the same two-hour lecture weekly, followed by a one-hour lab in groups of 40. This course is currently offered under the name "Design Thinking I," as "Design Thinking II" is also now being offered with a focus on sustainable design and design as activism.

The skills and backgrounds of the CCIT student body are diverse. There are five interdisciplinary programs: (1) CCIT Major, (2) Digital Enterprise Management Specialist, (3) Health Sciences Communication Specialist, (4) Human Communication and Technology Specialist, and (5) Visual Culture and Communication Specialist (has been moved recently out of the program). Students must take the CCIT Major in combination with another major or two minors. Hence, among the class, there may be students who are co-majoring in another subject, such as economics, computer science, art and art history, or psychology, making the group highly cross-disciplinary and therefore, necessitating a course that would be appealing and relevant to a diverse audience, with little design experience for the most part.

Due to the cross-disciplinary nature of the program and student body, this course is structured in five modules: (1) design thinking behind the design of symbolic and visual communication, (2) design thinking behind the design of material objects, (3) design thinking behind the design of spatial environments, (4) design thinking behind the design of organized services and activities, and (5) design as intellectual property and designers as visionaries. The first four modules are based on the four broad areas of design practiced by professional designers and those "who may not regard themselves as designers," as noted by Buchanan (1992, p. 7). Throughout the course, how design thinking is applied in design and subsequently how design is practiced and applied in the industry is emphasized. Guest speakers from the industry are invited to share their thoughts on their field of expertise wherever possible. Throughout the course, the thinking behind what motivates design is also questioned, based on the four kinds of design as proposed by Frascara: (1) design to support life, (2) design to facilitate life, (3) design to improve life, and (4) inconsequential design, which is commercial design (2001, p. 17).

In exploring each of the four broad areas of design, two key elements are stressed: firstly, the specific design process as practiced by that discipline in the industry, and secondly, the specific design principles and elements as practiced by that discipline in the industry. For

example, there is a specific design process, with designated points for client sign-offs, which is followed by the graphic design industry, and that process may directly or indirectly dictate the design thinking process. Similarly, there are specific design principles and elements that are integral to the graphic design thinking process, such as the principles of unity with variety, hierarchy, emphasis, balance, and legibility, and elements such as colour, line, texture, space, and shape. As the course unfolds, students are encouraged to examine any similarities and differences in the processes, principles and elements among the four broad design areas, and to apply any design principles and elements not normally found in one area of design from another. For example, Norman's principles of feedback, constraints, mapping, and visibility, as well as bridging the gulfs of execution and evaluation (2002, pp. 17, 23, 27, 49, 83), which are traditionally used in the design of material objects, could be applied to the design of organized services and activities with equal effectiveness. A universal process that students are introduced to is the Seven Universal Stages of Creative Problem Solving proposed by Koberg and Bagnell, with the stages: (1) accept situation, (2) analyze, (3) define, (4) ideate, (5) select, (6) implement, and (7) evaluate (1991, p.26).

One main goal of this course is to encourage innovative thinking by encouraging students to shift the points of reference within the parameters of the broad areas of design. A point of reference may be understood as an established or traditional way of doing things in any area of design. The parameters of an area of design may be understood as the boundaries of practice that is represented by that area. There is an assumption that areas of design can also overlap. For example, students may be encouraged to redesign a material object, such as a chair, in such a way that it falls in or embraces both the design areas of material object and spatial environment. This approach is inspired by what Buchanan refers to as "repositioning" (1992, p. 9). Since CCIT is an integrated technology program, students are also encouraged to be innovative by considering the use of new media and technologies where applicable.

There is one significant emphasis placed in this course that is hitherto not emphasized in other courses, and that is visualization. In the weekly studio/lab component of this course, students are given a set of tasks to complete using Adobe Illustrator, by way of building their Illustrator skills, from making simple shapes and drawing with the Pen tool, to more advanced skills such as using the Gradient Mesh to depict three-dimensionality. Throughout the course, in both lectures and labs, activities involving visualization are incorporated, such as sketching, simplification and abstraction of shapes, perspective and axonometric drawing, overview of illustrative styles, how to do patent drawings, and doing flow charts using proper symbols to document processes. In the final assignment, where students are asked to reconsider a design issue by following the seven universal stages of creative problem solving, they have the option of working in groups or individually. A new design is proposed following due analysis and brainstorming, and a written essay along with supporting diagrams executed in Illustrator are required. The author believes that visualization is not only a product of design thinking but may also be a tool or conduit through which design thinking occurs. By incorporating visualization, tangible and intangible details such as the look and feel, semiotics, and overall aesthetics, may be considered. Design thinking as an interdisciplinary and holistic design experience is thus a major emphasis of this course.

Reflection – Learning from Colleagues

To summarize this survey, the first thing noted as common to all courses is that a design process or multiple design processes is/are always stressed; there may be minor variations that reflect the nature of the disciplines, or the names of the stages may be different but they essentially follow the stages of research, ideation, implementation, and review. From the information gathered, the one used in engineering is the most detailed and technical.

In terms of overall strengths and weaknesses, the course at OCAD is the most

multi-directional in terms of multiple design processes, but it strictly addresses the design process and not design thinking, even though the assignments do require some analytical and creative thinking skills. The engineering course at UT is extremely thorough, systematic, and organized in the way the design process and methodologies, including creativity methods, are covered. There is a strong emphasis on preparing the students for the industry, in terms of practice, team, and communication skills. However, due to the inherent nature of engineering, it lacks a more holistic view of the user experience. On the contrary, Rotman is progressive in terms of its spirit of experimentation and innovation, with a willingness to act and modify quickly and strategically, and an unusually deep sense of user understanding and consideration, that is potentially translated into breakthrough design and business models. The CCIT course is perhaps the most cross-disciplinary, with a strong reflection and emphasis on industry practices, and equally an aspiration for innovation utilizing design principles and elements that could be cross-disciplinary. It is the only course surveyed with a strong visualization and technology component. Lastly, the Bachelor of Design program is as systematic and thorough in its course content and delivery as the engineering course, though the subjects are inherently different in nature. Interestingly, as much as the engineering course is thorough in its creativity methods, so is the Bachelor of Design course in its scientific component. Finally, the Bachelor of Design course is perhaps the most designer- and craftsmanship-oriented course of all. Table 1 represents a matrix comparing the five courses surveyed. Table 2 represents a cumulative list of components covered in these five courses.

In conclusion, it appears that even though the design thinking courses surveyed do cater to their specific audiences and disciplines in terms of course content and method of delivery, there is also an overall trend of a more integrated, cross-disciplinary, and holistic approach in how design works. While it is possible to reduce all design thinking processes and elements found to some form of universal methodology, from a design education perspective, one must take care

to infuse, respect, and encourage diversity in a design curriculum, particularly in the realm of inspiration and implementation; otherwise, any singularity derived would contradict the spirit of design, which is innovation itself.

Table 1: Survey of Courses: Matrix

	OCAD	Engineering, UT	Rotman, UT	CCIT, Sheridan/UT	BDes, Sheridan/York
Design thinking	No	Yes, design methodology	Yes	Yes	Yes
Design process	Yes, multiple processes	Yes, product design process	Yes	Yes, specific and universal	Yes
Number of students	300	800	9	160	50, usually under 30
Class size	28	Lecture: 267 Tutorial: 27	9	Lecture: 160 Lab: 40	50, usually under 30
Academic level	First year undergraduate, multi-disciplinary design	First year undergraduate, multi-disciplinary engineering	Second year MBA	Second year undergraduate, double-majors	Second year undergraduate, graphic design
Team work	Not sure	Yes, mandatory	Yes, mandatory	Optional	No
Designer- or client-oriented	Both	Client	Client	Both	Designer
Design areas	2D, 3D, 4D	All engineering disciplines	Business	Symbolic and visual communication; material object; spatial environment; organized services and activities	Graphic design
Studio component	No	No	No, workshops	Yes, Mac lab, Illustrator	Yes, handwork
Assignments	Essays	Group design project with real client and project manager	Group design project with real client	Essays and designs done in Illustrator	Creative essays and objects
Human factor	Yes, consumer	Yes, user	Yes, user	Yes, user	Yes, designer

Table 2: Survey of Courses: Cumulative List of Components

1	Design process
2	Design principles and elements
3	Purpose of design
4	Types or areas of design
5	Relationship and/or communication with the user
6	Accessibility
7	Usability
8	Human factors
9	Industry standards and practices
10	Codes and regulations
11	Business models
12	Tools, techniques, methods for critical and creative thinking
13	Team work, collaboration, partnership
14	Project and time management
15	Strategic and conceptual thinking
16	Styles, look and feel, creative and art direction
17	Visualization
18	Use of technology
19	Intangible realm of design, e.g. emotional, psychological, perceptual effects
20	Trends, innovation, and vision for future
21	Green design, biomimicry, sustainability
22	Design paradigms, metaphors
23	Social, environmental, global, ethical aspects and impacts
24	Role models of design thinkers
25	Cognitive aspect, anatomy of the brain

Table 3: Survey of Courses: Pedagogical Approaches

MOTIVATION	ARTISTIC SKILLS	OTHER SKILLS, TOOLS AND/OR KNOWLEDGE	PROCESS	THEMES
Purpose of design	Design principles and elements	Industry standards and practices	Design Processes	Relationship and/or communication with the user
Types or areas of design	Styles, look and feel, creative and art direction	Codes and regulations	Team work, collaboration, partnership	Accessibility, Usability, Human factors
Trends, innovation, and vision for future		Business models		Green design, biomimicry, sustainability
		Tools, techniques, methods for critical and creative thinking		Intangible realm of design, e.g. emotional, psychological, perceptual effects
		Project and time management		Role models of design thinkers
		Visualization, Strategic and conceptual thinking		Social, environmental, global, ethical aspects and impacts
		Use of technology		
		Design paradigms, metaphors		
		Cognitive aspect, anatomy of the brain		

CHAPTER 5: IMPLEMENTING IDEAS

PRACTICUM

Constraints and Continuum

CCT204 "Design Thinking" is a 0.5-credit course offered in the fall semester. As such, there are twelve weeks of classes, consisting of a two-hour lecture and a one-hour lab each week. The maximum enrollment is 160 students, who attend the weekly lectures together but attend 4 lab sections separately, with a maximum of 40 students per section. The labs are equipped with 40 iMac computers with some of the latest software, including the Adobe Creative Suite programs, as well as an additional puddle table to accommodate students who might bring their own laptop computers. Lectures are conducted in a typical lecture hall setting, with multiple tiers of seating and desks, a podium with all necessary connections, such as Internet, DVD player, document camera, and projector.

The format, number of students and classes, and duration of lectures and labs are constraints within which the course content is delivered. In addition, another constraint comes from the experience and background of the students, which are diverse. Many of them are second-year students enrolled in the CCIT program, but there are also other students who take the course as an elective, and some third- and fourth-year students taking the course in order to graduate. Occasionally, there are students who are double-majors, such as CCIT and Art and Art History or Computer Science, and some who have switched from other programs, such as Engineering. Despite these differences, it is normal to assume that the majority of the students have very little or no design experience, with a few who are keenly interested in design or may even have already had a diploma in graphic design. Being in the CCIT setting, most students are very well versed in the realm of communication and technology. Students in the past have moved on to graduate and become marketing and social media professionals, designers, creative directors

and account executives, entrepreneurs, among others, including those who pursue graduate degrees including law. Hence, it is a diverse student population, who are generally very serious in their studies.

In order to try out the new, selected ideas identified earlier, I must work within the constraints of the course, while transitioning to a modified course with a sense of continuum, if not for the students, at least for myself. The pilot teaching project conducted in the fall of 2009 is a modified course, not an entirely new course, which means that some components from the "old" course are retained, while introducing new elements, and in attempting to shift the focus of the course. That is to say, the shift in focus would be from functional skills to guiding values; in other words, functional skills are still important, but the emphasis would be on guiding values as what drives the design thinking process.

The modules and lectures of the modified course will be presented first, followed by reflections on each module based on ongoing observations and interactions from students. Labs focusing on the learning of technical skills and the application of theories learned in lectures will be discussed later in this chapter, while the materials, assignments, tests, discussions, and surveys collected from students throughout the course will be presented and analyzed in greater detail in the next chapter.

Module One – Introduction: What is Design Thinking?

Week One

After briefly introducing myself, I asked the usual questions: "What do you think design thinking is?" and "What are your expectations from the course?" The students' overall response to these questions, as expected since it was the very first class, was shy and hesitant, with a few brave souls answering, apparently from what they had heard from friends who had taken the

course, that design thinking is anything that would help them do design, that they expect to learn how to do logos, and learn to use Adobe Illustrator. We went over the course outline (Appendix X) together, in going over the course description, that the course

a) Introduces the role of design thinking in the communication of information;
b) Emphasizes creative and critical thinking in the design process, and
c) Provides the theory and operational skills to improve the design process.

This course description is actually one that has been in use since the course was first conceptualized and offered in 2003, and has not changed since then. Since changing course descriptions involve an approval process and lead time, instructors would normally make their own adjustments in terms of course content, while loosely staying within the parameters of the course descriptions. The way that I have been addressing any discrepancies in what is actually delivered is to clarify to students what the definition of "information" is, as in "design thinking in the communication of information," so that they are not simply envisioning the design of pages of textual information, for example, but the design of information as in what is conveyed or represented by an arrangement or sequence of things. In this broader definition, the course content could embrace and encompass the design of many different things.

Traditionally, much of design is confined within the discipline in which it is practiced. For example, there are the four broad areas of design: (a) visual, (b) industrial, (c) interior/spatial/environmental, and (d) organized services and activities (Buchanan, 1992, p. 7). What I have always stressed, even in previous years, is that, these disciplines could be explored separately but also in interconnected ways. Some of the significant and potentially innovative areas in design, in my opinion, lie in (a) creating opportunities where these areas of design might overlap, (b) exploring what is unique in these disciplines, and (c) cross-apply what might be common across these disciplines, in terms of design process, design elements and principles, and

schemes of representation (Sample Slide 1). I realized that the approach that I had adopted previously is actually the beginning of my insight in a holistic, interdisciplinary approach. What I did differently this particular term is that this was no longer an afterthought, but a major focus; not as isolated designs in isolated disciplines, but as interconnected systems of design. I was proposing a broader, more holistic, transdisciplinary approach.

For a lot of the students, that particular term was the very first time that they had taken a course at Sheridan. For that reason, I welcomed them to the course and also to Sheridan by sharing Sheridan's values (Sample Slide 2), which, among a few core values, was one item that was especially applicable to this course – "innovation and creativity." I briefly explained that innovation means a new way of doing things and that creativity is the ability to use the imagination to come up with new and original ideas; though, having said that, the course is not about science fiction, and that design should be backed by reason, research, and feasibility (Sample Slide 3). One important aspect in this regard is that I encouraged them to leave their preconceived ideas and/or judgments about design at the door, so that they would not be so inhibited and would feel freer to come up with fresh ideas. However, this is to be done with the understanding that design is for the good of mankind. I felt that it was important to clarify that what is good for mankind would actually open up a debate, which might extend beyond the scope of this course. A simple example, though, is the design of markers: first we had original, plain markers, then we had markers with fruit scents, what if one was to come up with a new marker that has designer fragrances? In order to brainstorm for new, fresh ideas, one must withhold judgment and preconceived ideas, at least temporarily. The advantages and disadvantages of that idea could be dealt with later.

In this first class, I wanted to encourage students to think of what types of design there are. Quoting Buchanan (1992), "No single definition of design, or branches of professionalized practice such as industrial or graphic design, adequately covers the diversity of ideas and methods

gathered together under the label" (p. 3). I asked the students, "When you think of design, what kind/s of design comes to mind?," to which students answered "fashion design," "interior design," etc. While acknowledging their responses, I added that in fact, the evolution of the boundaries of designs also reflects the evolution of design thinking. Another approach suggested by Frascara (2001), defines the four types of design as (a) design to support life (save and protect life), (b) design to facilitate life (to do things faster), (c) design to improve life (enhance the quality of life, e.g. spiritually, culturally, humour, pleasure, beauty), and (d) inconsequential design, which is commercial design (p. 17); though again, a design could fall in one or more of these categories. At this point, I did an informal poll, asking students, if they could only pick one category, which one are they most interested in? After letting them think for a minute, the poll reveals that there was only one student who was interested in "design to support life," a small number of students (10-20) were interested in "design to facilitate life," while an equal, greater number of students (30-40) were most interested in "design to improve life" and "inconsequential design," adding that they were interested in possibly pursuing graphic design as a career.

At this point, I addressed the students that in fact, it is important to realize what motivates you to do design, and that the awareness of what interests you may be a powerful source of motivation in your design thinking process. This could be the difference between being a follower and a visionary. Above all, be aware that there may be guiding values that drive the designs, such as the importance of saving one's life, efficiency, or enhancing beauty (whatever your definition is, everyone has a sense of the sublime). In other words, the categories or broad areas of design could be under the umbrella of these guiding values (Sample Slide 4). An example that I illustrated this concept with is the One Laptop Per Child project (http://laptop.org/laptop).

To expand on the topic of design thinking, I tried to share with them the comparison of the five Design Thinking courses that I surveyed (Chapter 4). While the findings were not shared in detail, some major points were presented, including the range of components, similarities and

differences, strengths and weaknesses. Slides with additional details were also provided if students were interested in finding out more on this survey. Against this backdrop, I introduced my own perspective in the study of design thinking, that rather than having functional skills at the forefront of the design process, that we could have guiding values as the umbrella under which all design activities take place. Some examples of these guiding values are humanitarianism, holism, accessibility, sustainability, and progress (not only technological, economical, but also social, cultural, and spiritual).

Week Two

This week, I started introducing the concept of values-based design (vs. functions-based design). Building on Frascara's four categories of design and the idea of what motivates design, I shared with the students the concept of *values-based design*, a term that I started using in 2008. This concept is closely related to one's sense of values, that is, one's principles or standards of behaviour, or what one deems important in life. Values-based design reflects the values that are important to us as a society and/or individual designers. Quoting Boekraad and Smiers (1998): "Design engineering appears to be gaining the upper hand…Designing for industrial scale production is confined in practice to an unending chain of redesign. Designers are degenerating into specialists in form, line and colour" (p. 1). The problems indicated in this statement are, therefore, twofold: (a) that designers are preoccupied with constantly improving a flawed product, and (b) that designers are only preoccupied with the physical appearance of products. As Boekraad and Smiers observe:

> Thinking about design is in danger of confining itself to reacting to signals from the marketplace…design has become far more closely intertwined with strategic communication, so that what threatens to disappear is a specific objective based on

> design thinking, whether or not it is nourished by a critical and humane picture of culture and society. (p. 4)

At the extreme, values-based design could also be viewed from the perspective of what Slack and Wise (2005) call *expressive causality* – "one critical factor for all of our culture for every instance…every aspect of it…Thus the whole culture, what is called a 'cultural totality', evolves together" (pp. 110-111). In other words, if one deems that the appreciation and preservation of nature is that one critical factor for all of our culture, then designs in all four broad areas: visual/symbolic, industrial, spatial/environmental design, and the design of organized services and activities would be inspired by nature and for the benefit of appreciating and preserving nature. As an example, I showed an interactive digital journal that I designed based on this idea of design revolving around the one critical factor of nature.

Using examples of a wide range of designs, I shared with students the realization that design has always been a reflection of one's values. For example, many tools and appliances are designed driven by efficiency. Hospital environments are traditionally designed to be practical and easy to clean, but at a recent interior design show, designers have shifted the focus to reflect more emphasis on making the patients feel like they are in a warm, home-like environment. Transitioning to a more global level, the project and exhibition *Massive Change* was presented, spanning multiple disciplines such as living, manufacturing, military, urbanization, and politics. Among the many questions asked, perhaps one of the most thought-provoking questions is "Now that we can do anything what will we do?"

Another project used to demonstrate values-based design is from the Things East West exhibition, curated by Benny Ding Leong. The designs featured in this exhibition deal with issues that originate in everyday life. As Clark and Leong state (2003), "these human-oriented designs are intended to develop new value orientations…They particularly are intended to address the

lack of communication within families…heighten awareness of and concern for nature…and to encourage the careful utilization and respect for objects" (pp. 57-58). Some of these objects are a Story Telling Device, intended for children to share and discuss their feelings and perceptions, Nature Radio, intended to record sounds of nature and transform them into corresponding tunes, and Timed-Words, intended to store electronically timed messages (like time capsules) in custom-made jewels, as a bonding tool with previous/future generations.

A significant point that I drew students' attention to at this juncture, is how values-based design also impacts style. I feel that this connection is important to bring up as it affects what is often referred to as *look and feel* in design, affecting the sense of appropriateness in communicating a message. For example, in some haute couture, some of the important values are exquisiteness and luxury; the style of the designs would reflect them accordingly. Another example is the Dove campaign for real beauty. To embrace a friendlier, more inclusive sense of values, the style or look and feel of the communication designs embodies a refreshing, clean layout, imagery of down-to-earth women of different sizes and ethnicities, and choice of typeface that is round and friendly. Without going into details of what design elements are, the students are introduced to the concept of style and look and feel, and the importance of appropriateness in the means of communication.

In terms of methodology to help students develop ideas on values-based design, I introduced the concept of cultural integration, as inspired by Clark and Leong (2003) – "Cultural integration concerns the hybridization of a particular culture with the contemporary Western of 'global' culture that forms a kind of artificial acculturation of the particular and the universal. However, the key issue is the choice of cultural elements" (p. 57). Leong's example of the Double-Happiness condiment set was presented to explain the concept of acculturation. However, instead of strictly limiting the three levels of material, behaviour/rites/institution, and ideology and ways of thinking in an ethnic/cultural sense (e.g. Western and Chinese) as Leong relates, I

expanded on this definition by inviting the students to include other types of cultures and sub-cultures in this methodology. For example, corporate culture, vegetarianism, and hip-hop are all types of cultures without necessarily any ethnic boundaries.

Week Three

As visualization and sketching are crucial components of design thinking, I have decided to cover some key concepts, techniques, and nature of sketching at this point to prepare students for further creative activities in the course. To that end, I have chosen to review Rudolf Arnheim's article "Sketching and the Psychology of Design." Citing Goldschmidt, Arnheim (1993) explains: "sketching does not consist simply of representing on paper the images held in the designer's mind; it consists rather in a dialectic process, 'the oscillation of arguments which brings about gradual transformation of images" (p. 70). In other words, the process of creative design involves an interaction of arguments and moves, consisting of reasoning surrounding the task and physical moves, i.e. sketching, following the arguments. Referring to Ernst Mach's *The Analysis of Sensations and the Relation of the Physical to the Psychical* (1886), Arnheim continues to describe that sketching, or rather drawing from memory in this instance, relies largely on mental images, which depend loosely on the optical percepts based on memory. In turn, optical percepts remain committed to the physical (concrete) objects of which they are projections. In other words, mental images are derived from optical percepts but are not identical copies of them; they are reduced in intensity and are easily wiped off from memory. Arnheim continues to explain: "Creative designing always involves the solution to a problem, the carrying out of a task, and therefore, the image unfolding in the mind always refers to a goal image" (p. 71). This dialectic process of working towards a goal image with arguments and moves along the way happens to correspond to the design process discussed by some other scholars, such as Lawton and Rowe.

Two concepts brought up by Arnheim that are particularly useful in design thinking involving visualization and subsequent representation are simplification and abstraction. As Arnheim (1993) states: "Drawings from mental images…rely on generalities, on the simplifications that remain in memory as abstractions from the multiplicity of individual experiences" (p. 71). As implied in this statement, simplification and abstraction are closely related with abstraction being the result and simplification being what happens in the process. Technically, simplification means making something less complicated or easier to understand while abstraction means the forming of general ideas from multiple, concrete examples. To illustrate, I used two examples: the sun and high-rises. I showed different photo images of the sun and different photo images of high-rises and asked students how they could be simplified and how they could be abstracted so that the drawings thereof would still be discernable as the sun and high-rises, generally speaking. Students responded quite enthusiastically with suggestions such as simplifying by not showing too many details like craters, but retaining enough features that are essential to depicting those objects, e.g. hotness/redness and flare/rays of the sun, tallness, rectangularity and rows of windows for high-rises. I asked some students to come up to the white board to draw what they suggested and some of them were quite enthusiastic to do so. I took the opportunity to bring up the point of stereotypes based on thoughtless replications, such as the sun consisting of a circle and nondescript straight lines radiating out of the circle that we all did back in kindergarten. They all smiled and nodded. Thus cautioning students, I showed examples of different renditions of the sun; by varying the use of lines, colours, shapes, space, that is, design elements, different look and feels could be achieved, depending on what message you want to communicate, e.g. that the sun is a guiding light, it is friendly, mystic (Sample Slide 10). In other words, adjectives used are directly or indirectly linked to the values reflected, e.g. mystic for mysticism.

Arnheim concludes by contrasting the use of topological shapes as opposed to geometrical shapes as the guiding image is developing. Topological shapes represent a range of possibilities without tangibly committing to any of them; they are vague and tentative. As well, one could approach the task by organizing from below or organizing from above; that is, starting with the overall structure or starting with details, where the ideal solution is that of a balanced approach.

Week Four

The focus this week is on the use of design elements and principles and how it relates to semiotics. As an introduction, I brought up the overall principle of aesthetic, which is what appeals or is pleasing to one's senses, especially sight. This sense of aesthetic or what one finds aesthetically pleasing varies from person to person, but often reflects the preference of a particular time or group of people. For example, at the earlier decades of the last century, with the influence of some of the Modern Art movements such as Cubism, graphic communication correspondingly took on the Cubist influence and style. Aesthetics are not just applicable to works of art, posters or logos, but also equally applicable to other objects, environments, or experiences. For example, one finds and could apply the principle of aesthetic in fire extinguishers, chairs, buildings, bridges, or other landscapes.

Before going over the design elements and principles that are traditionally found in the realm of graphic communication, I encouraged the students to think in the back of their minds how and where else these design elements and principles can be applied. I told the students that, to illustrate the ideas, a lot of the examples that I was going to use are logos, as they are very established and succinct displays of how design elements communicate desired attributes. However, examples from other realms of design would also be incorporated. The design elements reviewed are line, shape, form, value, colour, texture, space, and light. While going through each

design element, visual examples were shown and additional details were discussed. For example, there are more obvious aspects of lines, such as length and thickness, but they could also create texture, show a particular energy or gesture, or define shapes and space. Lines could be found not only in logos or drawings, but also in objects or environments, e.g. chimneys, bridges, how a road bends. Relevant strategies were shared, such as the strategy of killing two birds with one stone. For example, in one version of the logo of Georgia Music Hall of Fame, five quavers (eighth note in music) were placed in such a way that the shape of a star is formed, thus communicating both the ideas of music and fame. While all of the design elements reviewed are applicable to the visible realm, some are more relevant and pronounced in certain disciplines. For example, the element of light is an especially important consideration in interior design.

Following the discussion on design elements, design principles (in the visible realm) are explored. Some of the key principles are emphasis, hierarchy, balance, legibility, and unity. After each was briefly explained, the study of semiotics, with which the majority of students were familiar from another course, was reviewed for relevance. Looking at different design alternatives for the same design, the three branches of semiotics: (a) syntactic, structure of an image, (b) semantic, meaning of an image, and (c) pragmatic, effect of an image, were examined. These three branches coincidentally correspond with the levels of communication problems observed by Shannon and Weaver: (a) How accurately can the symbols of communication be transmitted? (b) How precisely do the transmitted symbols convey the desired meaning? (c) How effectively does the received meaning affect conduct in the desired way? (Mollerup, 2003, p. 68). For example, the Adidas logo with the three slanted, cropped rectangles, going up and towards the right, would have an entirely different and less desirable meaning and effect if it was flipped horizontally. That is to say, the logo in its correct placement, seen with the three cropped, slanted rectangles going up and to the right could be read as the company's and the athlete's performance going up; whereas if it was flipped, then the connotation would be reversed, turned into something negative,

as well. Likewise, the choice of design elements should be appropriate to reflect the message accordingly. To that end, to form the habit of describing what you see, using adjectives, e.g. bold, strong, thin, weak, elegant, futuristic, rational, organic, would be the first steps in identifying and selecting an appropriate art direction. Other examples shown are the concepts proposed for the logos of the city of Charlotte and Cinesound.

Ann Tyler's article "Shaping Belief: The Role of Audience in Visual Communication," this week's reading, was summarized and reviewed at the end of the lecture.

Reflection

Especially at the beginning of the course, when I introduced the motivations behind design and asked students what motivates them, I could see some of their eyes widening and sensed that they were somewhat inspired. This is especially true when I encouraged them to be passionate, to be aware of and develop their own style, and realize their own beliefs. I felt that there is definitely value in helping students to be in touch with themselves and feeling empowered in doing so through design. Their initial understanding of design as fashion design, for example, was hopefully, eventually broadened.

There were challenges, however, in transitioning to the modified content with a shift in focus on values as opposed to functional skills, especially when there was still a need to teach these skills to students in this class. One student was concerned as to how the theories discussed in lectures would relate to the technical skills learned in the labs. I explained how design ideas would eventually need to be visualized, requiring technical skills in doing so; how simplification and abstraction are key concepts learned in lectures but could be applied in design activities in labs.

There was one thoughtful comment made by a student after the lecture where I had mentioned that efficiency was the value behind the designs of a lot of the post-war electrical appliances. The student remarked that by designing those appliances and by making things more efficient for users, people would have more time to be with their family, so the importance of spending quality time with family was actually the real value behind efficiency. I thought that was an insightful observation.

Module Two – Integrated Design Principles, Methods, and Processes

Week Five

Since the assignment brief for Assignment One was made available the previous week, some time was dedicated to clarifying details about it. To summarize, this assignment consists of a values-based design activity, with two components:

1. Write-up of about 600-700 words in total, describing
    a. What values are most important to you and explain why you believe they are important (values are a person's principles, standards of behavior, or judgment of what is important in life);
    b. One or two values from the above that you would like to promote. Come up with an endeavor that would help promote this/these values (an endeavor could include starting a business, profit or non-profit organization, event, association, product, service, place, or any project at the local, national, or international level); asking questions such as "what does it aim to achieve?", "what is its name?", "what is the target audience?", "what are the logistics in running this endeavor";
    c. Your design thinking process.

2. An illustration of this endeavor, done in Illustrator, considering the use of semiotics and integrating the name of this endeavor in your illustration.

To give students a better idea what types of illustrations are acceptable, examples from logos to complex illustrations are shown. In other words, the range of possibilities lies anywhere between designs that are simpler, more like logos, to drawings that are more pictorial and more complex (Sample Slide 11). I specifically used the term "illustration" to encourage a bigger range of artistic possibilities. Simplification and abstraction, as well as semiotics are all applicable. The term *concept*, which is commonly used in the industry, was introduced. Generally, a concept includes the look and feel and art direction, which in turn includes the choice of typeface/s, typographic treatments, type of imagery, choice and use of design elements, and composition, e.g. dynamic or static. Some examples used can be seen at http://bestphotoshoptutorials.net/2009/03/19/40-examples-of-beautiful-typography-in-advertising-design/. Further, a concept could also be an idea, approach, or strategy used to communicate a message, sometimes including the use of a slogan, a question, statistics, or any other device to trigger a deeper mental process, in addition to the visual realm.

The principle of functionality was the main focus this week. This principle means that the basic requirement of any design is that it should work. This is particularly apparent in the design of material objects. As an example, I showed students a small piece of paper with instructions that came with a product that I had recently purchased. The gist of the instructions, along with the accompanying diagrams, conveys the message that, if the product does not work after you have followed the instructions, then use a screwdriver to open it and adjust a particular component inside the device. My personal experience with this product was that, after following all the instructions, it still did not work. This type of design, in this day and age, is simply not acceptable.

Additionally, the principle of functionality means that a design should not just work, it should work well. This concept applies to how users interact with designs and falls under the realm of cognitive science. To that end, Donald Norman's classic principles of good design were introduced. They are visibility, mapping, feedback, affordance, and constraints (as described in Chapter 2), as well as bridging the gulfs of execution and evaluation (facilitating the user to operate the device and to see that it is working), and integrating the usage of knowledge in the world and knowledge in the head (drawing from clues in the environment and those in the user's mind). In addition, Norman's discussion on the different types of errors was touched on, to remind students of the unnecessary and potentially dire consequences of human errors due to improper designs. In this respect, designing with safety in mind is particularly important.

The principle of functionality can also be manifested in other disciplines, though the emphasis or terms used might be different. For example, in the realm of business, in particular the branch of operations management, the importance of a smooth and positive customer experience is emphasized in the service delivery cycle. Albrecht and Zemke's Service Triangle, consisting of the main sphere of the customer in the centre, and surrounded by the supporting spheres of service strategy, system, and people, is a fundamental concept in customer satisfaction. Schroeder's concept of managing what he calls *moments of truth* in a service delivery cycle is also applicable. According to Schroeder, anytime the customer comes in contact with the service system during the cycle of service delivery constitutes a moment of truth. In the end, the customer's perception of the service is a function of all the previous moments of truth experienced. Thus, managing the moments of truth to create a positive service experience is the essence of service management. A useful tool to think through and document any process, such as service processes, is the flowchart, which can in turn be broken down into two levels: process flow and information flow. These two levels of flow charts can be represented in a linear, parallel

fashion, indicating where the steps in the procedures interact, to ensure a thorough, seamless process of management (Sample Slide 12).

The Seven Universal Stages of Creative Problem-Solving, as proposed by Koberg and Bagnell was presented as a design process that has been followed in the industry for decades. The stages in the process may be called by different names, but essentially they make up the same process. The stages are Phase 1, Analysis, consisting of (a) accept situation, (b) analyze; Phase 2, Concept, consisting of (c) define; and Phase 3, Synthesis, consisting of (d) ideate, (e) select, (f) implement, and (g) evaluate. To demonstrate how this process is practiced in the industry, I showed the video: *The Deep Dive*, which documents a typical design process, in this case, the design of a shopping cart, by the renowned product development firm, IDEO. I asked the students to adopt a critical mind while watching the video, asking themselves if this kind of process would still be relevant in today's world. This theme would be picked up again when Assignment Two was to be introduced with a modified design process.

Week Six

Creativity methods were introduced, with a special emphasis on applying across different disciplines. For example, Norman's principles of visibility, mapping, feedback, and constraints, to name a few, are traditionally applied in the design of material objects, i.e. in engineering. However, they can be potentially very effective in the design of organized services and activities, i.e. in processes in general. Two examples would be applying the principle of feedback to the cycle of service delivery and applying the principle of constraints to online order forms. One can always observe and learn from designs as a whole and cross-apply methods and principles amongst different things. I showed a picture of my travel toothbrush, focusing on the centre where the brush connects to the handle, and asked students what might have inspired that design (the bottom of the brush connecting to the handle is in the shape of a square with a hollow circle

inside). The truth is that I do not know for sure, but I speculate that the principle lies in finding a way to strengthen that part of the toothbrush, where it is most vulnerable for breakage; and the technology that could have inspired it is that of building arch bridges (Sample Slide 13). Arches are highly resistant to bending forces; hence, the weight of an arch bridge is diffused out to each end.

Design paradigms, as presented in Warren Wake's book: *Design Paradigms: A Sourcebook for Creative Visualization* was presented next as a creativity method. This is an extremely thorough and systematically presented book, based on the author's observations on design paradigms that are found in our natural and manmade world. Basically, design paradigms are distinct methods of solving a problem. Different categories of design paradigms embody different fundamental design strategies and are frameworks for explaining how many things work. Therefore, exploring and examining design paradigms that already exist would help designers think of how similar problems are solved. Some examples mentioned in Wake's book include simple shapes, e.g. ball, spiral, sheet, disc; enclosure, e.g. skin, bubble, net, wrap, coating; bending and flexing, e.g. hinge, elbow, Gumby, flexstraw; attaching, e.g. glue, magnet, clips; passages, e.g. pipe, bridge, wire; objects within objects, e.g. Russian dolls, reversible jacket; and multi-function objects, e.g. Swiss Army Knife, computer. In other words, the travel toothbrush example brought up earlier also exemplifies a potential category of design paradigms, that is, for strengthening objects. A similar approach suggested is *biomimicry*, a concept that is similar to Wake's design paradigms except that it strictly models upon nature. According to the Biomimicry Institute, founded by science writer and consultant Janine Benyus, biomimicry "is a new discipline that studies nature's best ideas and then imitates these designs and processes to solve human problems" (2007-2011, ¶ 1). Harnessing energy like a leaf, building ceramics like an abalone, computing like a cell, and running a business like a hickory forest are all applications of biomimicry.

Additional creativity methods were also briefly introduced, including the ones suggested in George Dieter's book: *Engineering design: a materials and processing approach*. Some of the very systematic creativity methods suggested include the SCAMPER checklist (substitute, combine, adapt, modify/magnify/minify, put to other uses, eliminate, and rearrange/reverse), force-fitting methods (e.g. asking "what if"), mind map and concept map, conceptual decomposition (exploring features in the physical and functional domains), and morphological chart (listing and arranging the functions and sub-functions and corresponding "hows").

Reflection

As this whole idea of proposed integrated principles, methods, and processes is new and evolving, I could only present the information as current as possible, by utilizing and synthesizing what information I had to the best of my abilities. I was aware that there would definitely be limitations and areas that could be further developed.

As Assignment One was introduced, students started trying to understand what was required. A couple of students in particular found it difficult to make the connection between their chosen values and endeavour, and subsequently the illustration thereof. I think that for those students, the assignment was not as straightforward as would have suited them. The students overall were also looking more tired than usual, as the course hit its halfway mark.

There was also a huge amount of content to be covered and I was suspecting that there might have been an information overload on the part of students. Perhaps an alternative way of getting the point across is to select only one or two ideas, e.g. creativity methods, and inviting the students to brainstorm in groups, even during the lectures, and have them present their ideas to the whole class. Additional material could be provided and made available separately.

Module Three – Foresighting

Week Seven

Quiz One, consisting of 30 multiple choice questions was conducted today in the lecture. The lab test portion was conducted in respective lab sections. With the remaining time left in the lecture, creativity methods from the previous week were reviewed.

Week Eight

Since the assignment brief for Assignment Two was introduced last week, some time was dedicated to going over the assignment in greater detail. The topic for this assignment is "Foresighting to Aid the Betterment of Humanity." Following my proposed integrated design process, students were to write an essay of 1,600-2,000 words on how their proposed design may aid the betterment of humanity. Accompanying the essay were a minimum of one graph and one diagram to be done in Illustrator to show the effectiveness of their proposed design. Requirements stated in the assignment brief are as follows:

- Choose an area or aspect of humanity that you believe needs improvement.
- Propose a design that can better this aspect of humanity.
- Build your essay by following Donar's integrated design process, as follows (the order of these steps may be modified or combined to enhance the flow of your argument):
    a) What values are to be promoted?
        - This introduction is not unlike what you have already done in Assignment One – discuss what values are most important to you, hence values that you would most like to promote.
    b) How can these values be promoted through designs?

- Generally discuss how these values can be promoted through designs – consider a broad range and types of designs.

c) What is the thing that needs designing or redesigning?
    - Shift and transition the discussion to your chosen area or aspect of humanity that you believe needs improvement. What exactly needs to be improved in your opinion? Identify the thing/s that need designing and/or redesigning in order to bring about the desired improvement/s.

d) What impact does this design (or the lack thereof) have on our world presently?
    - Transition the discussion to your proposed design. (Note: Your proposed design may include a combination of "things," visible or invisible, tangible or intangible). If your proposed design pertains to redesigning something that already exists, discuss what impact this existing (old) design has on our world presently. If your proposed design pertains to designing something totally new (nothing like this ever existed before), then discuss the likely impact the lack of this design has on our world presently (that is, without this new design, these things are suffering; without this new design, these things are not possible or cannot happen).

e) What would the world likely be like with (or without) this design in 50 years?
    - Using foresighting techniques and research, educated speculation and analysis, estimate what the world would

likely be like with or without this design in 50 years.

f) What options are there in designing or redesigning this thing?
    - This section pertains to brainstorming. What are some of the ideas that you can come up with in designing this thing?

g) How can the integrated design elements, principles, and strategies be applied in the design or redesign of this thing?
    - Apply some of the integrated design elements, principles, strategies, and/or methods in the visualization of your proposed design.

h) How effective does this design function as a collaborative system in the visible and invisible realms?
    - Transition your discussion from the initial concepts of your design to a more concrete, modified, final iteration. On what grounds are the features in the final iteration selected? Address how your proposed design function as a collaborative system in the visible and invisible realms.

i) What is/are the prototype/s?
    - Continue your discussion with a description of the prototype of your design. How is the design configured? If you choose to do multiple prototyping, describe the prototypes.

j) How will this design be tested to ensure that the integrated design principles are met?
    - Propose ways to ensure that the design has been properly completed and tested, and that all applicable integrated design principles have been appropriately considered.

k) How will this design be delivered?

- If applicable, discuss how you foresee your proposed design is to be deployed.

l) What post-delivery services will there be and what post-delivery actions will be taken?

- Make recommendations as to what post-delivery services and/or actions may be taken to enhance the effectiveness of your design.

m) How will this design be evaluated in the long-term, especially in leaving minimum waste, toxins and carbon footprint?

- Suggest ways to ensure that the impact and effectiveness of your proposed design will be monitored, evaluated, and further adjusted as needed.

This process was briefly compared to the Seven Universal Stages of Creative Problem-Solving, as introduced previously and seen in the video *The Deep Dive*.

Types of drawings suggested to illustrate the designs include flow charts (to demonstrate a process), mind maps or concept maps (to show the flow of ideas), two-dimensional drawings (Sample Slide 14), e.g. top view, side view, back view, cross section, floor plan, artist's rendering, three-dimensional drawings (Sample Slide 15), e.g. axonometric drawings such as isometric drawings, and perspective drawings. Technical skills required to do these drawings would be covered in labs.

Week Nine

The concept of foresighting or futures-thinking was introduced. Key definitions of these terms as defined by Evans and Sommerville, Dewberry and Sherwin, and Margolin, as well as their corresponding approaches and techniques were shared. In particular, some of the suggested foresighting concepts that students could apply in their Assignment Two include

a) *Horizon scanning*: identifying significant changes in the external environment beyond the immediate area of operations; techniques include environmental scanning, monitoring, tracking to identify emerging, consistent trends;
b) *Trends*: spotting a general direction in which something is developing or changing over time; a *tipping point* is when a trend becomes recognizable;
c) *Scenarios*: a sequence of events that might possibly occur in the future;
d) *Forecasting*: looking at the qualities and probabilities of a future trend or event based on historical and current knowledge; not point-specific as in a prediction, which is usually quantitative;
e) *Backcasting*: creating a vision or image of the future, i.e. envisioning a desirable future, and then work backwards in a series of steps in order for the future end-state to come about

(Evans and Sommerville, 2007, pp. 9-11).

Corresponding techniques include

a) *Trend extrapolation*: using past data to define a pattern of change;
b) *Analogy analysis*: using one or more comparable situations to project future trends or events; useful where there is no established benchmark;
c) *Predict next year's headlines*: identifying how customer relationships

could be sustained and developed;

d) *Impact analysis*: analyzing impacts and implications of trends;

e) *Content analysis*: analyzing information obtained from newspapers, magazines, trade journals etc.;

f) *Morphological analysis*: envisioning new products and services by defining the functions involved and ways to achieve them;

g) *Nominal group analysis*: collecting group expert-opinions based on agreed-upon criteria

(Evans and Sommerville, pp. 11-12).

Another set of approaches that students could look at include

a) *Predictive* approach: speculating or envisioning more than one future;

b) *Prescriptive* approach: articulating strongly what should happen

(Margolin, 2007, p. 6).

At this juncture, a relevant principle that was brought up was the principle of sustainability. Dewberry and Sherwin's redefinition of sustainability was introduced; one that requires a broader definition of design that would shape the human-made world in the future. The paradigm shifts that need to happen include envisioning designs as systems of delivery or system innovation, and changing one's thinking from incremental to breakthrough thinking. In addition, a suggested set of integrated design principles was disseminated to help students prepare for Assignment Two.

Reflection

This was another packed module with lots of new ideas to explore. The foresighting concepts and techniques are potentially overwhelming, though there was definitely value in

imparting such knowledge. With a class size this big, it is best to offer alternatives in approaches. For example, the concepts and techniques proposed by Evans and Sommerville are precise and detailed, while the approaches suggested by Margolin are fundamental and easy to understand.

Since the assignment brief had mentioned the component of designing in the visible and invisible realms, and since we had not got to the module on complex systems yet, a student came up to me after class to ask what is meant by designing in the invisible realm. This was a very valid question, which I hoped to elaborate on in the next module.

Module Four – Complex Systems of Designs

Week Ten

To further clarify an aspect outlined in the assignment brief for Assignment Two, examples of complex systems of design, as well as the range of designs between the visible/tangible and invisible/intangible realms were presented. For example, designs in the visible and/or tangible realm might include concrete objects, architecture, visual or symbolic works, motion graphics, and aesthetics. Designs in the invisible and/or intangible realm might include actions, services, policies, procedures, beliefs, culture, lifestyles, behaviours, emotions, psychology, cyberspace, and relationships. Those in between these two realms might include space, environments, and actions (Sample Slide 16).

Using public transport (e.g. TTC) as an example of the design of complex systems in the visible and invisible realms, one could see, in the visible and/or tangible realm: buses, streetcars, subway trains, tracks, signage, bus shelters, platforms, employees/uniforms, maps, passes, tokens; in the invisible and/or intangible realm: quality of service shown by staff, overall quality, e.g. cleanliness, reliability of services, schedules, policies, procedures, pricing, atmosphere in stations, relationships with other transit systems, perceptions by the public, relationships with the public

and the government; in the realm in between: environments, stations, brand/corporate identity, routes, and parking. So the designs already exist, it is just a matter of consciously and intentionally focusing on the overall design of the system as opposed to separate things (Sample Slide 17).

Additional examples could be seen in the design of mobile homes, where, in the visible and/or tangible realm, there are trailers, prefab houses, aesthetics of the designs, structures, residents; in the invisible and/or intangible realm: costs, perceptions, stigma, quality of life, security, stability, mobility, safety, protection and lifespan, zoning, partnerships with other sectors of the society; and in the realm in between: trailer parks, locations, and foundations. Applying breakthrough and radical thinking, while brainstorming for wild ideas, one could envision designing balloon homes, initiating a new kind of lifestyle and behavior, and challenging the definition and use of air space (Sample Slide 18)

Finally, this week's reading, Martin Krampen's article "Semiotics in Architecture and Industrial/Product Design" was summarized and reviewed.

Reflection

It took some time for me to clarify this new idea of complex designs as systems in my own mind. I found that I had to thoroughly and consciously think of concrete examples in the visible/tangible, invisible/intangible realms as well as examples in between the two. After I had clearly written down and drawn out the examples, I realized that such designs have actually been around for quite a while. However, it is definitely an area that still needs exploring as a holistic concept. I am happy that I made it a point to teach this idea and hope that the students were inspired by it.

Module Five – Designers as Visionaries

Week Eleven

Every year, we have the privilege of having a speaker from Gilbert's LLP to share their expertise with our students in this course. Gilbert's LLP specializes on intellectual property law and our speakers have been registered trademark and patent agents. This year, Alison Lester continued to be our guest speaker. In addition, Gilbert's LLP has been extremely generous in creating the Gilbert's LLP Prize in Design Thinking each term, by donating back their honoraria and matching them with their own corporate donations. This prize goes to the student with the highest final mark each term in CCT204: Design Thinking. Ms. Lester's lecture was the key component of this week's class.

With the remaining time, the case study of Buckminster Fuller was shared. Part of the video *Buckminster Fuller: Thinking Out Loud*, a film produced and directed by Karen Goodman and Kirk Simon was shown. Additional information on some of Fuller's innovative designs was provided, including 4D House, Dymaxion Car, Dymaxion Deployment Unit, and Geodesic Dome. While watching the video, I encouraged students to think what qualities a visionary should possess and to ask themselves whether they think they have the qualities to become visionaries.

Week Twelve

Quiz Two was the main event this week (last class of the semester), with the lab test portions taking place in respective lab sections.

Reflection

The course went by quickly and there was a frantic push towards the end to cover all material planned. At times, I felt that there could have been less theoretical emphasis, or at least,

it could have been made more concise and balanced with a more engaging, creative component, even during lectures, to sustain students' interest.

I was not sure how interested students were generally in these new ideas that I had incorporated this term. Occasionally, I did see some glimmer or spark in the eyes of a couple of students, though these were few and far between in a class this big and with such diverse backgrounds and aptitudes. I was most touched when one student came up to me after one class to say how inspired she was by the idea of balloon housing. Even though that was totally a product of my own imagination, I felt that it served the purpose of encouraging students to make some creative leaps and radical propositions in their designs.

Labs

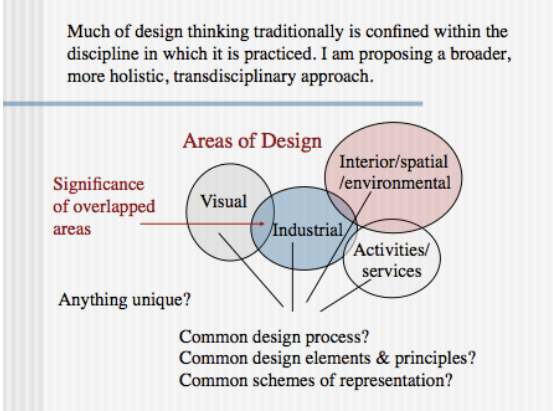
Labs were held in four separate, consecutive sections with identical content following the lecture each week. This term, as in previous terms, I had the privilege of working with Graham Gentleman, who was the technologist for this course. Graham's role was to do demos each week on the technical skills that I had written up and documented in weekly lab activity sheets. The application to be used this term was Adobe Illustrator CS4. Instruction was planned with the intention of building the students' skills from the most basic to the more advanced skills. They would start with doing simple designs and drawings with the most basic tools and by the end of the course, would be able to do more complex drawings, e.g. perspective and isometric drawings, using more advanced techniques, such as gradient mesh. Although the labs appeared to culminate in more advanced skills, emphasis would still be reiterated that some of the best designs could be very simple, economical designs. Thus, simplification and abstraction would prove to be invaluable, basic design concepts. The activities and technical skills explored each week are as follows:

1) Communicating through shapes
    - Shape tools, Shape Modes on the Pathfinder palette, Selection and Direct Selection tools, align/distribute, Transform tools;
2) Drawing using lines and shapes
    - Pencil, Pen, and Smooth tool, Path Eraser tool, Scissors tool, Artistic Brush Libraries, group and arrange, Scale tool, Free Transform tool;
3) Expressing through colour
    - Swatches palette, Colour palette, global, spot, and process colours, PANTONE colours;
4) Using type
    - Text tool, kerning, tracking, leading, Type on a Path tool;
5) Value and texture
    - Liquify tools, Blend, Reshape tool;
6) Flow Chart
    - Using different Shape tools to create the symbols necessary in s flow chart;
7) Presenting statistics
    - Graph tools, custom graph designs
8) Perspective drawing
    - Layers palette, LivePaint
9) Axonometric drawing, in particular isometric
    - Isometric grid
10) Gradient mesh
    - Mesh tool

11) More on mesh objects

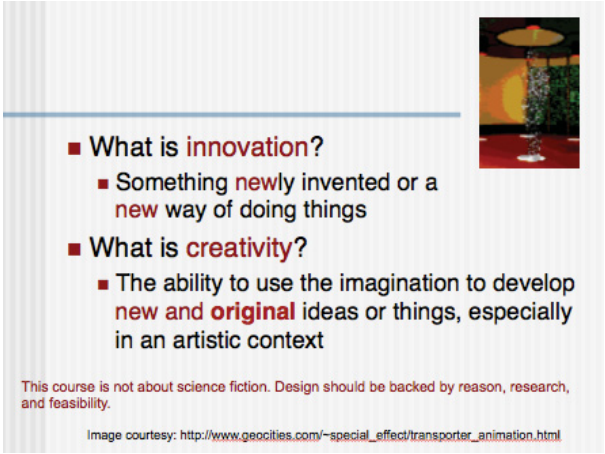
- Envelop Distort, Smart Guides, review Shape Modes on the Pathfinder palette

Sample Slide 1

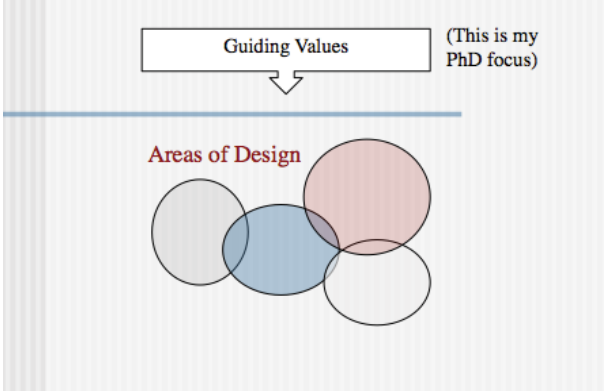


Sample Slide 2

Sample Slide 3



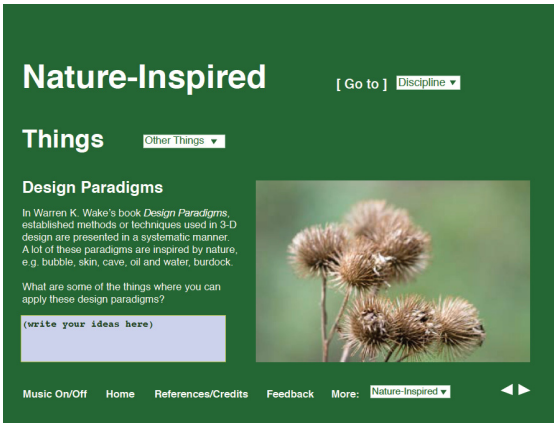
Sample Slide 4



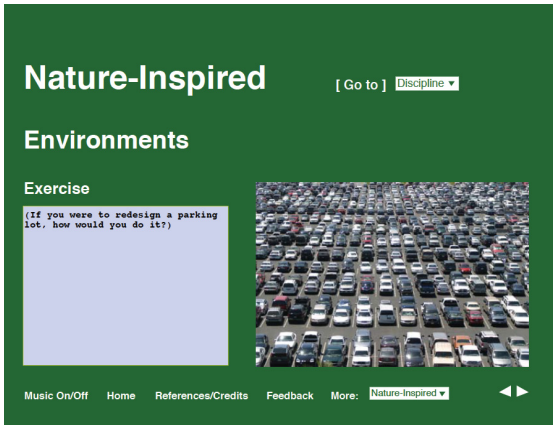
Sample Slide 5

Sample Slide 6

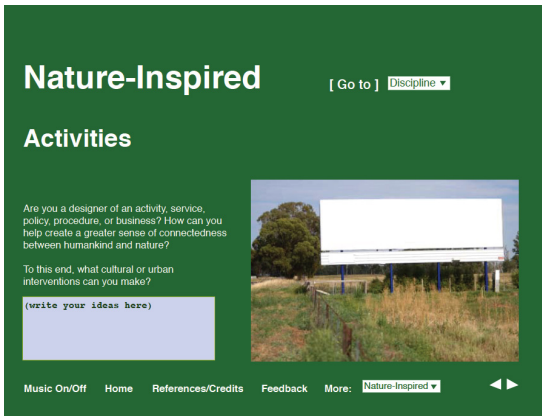
Sample Slide 7



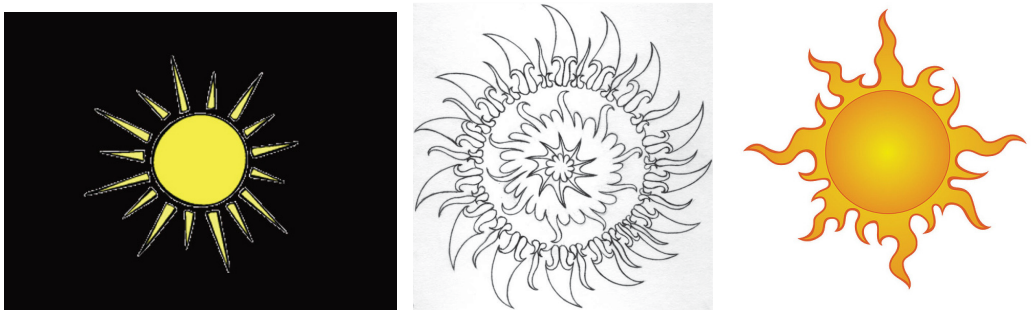
Sample Slide 8



Sample Slide 9



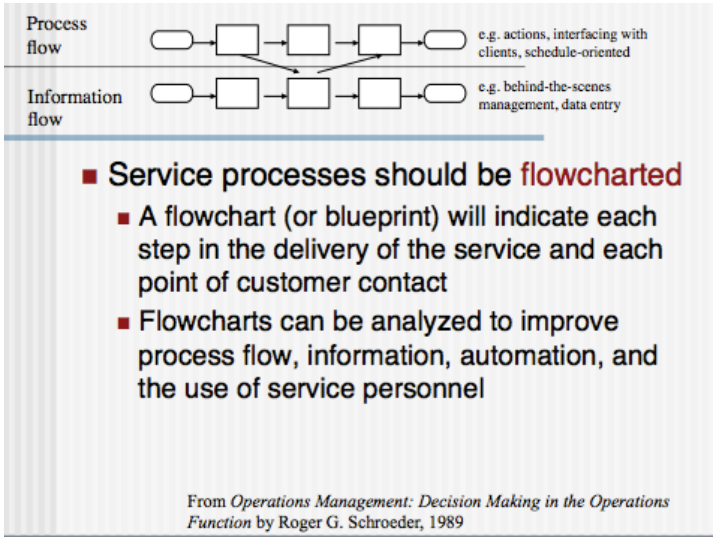
Sample Slide 10



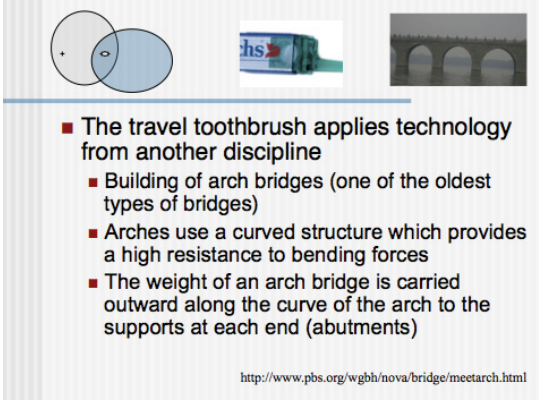
Credit: DJ Josh

Sample Slide 11

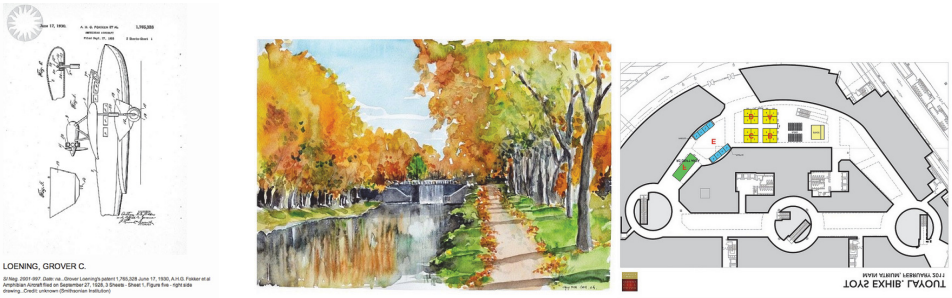
Sample Slide 12



Sample Slide 13

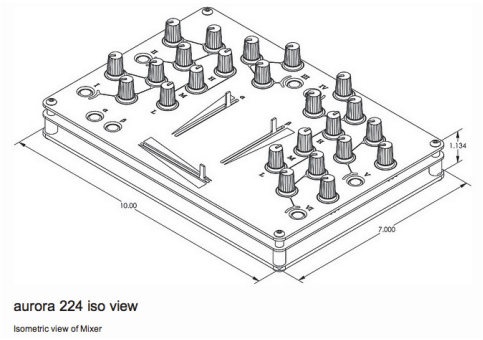


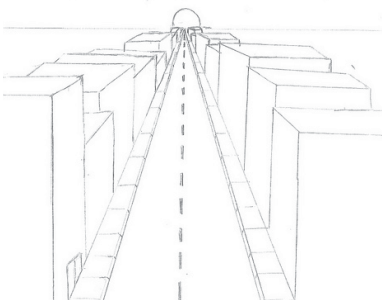
Sample Slide 14



Credit: Guy Moll

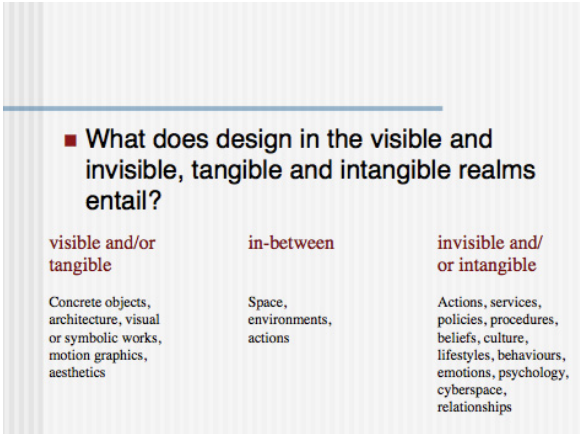
Sample Slide 15



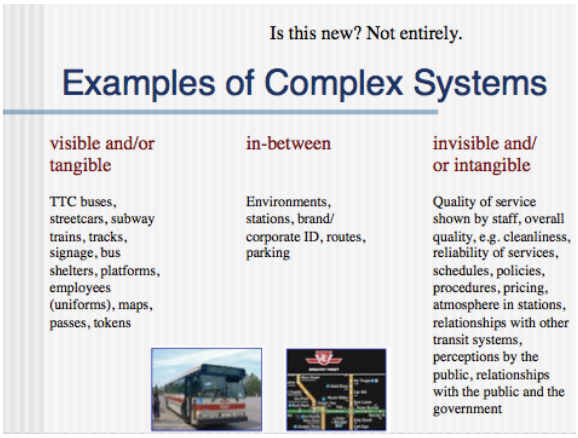


Credit: Chris Newton

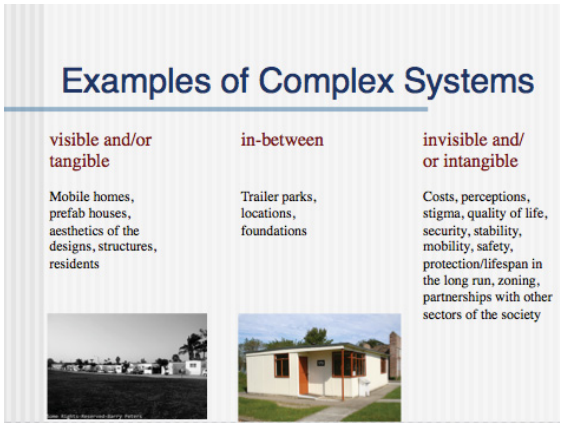
Sample Slide 16



Sample Slide 17



Sample Slide 18



CHAPTER 6: LEARNING FROM STUDENTS

ANALYSIS

In-Class Assignments

One – Most and Least Important Values

In Week Three, an informal survey was conducted. Students were asked to list the 3 values most important and 3 values least important to them. They were asked not to put their names along with their answers, so as to encourage truthfulness. The survey was preceded by a brainstorming session about what values were most important to them. Some words that came up at the time were "caring," "equity," "transparency," "health and wellness," "education," "awareness of safety," "spirituality," "food/nutrition," "sexiness," "family," "integrity," and "peace." Table 4 documents a cumulative list of these values.

Looking at what students had submitted anonymously, it can be observed that while there are minor differences in terms of the three chosen, most important values, some values were repeatedly and most frequently brought up. They are family and friends, health and wellness, respect, peace, love/compassion/care, education and knowledge. Therefore, these appear to be the most important values to the class collectively. There are other values that were brought up quite a few times and therefore could be assumed to be second most important to them. These values are creativity, spirituality/God, efficiency, equality/equity, happiness, loyalty, safety, beauty/aesthetics, honesty/genuineness, and environmentalism. There are yet some values that were only mentioned one or twice, but still, they were mentioned. They are integrity, diversity, creativity, simplicity, democracy, freedom, profit, money, luxury/comfort, change, growth, progress, balance, transparency, independence, character/personality, individualism, forgiveness, trust, fun, lust, and sexiness.

Reflection

It is indeed interesting to find out what values are most important and least important to students. It is equally interesting to find that what one student finds most important, another student might find least important. As well, the most vocal students in class may not necessarily reflect what students generally think. For example, sexiness was brought up as an important value during brainstorming before the survey, but a significant number of students indicated it as one of the least important values in the survey. In fact, one student expressed his/her shock that it was even brought up in class by writing "sexiness????" under the three least important values in the survey. It is also interesting to find out that some of the values that were ranked as the second most voted, important values, were also among some of the most often mentioned as least important. Some examples (other than sexiness) are spirituality, equity, transparency, beauty/appearance, safety or even environmentalism. This finding points to two potential areas of exploration in terms of design education: (a) that an awareness of the importance of environmentalism and sustainability needs to be raised among students and (b) that aesthetics needs to be more clearly taught and understood as a broader sense and use of aesthetics, e.g. as a particular choice and use of design elements or art direction that is appropriate to the context, as well as a kind of aesthetics that transcends appearance. The exploration of a humanistic aesthetic, "which encompasses the intellect, the soul, and all of the senses" (Zaccai, 1996, p. 8) definitely has immense potential in this regard.

Two – Design Paradigms

On the day of Week Five's lecture, a fatal accident happened on Highway 407 near Keele Street. According to a news report: "Police said the driver lost control of the eastbound vehicle….The SUV crashed through a wire fence, then plunged into a cement drainage bay about 10 metres deep" (680 News, 2009, ¶ 3-4). In Week Five, following the lesson on Warren Wake's

design paradigms, students were asked to apply one of the design paradigms featured to design or redesign something that could prevent similar accidents. It was stressed that the "something" could include a material object, part of an object, space, system, graphic, or any combinations thereof.

This activity was intended to see how students would apply design paradigms in real-life situations. By limiting the time given to 5-10 minutes, students were made to come up with creative solutions quickly by consciously applying a creativity method and communicating their ideas accordingly in a simple sketch.

Assignments collected could be loosely organized in a few categories: (a) 1-2 design paradigms were chosen and applied with reason, with enclosure as the the most applied paradigm, e.g. wrapping, bubble, netting, followed by passages (Artwork 1) and bending and flexing (Artwork 2); (b) good, reasonable ideas were suggested but were not directly to design paradigms featured, e.g. use of sensors; (c) design paradigms were used but were not followed through with logical explanations.

Reflection

The vast majority of students showed an understanding of what design paradigms were and could apply this method creatively. Their sketches were simple, sometimes child-like, but illustrated their ideas adequately. A few students applied their own common sense instead of consciously applying the design paradigms as asked, perhaps due to inattention to what was asked or not willing to apply their creativity outside of their comfort level. While most of the propositions were reasonable and did not require a stretch of imagination, e.g. wrapping something with protective materials, a couple of ideas presented involved bigger creative leaps and imagination. For example, one idea has aesthetic potential where the backdrop of the highway shows the texture and pattern of bubble wraps (Artwork 3). Another idea embodies a

more non-traditional, breakthrough type of thinking in incorporating the design of a parachute-type of design in the seat, so that the driver could be ejected in safety. If holistic thinking, e.g. involving a sense of aesthetics, and breakthrough thinking, e.g. involving more radical ideas, are to be encouraged, thus prompting students to come out of their comfort zones, then these examples could be shared and further discussed.

Three: Mind Map or Concept Map

In Week Eight, after a number of creativity methods were introduced, students were asked to draw a mind map or a concept map to explore the key issues of their selected topic for Assignment Two: "Foresighting to Aid the Betterment of Humanity." A mind map generally places the topic of discussion in the centre and spreads out multi-directionally with the related issues, connecting any directly related or indirectly related thoughts. A concept map, on the other hand, could be read like a story, where the topic of discussion is placed at the top and the streams or categories of issues would flow down from the topic in a parallel, linear fashion.

It is not uncommon that students are still deciding on a topic for Assignment Two at this point in the course, so this activity could also be used as an exploratory exercise for students to get more familiar with seeing design as systems and also help them decide what they would like to do. The majority of students chose to do a mind map while a few did a concept map. The assignments fall in two groups, almost in equal numbers: (a) those with an area of design listed as the central topic and (b) those with the values to be promoted listed as the central topic. Some of the more popular topics where areas of design were listed as the starting point include transportation (e.g. cars), clothing, housing, healthcare, and shopping (e.g. malls). Two examples that are more unique in this category include the topics of orphan adoption/sponsorship (Artwork 4), and food and hunger (Artwork 5). Some of the examples where values were listed as the starting point include environmentalism (e.g. saving energy), sustainability, politeness, safety

(Artwork 6), and charity (Artwork 7). As an example, the student who wanted to promote politeness drew her mind map in three directions: to the public, family, and friends. The realm of the public was further divided into the school/workplace and random people. Thoughts associated with these realms include words like "forgiving," "helping," "caring" and "attitudes" (Artwork 8). This is one of the more unusual submissions and it would be interesting to see if the student would follow through with this topic in the final assignment; and if so, how these thoughts would be translated into a design.

Four – Predictive Foresighting Techniques

In Week Nine, after some of the foresighting concepts and techniques were introduced, students were asked to define the predictive approach in foresighting as suggested by Margolin. Of the foresighting techniques proposed by Evans and Sommerville, they were then asked to identify the one/s that would be suitable for the predictive approach and explain accordingly. To summarize, the techniques are trend extrapolation, analogy analysis, "Predict Next Year's Headlines," impact analysis, content analysis, morphological analysis, and nominal group analysis.

Overall, the students could define the predictive approach correctly. Of all the techniques, the ones that were the most mentioned are trend extrapolation and "Predict Next Year's Headlines." However, there were a couple of students who selected the technique of nominal group analysis with especial relevance. One student, for example, explained her choice, using her own words, succinctly in this fashion:

> I feel that predictive approach is defined by difference of opinions – that's what makes problems complex. Step-by-step approach like prescriptive approach is easy for well defined problems where there is a consensus of opinions. For predictive approach, it

would be beneficial to have a group of people thinking about possible future outcomes and try to solve them together. Also, this way, all the complexities of the problem can be looked upon by individuals in the group – different people can focus on different aspects of the problem.

Reflection

Foresighting techniques can be quite overwhelming due to their analytical nature. For this reason, it is also helpful in balancing the creative aspect of design, especially when the consideration of the future is to be taken more seriously in the design thinking process. Perhaps one of the reasons why most students chose "Predict Next Year's Headlines" is because of its intuitive, non-threatening nature, while allowing them to conjure up some vision of creativity. Strictly learning these techniques per se, that is, learning what they are, could be informative and educational but at the same time, potentially dry. It would be even more beneficial, if the format and structure of the course would allow for more practical application, in the form of projects. Nonetheless, it would be interesting to see if any students would actively incorporate any of these techniques in their final assignment, Assignment Two.

Five – Attributes of a Visionary

In Week Ten, I asked students: "In your opinion, what qualities or attributes must a visionary have? Do you think you have what it takes to be a visionary? Why?"

Some of the attributes that came up most frequently involve these qualities: having fresh ways of thinking about things, being imaginative, having confidence, not being afraid, having passion and belief, thinking outside of the box, being creative, innovative, futuristic, open-minded, eccentric, and knowledgeable. As to the question of whether students think they have what it takes to be a visionary, the answers fall in these categories: About equal numbers of

students said that they had what it takes to be a visionary and those who said that they did not have what it takes to be a visionary. While the ones who answered "yes" appeared to be quite confident in their disposition and skills, those who answered "no" expressed their lack of knowledge and/or skills, or some other personality traits such as pessimism or giving up too easily as the reasons why they felt they could not be visionaries. Interestingly, quite a few students said that they believed that everyone could be a visionary and some who said that they did not think that they had "what it takes to be a visionary now." One or two students answered: "I don't know," while another couple clearly articulated that they had some skills necessary to be a visionary, but not other skills. For example, one student said:

> I don't think I am a true visionary because I am comfortable with the way most things work. I do notice design flaws from time to time but I do not feel inclined to act on them. While I believe I have and can achieve the leadership qualities required to be a visionary, I do not believe I have the necessary design qualities required of a visionary.

Another student expressed a similar opinion:

> I think that I possess one half of the required qualities to be a visionary. I do possess the creative thinking to come up with ideas to solve complex problems, but my technical abilities are still not completely sharp to fully achieve my goals.

Another student said:

> I don't think I have what it takes to be a visionary simply because there are so many visionaries already, and what I usually envision already exists. I'm constantly worried about my visions being unreasonable and unrealistic and that's something I don't believe visionaries would do. Visionaries stick to their ideas and have confidence in them.

Reflection

The diversity of the answers received has triggered a trail of mixed feelings and thoughts. At first, I wanted all my students to feel that they could be visionaries. While this remains an idealistic goal, it may not be a realistic or even a necessary goal. While a good number of students have the confidence necessary to succeed, in this case as visionaries, a good number of them do not. This negative sentiment may stem from the lack of a certain mindset or a certain type of knowledge or skills. As an educator, the very least that I want to achieve is to furnish my students with the necessary knowledge and skills, and cultivate the necessary mindset, so that students feel that they could do it if they want and choose to do it. Alternatively, they may be directed to the additional resources necessary to further their growth. Surely, the point of teaching is to empower and to help students feel that they are succeeding, not failing. If there is a chance that they feel that they are failing simply because they "are not visionaries," then this whole idea of encouraging them to be visionaries may need to be reassessed, re-articulated, and/or reconfigured. One potentially important message to communicate to students is that there is power in teamwork and that everyone could contribute whatever ideas and skills they have within their abilities. Perhaps this might take some of the pressure off and reinforce the idea that collectively, we could make changes through design.

There is yet another way of looking at this experience. If the students have articulated the qualities of say, having imagination, innovation, creativity, knowledge, open-mindedness, confidence, courage, passion and belief, as attributes of a visionary and they feel that they don't have what it takes to be one, then in other words, these may be the areas in the curriculum that could be further strengthened.

Discussions

One – Emerging Trends

There were two discussion threads that students were encouraged to participate in. The topic of the first thread is "Emerging Trends." There are a few common trends that students repeatedly brought up. The one trend that was mentioned most is going green, involving initiatives that would save energy and reduce carbon footprint. This trend encompasses products such as hybrid cars and solar panels, services such as grocery shopping, and passing of laws, e.g. charging 5 cents for each plastic shopping bag. It also involves a change in behavior, such as encouraging people to reuse and recycle, as well as investing in similar efforts in developing countries. Another trend that was mentioned quite a few times is that of the increasing use of the Internet, in particular in the areas of online shopping and social networking. The success of such websites such as Facebook and MySpace are self-explanatory of this trend. Likewise, the trend of technological convergence was mentioned at least a couple of times, such as in combining different technologies in one digital device, or selling a variety of different products in one place. Other students mentioned the development of 3D technology, accessibility to smaller, cheaper, and/or more efficient products as other emerging trends.

While most students who participated in this thread discussed the trends as they were at that point in time, a couple of students were able to discuss emerging trends while forecasting how those trends could possibly develop in the future. For example, one student mentioned the use of the cell phone as an increasingly necessary device:

> [T]he majority of people that have [a] cell phone [could] go on the Internet any time they want…people get to check email[s], Facebook to make contact with friends or family wherever they are. This trend will expand broader in the future and will [result in having]

> a cell phone that [commonly has Internet access]. I am thinking that the new design of a cell phone in the future will be [where] people don't need to bring a wallet or identification, all their identification will be in [the] cell phone as [their] ID, and also the cell phone is like [the] computer, people no longer need to bring [their] computer with them; all they need is the cell phone…also people don't need to bring cash with them, they can put money into the cellphone and whenever you want to purchase something [you] just need to scan it.

Another student also attempted to make a forecast in the area of land reclamation:

> An emerging trend [that] I believe will affect our society is the shortage of lands available on [e]arth where humans might have to adopt a new [lifestyle] such as living under the ocean or in another planet. Many countries have started land reclamation to create more space for the next generation. These new lands are created from [the] sea or riverbeds. Yet even with the construction of land reclamation, it is arguable that the whole population can be fitted in the future. Scientists have already started looking into the possibility of living on Mars in response to this emerging trend.

Reflection

It seems that a design lesson surrounding trends would be most beneficial if it consisted of three parts: (a) identifying the trend including its particulars, i.e. concrete manifestations and (b) a forecasting activity, e.g. using the predictive approach to come up with some possibilities, and (c) a design activity, translating one of their visions into a prototype. Such an activity is a good example of design thinking, balancing both imaginative, creative skills with analytical skills, while taking steps to shape the future through design. In the last two examples in particular, the students were seen making a divergent leap or practicing breakthrough thinking with enormous potential.

Two – Being a Visionary

In this thread, students were asked to state who they believed to be a visionary and why they admired them. The responses could be grouped in different categories:

- Scientists/Inventors:
    - Alexander Graham Bell, Thomas Edison, Albert Einstein, David Suzuki, Isaac Newton
- Filmmakers:
    - Mike and Matt Chapman, Jean-Luc Godard, Hayao Miyazaki, Stanley Kubric
- Computer programmers/designers/developers:
    - Tim Berners Lee, Jonathan Ive, Mike Lazaridis, Mark Zuckerberg
- Architects:
    - Steve Glenn, Zaha Hadid,
- Designers:
    - William Morris, Louis Vuitton, Coco Chanel
- Artistes:
    - Lady Gaga
- Athletes:
    - Jacques Plante
- Entrepreneurs:
    - Dhirubhai Ambani
- Activists:
    - Enzo Simone

- Politicians:
    - Pierre Elliot Trudeau, Gandhi

While the achievements of these individuals could speak for themselves, the reasons for which they were identified as visionaries are also indicative of the qualities that the students admired. For example, they had made some innovative inventions; they kept trying with determination; they used their imagination as a tool; they raised awareness and set standards; they were able to demonstrate innovative styles; they were able to combine function with aesthetics; or they built an empire.

Reflection

Regardless whether students wanted to become visionaries or not, or whether they believed they could be visionaries, they had indicated qualities or accomplishments that they aspired to. These qualities are in fact hints where areas or approaches in design education that could be enhanced. For example, more creativity and innovation methods could be taught, so that they are not simply gifts that one is born with (or without), they are in fact be skills that could be learned. As indicated in the diverse backgrounds of these visionaries, such creativity and innovation methods are ideally applicable to many disciplines. For example, the method could help students come up with an innovative style in terms of art direction, but in an interdisciplinary approach, this same method should also be able to help students come up with a new business or technology, for example. If the behaviour or attitude of not giving up, trying with determination is deemed critical for success, then the workflow of the projects in the curriculum could emphasize this aspect, e.g. multiple iterations and testing are encouraged. Goals could also be formulated and articulated by students themselves, so that their accomplishments would be more meaningful and relevant to them in the end. Importantly, examples, case studies, or role models from diverse

backgrounds and disciplines could be used, to encourage the potential and aspirations that are still budding and are yet to blossom.

Assignment One

To recap, students were asked to come up with an endeavour that would reflect the values that were most important to them. This could be a product, a service, an organization, a business initiative, a place, or any combinations thereof. A pictorial component integrating a typographic component with the name of the endeavour was to be part of the assignment, along with a write-up. The class average was 74.69 out of 100 for this assignment, which was "good," according to the grading scheme set out by the University of Toronto Mississauga. The evaluation scheme was as follows:

- Value and originality of the endeavour 10%
- Appropriate art direction and consistency in look and feel 20%
- Appropriateness, e.g. ability to capture the activity 20%
- Clarity, e.g. legibility, handling of details 20%
- Effective use of design elements and principles 10%
- Effective use of Illustrator skills 10%
- Write-up, e.g. organization, flow, grammar, theories applied 5%
- Presentation of the project, e.g. neatness, quality of printout 5%

Since students did not do too well in Quiz One, I decided to add some bonus marks to Assignment One, with each student getting 5 additional marks out of 100 on top of the marks that were given to them by the marker. Out of the 158 students officially enrolled in the course (maximum was 160), with the bonus marks, one student got 94 (unfortunately she did not sign the

consent form to participate in this study). 50 got 80-89. 84 got 70-79. 18 got 60-69. One got 50-59, and 4 students did not hand in their assignment.

There were two key objectives for this assignment. Firstly, I wanted to see how students would translate what values they deemed important into an activity, be it an activity of organizing an event, forming an association, designing a product or service, or any other kind of endeavour. Secondly, I wanted to see if they could appropriately and effectively communicate this endeavour through semiotics. In other words, the resulting design should display a relevant look, elicit an appropriate feel, and communicate a clear message, i.e. what the endeavour is/does. All these could have been achieved successfully if design elements were chosen and used effectively and if design principles were demonstrated clearly.

Overall, all students made very good attempts in this assignment. Most students translated their endeavours into concrete, well-defined endeavours. A wide range of values were represented, from community (Artwork 9), beauty and luxury, (Artwork 10), uniqueness (Artwork 11), health and activity (Artwork 12), caring of seniors (Artwork 13), love and compassion (Artworks 14-15), freedom (Artwork 16), to environmental friendliness (Artworks 17-19), among others. There was one particular endeavour that was intended to promote a number of different positive values through a line of T-shirts. While the name of the endeavour/company ("Value") was not visible on the T-shirt, the chosen values in this example (loyalty and leadership) were communicated nicely in the illustration (Artwork 20).

Reflection

Though the class average for this assignment was good, the areas that could improve most are still related to execution. For example, students still had challenges demonstrating a well-defined art direction that otherwise would bring character and personality to their designs. The adjectives that one would use to describe the designs are crucial, as they are also reflections

of the values behind the designs, e.g. warmth, friendliness, back-to-nature, rationality. If one could not use any specific adjectives when describing a design, then the design has become generic. In other words, a better demonstration of semiotics through a chosen art direction (sense of aesthetics) or creative direction (display of semantics) is needed. If one were to use the analogy of form and function, one could say that they are inextricably related. Such principles are not only applicable to this particular assignment, they also form the basis of many other areas of design. Once the art/creative direction is established, the right amount of details in the form of design elements have to be used. Often students put in way too many details thus jeopardizing the clarity of the art direction and message, not to mention a unified, balanced composition. The sense of proportion could sometimes be improperly configured, thus making details such as text illegible. Other times, spacing and alignment might be off. Other times, the paths might be jagged. In other words, the skills of execution are still important, perhaps equally important as guiding values. Although one could argue that design thinking is primarily focused on the "thinking"; at the very least, an appreciation of how good design (if the above defines good design) is done is required. This option of teaching design appreciation vs. design doing poses a dilemma; since even though it may be theoretically logical, students who attend this program do so because they value the hands-on approach. In other words, they still want to learn how to do it. They still want to acquire the skills of doing design.

Quizzes

There were two quizzes in this course: Quiz One was held in Week Seven and Quiz Two was held in Week Twelve. Both quizzes consisted of 30 multiple-choice questions to be completed in 45 minutes. They were straightforward quizzes where a proper understanding of theories and principles explored in lectures and technical skills learned in labs were tested. Quiz One was worth 15% and Quiz Two was worth 10%. The class average for Quiz One was 5.16 out

of 10 and for Quiz Two, 4.51 out of 10. The nature of the questions was the same as other years, but students did more poorly overall for this class. For example, in the fall term of 2008, the class average for Quiz One was 6.43 and for Quiz Two, 4.51. In the summer term of 2009, the class average for Quiz One was 7.68 and for Quiz Two, 4.39. In the fall term of 2010, the class average for Quiz One was 6.24 and for Quiz Two, 4.12. In the summer term of 2010, there was only one quiz at the end and the average was 5.69. Thus, generally students would do worse in Quiz Two at the end of the course and better at mid-term.

Reflection

Even though the performance demonstrated in quizzes is normally marginal, I think that it is still reasonable to expect students to know what value is as a design element or whether balance is a design element or a design principle, for example. This type of accuracy would contribute to the overall repertoire, e.g. in language, enabling students to talk about design comfortably and competently. As Martin suggests in his proposed Personal Knowledge System, the three components of stance, tools, and experiences, are all beneficial towards the mastery of design thinking. Quizzes still remain to be a simple, straightforward method of testing basic knowledge. Alternatively, in terms of helping students to build up the use of language to talk about design, i.e. the rhetoric, activities such as regular critiques and show-and-tell type of appreciation could also be considered.

Lab Test

The lab test was held in the lab portion of the class and students were required to attend the lab section in which they were officially enrolled. Since there were four consecutive sections, to prevent students from telling other students what the lab test was, Internet access was disabled

during the test and the test for the last two sections was different. Students were also asked to stay till the end of the lab so that the turnover time between sections was minimized.

This year, students were asked to redesign a sofa or a coffee table. In the first version of the test, students were asked to apply the SCAMPER checklist as a creativity method to the redesign of a sofa. To recap, the SCAMPER checklist is a brainstorming method asking for changes to a design in the following ways: (a) substitute, (b) combine, (c) adapt, (d) modify/magnify/minify, (d) put to other uses, (e) eliminate, and (f) rearrange/reverse. In the second version of the test, students were asked to apply the creativity method of Conceptual Decomposition to the redesign of a coffee table; meaning that they would come up with the design by examining the object by breaking down the physical domain and by examining the object by breaking down its functions. In both versions of the test, students had to illustrate their design in an isometric drawing, accompanied by a brief explanation. Colour was optional.

The most common mistake made was that, instead of doing an isometric drawing, some students did another type of axonometric drawing, i.e. dimetric or trimetric. The second most common mistake was in time management. For example, the explanation was missing or details of the design were mentioned in the explanation but they were not illustrated. Otherwise, the designs were all quite good (class average was 7.42 out of 10) with variations in degrees of application of the creativity methods, originality, and quality in execution. While most designs demonstrated nice, clean lines and form (Artworks 21-22), others demonstrated additional qualities through colour and texture (Artworks 23-25). A few designs were particularly innovative, showing bigger divergent leaps and uniqueness in terms of form or function. For example, one redesigned the sofa without the back (Artwork 26) and another designed it like a bunk bed (Artwork 27). Another student redesigned the coffee table with a built-in stove (Artwork 28).

Reflection

It is always very gratifying to watch the students do the lab test, walking around the room, witnessing their designs take shape in front of my very own eyes and in a very short period of time (50 minutes). This year, it was no exception. Asking students to apply a creativity method and then to illustrate the design in an isometric drawing make a positive recipe for productivity. If there is a creativity method to apply, something creative is bound to be produced. It is just a matter of originality that differs. Likewise, if there is a solid drawing or sketching technique to be learned, such as perspective or axonometric drawing, then students should be able to depict their ideas. It is just a matter of the quality of execution that differs, in terms of using the software (e.g. using the pen tool, shape tools, and guides), pushing their comfort levels (e.g. drawing curvatures on an isometric grid), using design elements (e.g. line, shape, colour, texture), and applying design strategies (e.g. proportions, repetitions). In other words, teaching creativity methods and drawing/design skills create a win-win situation, helping the design thinking process materialize and take shape. An even better addition to this recipe would be the teaching of breakthrough thinking or revolutionary innovation techniques, enabling students to take bigger, more original creative leaps.

Assignment Two

The final assignment has always been the most demanding project, having both an essay component as well as an illustration component. It is usually a test of not only how thorough students can think and research, argue and imagine, but also how well they can write and translate their ideas visually. During the last two weeks of the semester, it is also a test of how well students can manage their academic obligations, having deadlines to meet in all courses. Given this context, I was pleasantly surprised to see that the class average for Assignment Two was

73.05, which was good. A few students had dropped the course by this time, but out of the ones remaining, one student got 90, 13 got 80-89, 84 got 70-79, 35 got 60-69, and 5 got 50-59.

Following up on some of the students whose mind maps were featured previously, a couple of them had followed through on their original topics with a narrower focus, and the rest had pursued new topics altogether. The student who had indicated that she wanted to promote the value of politeness, ended up focusing on the redesign of seats on the Mississauga Transit buses, namely priority seats for the elderly and those with physical disabilities. Another student who indicated that she wanted to design something to solve the issue of hunger ended up addressing the issue of clean water in developing countries. Specifically she proposed the design of a sustainable water filtration system used for collecting rainwater. Included in her discussion was also a forecast of what the world would be like in 50 years and how the design should be maintained:

> In 50 years, the world would most likely [be] on the verge of losing all of its natural water resources if humans don't change the way they use water. Also, a lot of human lives will be lost especially in third world countries…the constant pollution and increase in toxic waste will have contaminated Earth's natural water resources even more…According [to] the United Nations, in about 50 years more than half [of] the world will be without water. On average, a human being needs 20-50 litres of water a day for basic needs yet about 40% of the population in the world do not have access to fresh water….Post-delivery services and actions which will be taken to enhance the effectiveness of [the] proposed design are filter changes, repairs if necessary, upgrades if applicable, surveys to estimate effectiveness, efficiency, and sustainability of proposed design. Surveys should also ask for recommendations for better design, what the villagers would like to see done to proposed design, whether or not they like the design, and where they find it easy to use.

Another student whose original mind map proposed a topic surrounding safety ended up focusing on the redesign of subway platforms to prevent suicidal attempts (Artwork 29).

Looking over the topics chosen, the overwhelmingly popular topic was redesigning cars with green or sustainable, energy-saving features. The incorporation of other broad areas of design, such as the provisions of charging stations for electric cars in the city, recharge strips in residential areas (Artwork 30), double-decker highways (Artwork 31), or the redesign of the urban environment with more bike lanes, were also considered. Throughout most assignments, the elements of sustainability and environmental friendliness were included, regardless what the topic was. Examples include window designs (Artwork 32), irrigation systems (Artwork 33), solar roofs using Shape Memory Alloys (Artwork 34), recycling systems (Artwork 35), and interactive solar-powered street lamps (Artwork 36).

One topic that particularly stood out was that of the redesign of public housing, where the role of aesthetics in possibly changing the perception of inferiority, typically associated with low-cost housing, was emphasized, thus bringing forth the value of egalitarianism (Artwork 37).

While most assignments focused primarily on the design of the visible realm, in one assignment, the consideration of reducing noise pollution in the redesign of public transport was specifically pinpointed as redesigning in the invisible realm:

> If quietness could be promoted, it will decrease the percentage of stress level as people can rest themselves through a better environment. In the invisible realm, the design cooperates with the world for acceptable noise level and light level to humans. A person's normal conversation is around 60 decibels, if the sound level is to be twice as loud, it will increase 10 decibels (Carol). Therefore, the design should be programmed sensitive to 75 or higher decibels for it to [light] up and project light. It would also follow the world standard of acceptable light level which is 65Hz.

Accordingly, an automatic noise sensor spotlight system within modes of public transportation was proposed (Artwork 38). Another memorable example was where a pair of students who worked as a team came up with a more radical design that involved the outer space as the invisible realm; their design was a spaceship containing a system of hotel rooms that would accommodate space travel in the future (Artwork 39).

Very few students dedicated much of their argument to the role of foresighting. However, one student in particular proposed the design of "The Animal RoadTrip Project," intended to reduce road kill, based on foresighting:

> Using forecasting techniques, one is able to analyze and predict outcomes based on current trends. One of the major patterns of change occurring today is the expansion of suburbs around Canadian metropolitans. As the population grows steadily, so does the number of construction sites for residential and commercial buildings. Developing roadways and highways is inevitable for the increasing number of vehicles and the effect of these fast growing social needs have a direct impact on wildlife. It is important to understand the idea of reciprocity that points out the inseparable relationship between an organism and its environment (Donar, 2009). The animals cannot be separated from their surroundings and the increasing danger of human expansion is inescapable for them. Thus, it is up to us to take responsibility for the consequences of our actions….Assuming there is no alteration in the rate of change, trend extrapolation is used to study the effects of a growing population on the amount of vehicles on Canadian roads in the next 50 years. Data collected in 2005 by Transport Canada predicts that there are 557 light vehicles (cars, station wagons, vans, sport utility cars, and light trucks) on the road for every 1,000 people (Transport Canada, 2007). Statistics Canada expects a steady increase in the country's population as recorded in table 1 (Statistics Canada, 2008). By combining these figures, the increase in the number of light vehicles can be roughly estimated.

The student continued to propose the use of the prescriptive approach "to promote the collective value of caring for wildlife." The thoroughly researched essay integrated principles learned throughout the course, such as the principles of sustainability, functionality, and progress; along with the foresighting techniques, culminated in the proposal of "The Animal RoadTrip Project":

> In terms of the natural environment, it is designed to constraint the animals into a safer pathway. The sound dissuasion device would have prototypes and engineers whose goal it would be to bridge the gulfs of execution and evaluation even further (Donar, 2009). Ultimately though, the Animal Roadtrip Project follows the principle of progress. One based on future-thinking, environmental sustainability, technological innovation and alteration of human behavior and lifestyle to accommodate other species that live around us.

(Artworks 40-45).

Reflection

In my experience, it is not unusual that the majority of students would rush through the assignment at this time of the semester. As all major assignments are due around the same time, it would take the most disciplined and driven students to give their best to this final assignment. The result is that the development of the essay is usually superficial, with some evidence of research but very little, conscientious integration of theories. The conception of designs is usually indicative of incremental thinking, with a few exceptions where ideas are radically innovative, substantiated by reason and research. The assignments from students this year were of a similar nature, though there was at least one brilliant essay, that was convincingly and consistently well followed through. Putting the writing aside, the creative ideas demonstrated were generally innovative, at least in an incremental way, and were illustrated nicely. I think that from what I have observed from the lab tests and the final assignments, students could apply themselves quite

well in isolated design activities, though they do not necessarily have the passion, dedication, discipline, maturity, or simply time to think of design as a world-changing tool or themselves as visionaries. This is not to say that this is a problem, but it does lead me to better understand or plan in terms of the weighting of components in some such curriculum. For example, the majority of the emphasis could be placed on equipping students with solid design skills and knowledge, including theories and principles, thus building up a repertoire of language and paradigms. A secondary emphasis could be placed on creativity and innovation methods and other techniques, such as foresighting techniques. Finally, the least emphasis could be placed on becoming visionaries and formulating their own philosophy and direction. This proposition could be understood and visualized in the shape of a pyramid, with "vision" at the top, "methods and techniques" in the middle, and "skills and knowledge" at the bottom.

Surveys

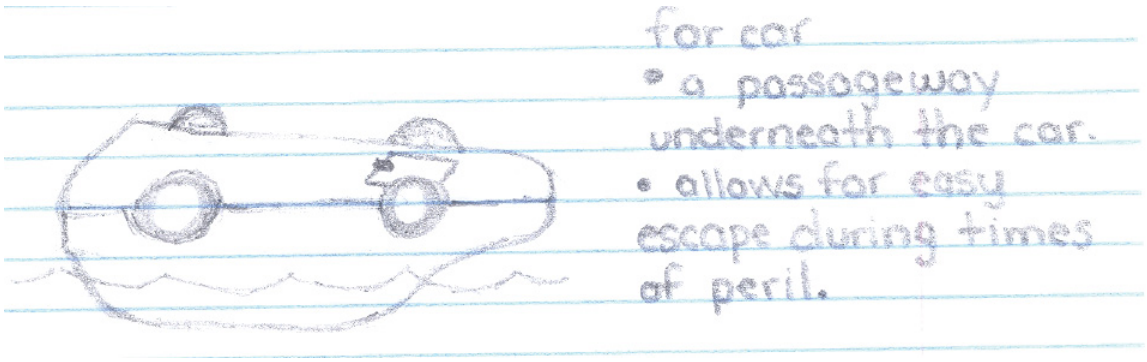
In the last week, I gave out a survey for students to complete (Appendix E). There was also a separate, standard UTM student survey that was conducted in Week Nine. While the majority of the students indicated that they had learned from the course, there were also a number of students who indicated that a personal research project should not be more important than the teaching of the course or the students in it. In fact, both the director of the program at UTM and my associate dean had cautioned me that the students might be prejudiced if they were made aware of the research project early on in the course. However, the requirements of the ethics committees were such that consent forms must be signed as early as possible. I think that the fact that students were aware that the revised curriculum was part of a research project and that they were subjects, had something to do with the remarks, although I have no doubt as well that in time, when the content is appropriately tweaked, that the reception would probably be more positive.

Table 4: Survey of Values: Cumulative List of All Submissions

3 Most important values	3 Least important values
• Love, respect, honour	• Transparency, food, appearance
• Family, health, wellness, happiness, peace	• Sexiness, safety, power
• Spirituality, family, self-awareness	• Equity, transparency, friends
• Health, education, accessibility	• Aestheticism, transparency, spirituality
• God, family, good living	• What people think, status quo, reality TV shows
• Passion, freedom, humanitarianism	
• Spirituality, honesty, caring	• Environmentalism, being conservative, family image
• Honesty, equity, intelligence	
• Justice, forgiveness, love	• Ethnic origin, nonsense
• Family and integrity, health and wellness, aesthetics	• Inefficiency, ethnicity, nonsense
	• Luxury, sexiness
• Food and nutrition, peace, equity	• Transparency, spirituality, tradition
• Health and wellness, family, simplicity	• Transparency, advancement, spirituality
• Friendship, family, compassion	• Commercial, technology, transparency
• Education, family, friendship	• Transparency, spirituality, nutrition
• Honesty, down-to-earth, artistic/musical, loyalty	• Materialism, sexiness, stolen wealth
	• Materialism, fraternity/sorority, sexiness
• Integrity, honesty, loyalty– family and friends	• Environmentalism, sexiness
	• Greed, anger, wealth
• Friendliness, happiness, well-being	• Rules/laws, nurturing?, secrecy
• Efficiency, elegance, originality/uniqueness	• Sexiness, luxury
• Family, health, caring	• Equity, rich, truthfulness
• Spirituality, peace, purity	• Profit, spirituality, awareness and safety
• Elegance, individuality, simplicity	• Equity, spirituality, sexiness
• Health, awareness of safety, caring	• Popularity, what people think, money
• Family, health, education	• Equity, environment
• Food and nutrition, health, family	• Spirituality, religion
• Family, friends, education/career	• Wealth, comfort, luxury
• Religion, entertainment, longevity	• Fame, money, profit
• Family, beauty, comfort	• Luxury, profit, integrity
• Awareness of safety, efficiency of products or services, peace in family	• Sexiness, awareness of safety, power
	• Spirituality, luxury, timeliness
• Family, education, health and wellness	• Sexiness, food, physical appearance
• Education, health, safety	• Fashion, spirituality, equity
• Family/friendship, education, equity	• Sexiness, wealth, having a relationship (boyfriend)
• Health, safety, family	
• Food, enjoyment, social interactivity (with friends and family)	• Sexiness, wealth, drinking
	• Spirituality, sexiness, transparency
• Peace, environmentalism, family and friends	• Entertainment, sexiness, transparency
• Caring, nutrition, integrity	• Spirituality, faith, sexiness
• Family, respect, health and wellness	• Beauty, luxury, flexible
• Love, respect for others, peace	• Food, sexiness, superiority
• Loyalty, honour, respect	• Wealth, outer beauty, popularity
• Family, equity, education, discipline	• Transparency, pride, spirituality
• Caring, integrity, family	• Spirituality, integrity, pride

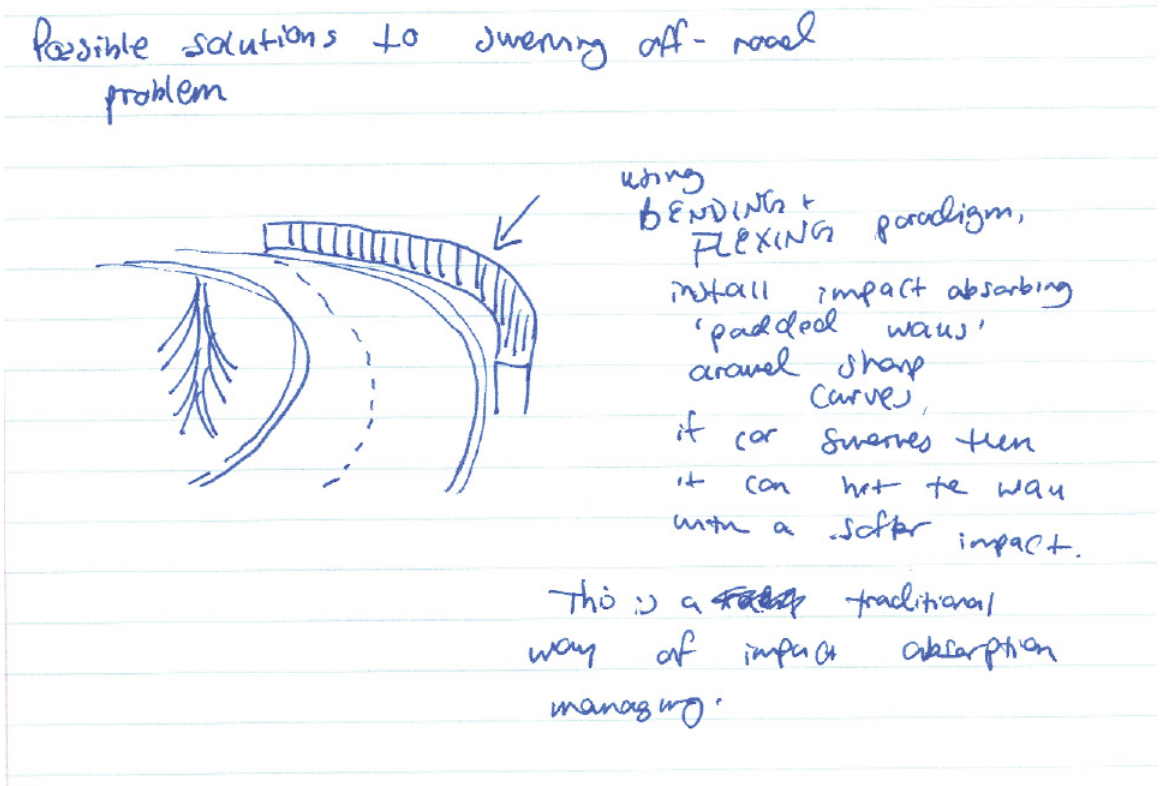
• Happiness, love, equity, overall well-being • Family, caring, equity • Respect, honesty, health • Health, beauty, security • Cost, health and wellness, caring • Family/friends, creativity, achieve one's goals • Health, love, happiness • Creativity, sexiness, caring • Family, education, sensibility • Heart • Family, happiness, music • Wealth, beauty, relationship • Knowledge, wealth, health • Family, love, beauty • Passion, creativity, time • Artistic integrity, being genuine, loyalty • Loyalty, integrity, humour • Education, money, family, health • Sexiness, food, fun • Spirituality, confidence, family • Family, integrity, organization • Health, friendship, equality • Family, diversity, health • Family, food, education • Caring, gratitude, sharing, unselfishness • Family (love, loyalty), progress, love, harmony, balance • Morality, respect, love • Profit, education, beauty • Family, health and wellness, beauty • Integrity, equality, freedom • Efficiency, innovative, transparency • Family, knowledge, health • Luxury, comfort, profit/monetary value • Environment, equality, democracy • Personality/character, independence, family • Love, lust, equality • Creativity, being yourself, family • Honesty/trust, change, growth, respect • Health, peace, money • Family, integrity, knowledge • Family, beauty, helping others • Capitalism, individualism, equity • Family, education, health/wellness • Efficiency, equity, preserving nature	• Spirituality, food, equity • Stability, religion, safety • Fame, popularity, extreme wealth • Violence, destructiveness, superiority • Power/money, sexiness, beauty build, dominance • Religion, spirituality, equity • Security, transportation, spirituality • Luxury, nutrition, environmental awareness • Dishonesty, equity, negativity • Money, fame, recognition • Peace, equality, compassion • Efficiency, food, work • Education, transparency, socializing • Spirituality, equity, transparency • Sharing, spirituality, transparency • Sexiness • Greed, temper (hot-headed people), money • Materialism, spirituality, equity • Food, appearance • Safety, spirituality, nutrition • Fame, power, political • Sexiness, education, greed • Luxury, spirituality, equity • Sexiness, money, honesty • Equity, caring, love • Sexiness !!!???, food • Food, spirituality, transparency • Environmental care, money, spirituality • Power/control, popularity • Compassion/caring, environmentalism, spirituality • Sexiness, food, family • Political, nutrition, material • Transpiracy?, privacy, awareness of safety • Spirituality, beauty, wealth • Education, spiritualism, nutrition

Artwork 1: Application of Design Paradigm – Passages



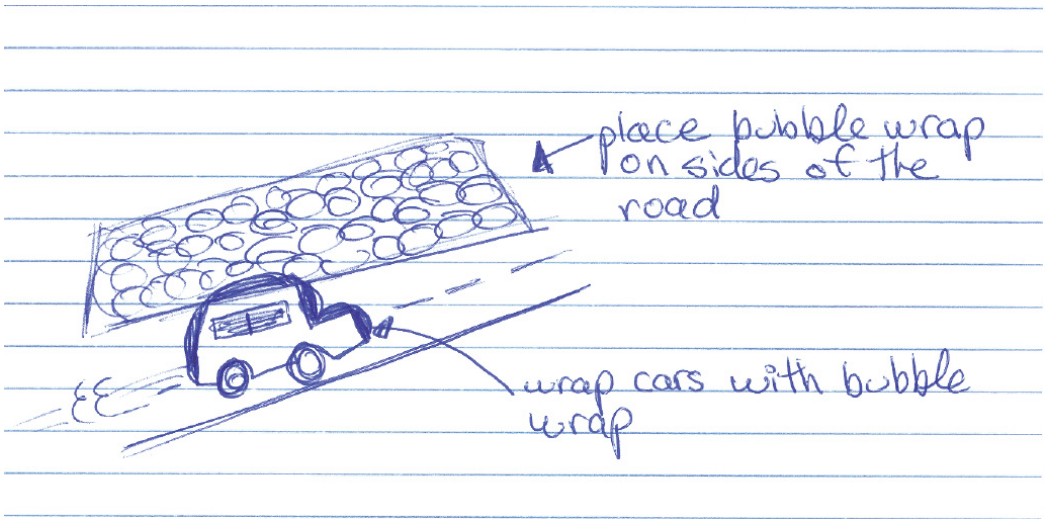
Student: John Spagnolo

Artwork 2: Application of Design Paradigm – Bending and Flexing



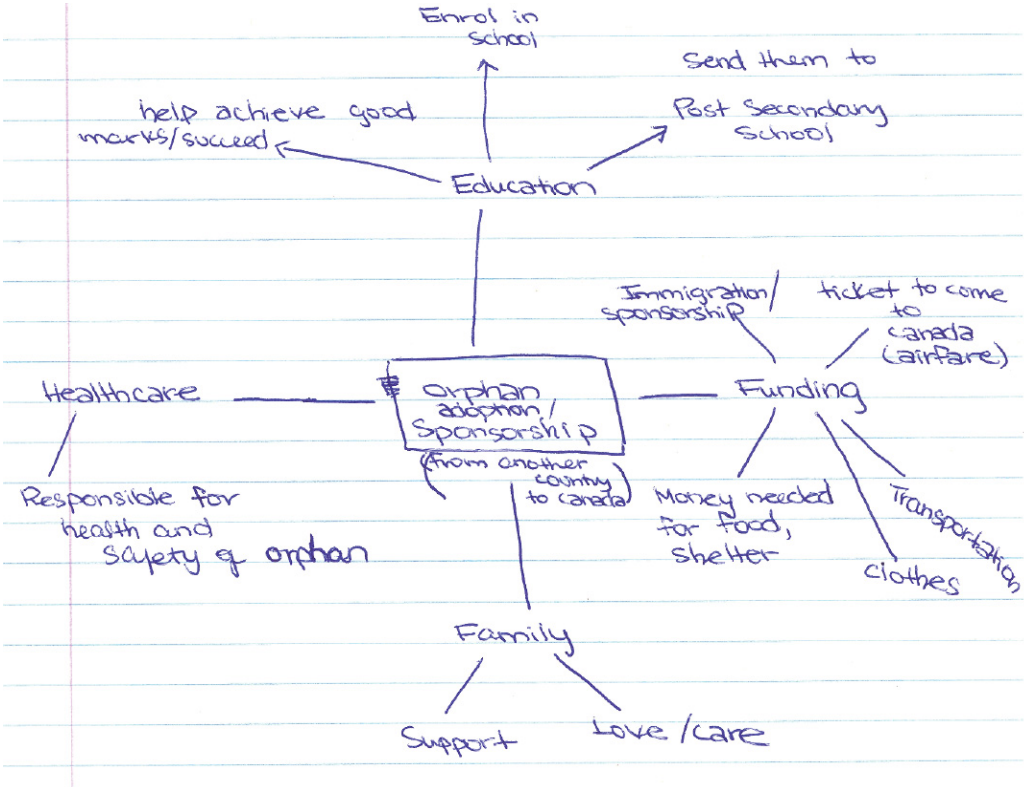
Anonymous Student

Artwork 3: Application of Design Paradigm – Wrapping



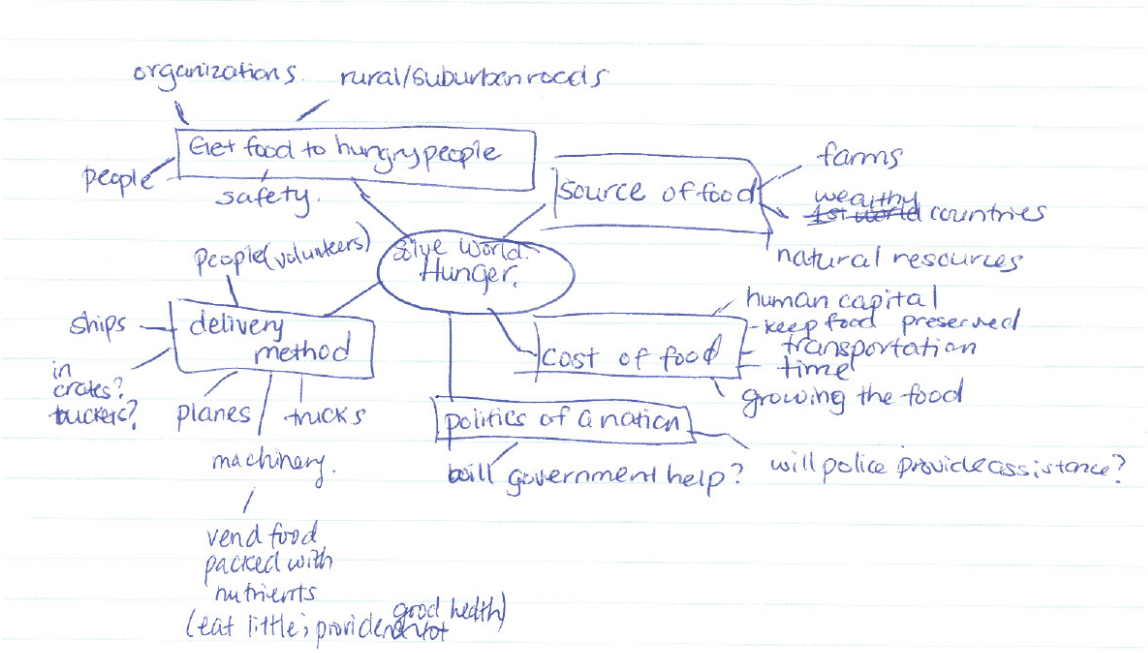
Student: Marcedes Andrews-Overell

Artwork 4: Mind Map – Orphan Adoption/Sponsorship



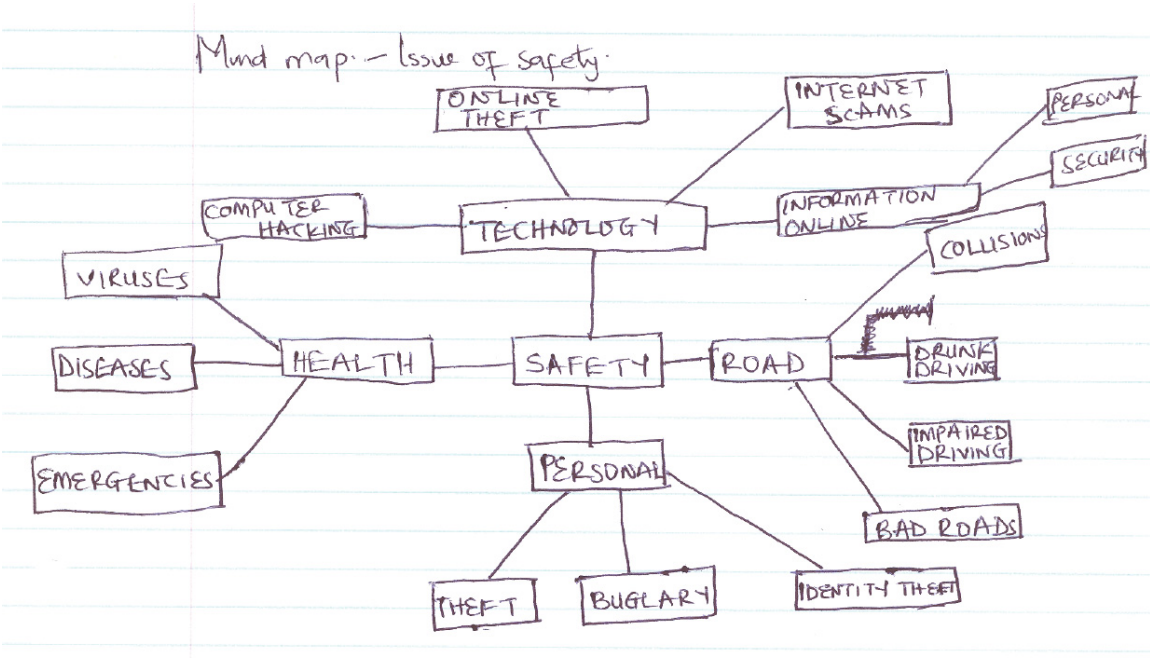
Anonymous Student

Artwork 5: Mind Map – Food and Hunger



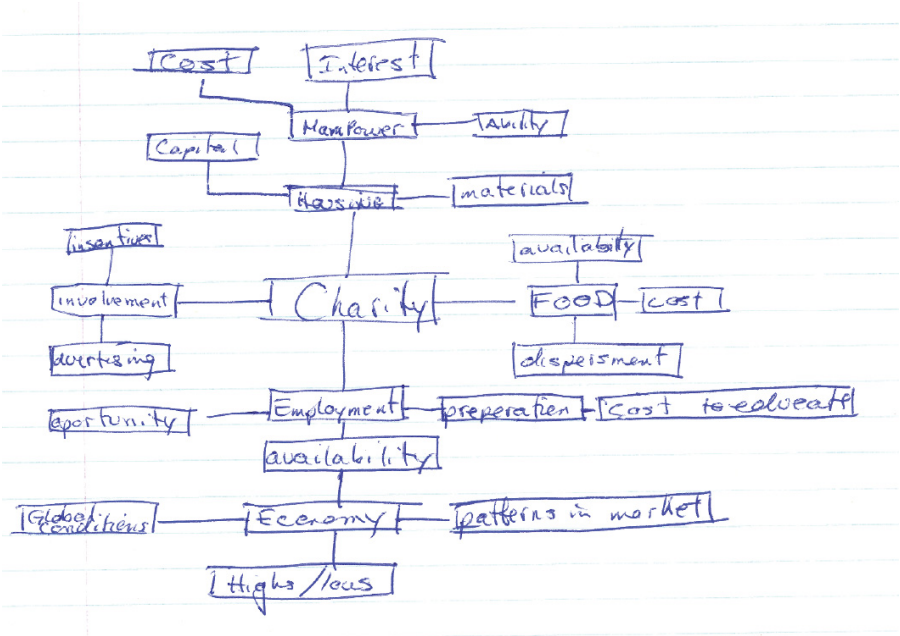
Anonymous Student

Artwork 6: Mind Map – Safety



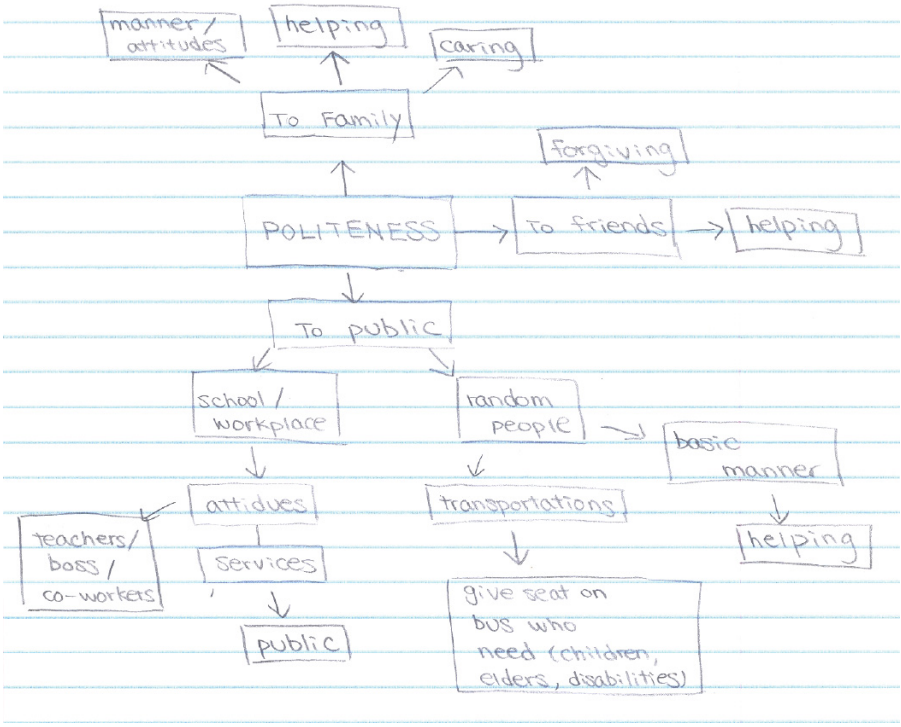
Student: Nefisat Isa

Artwork 7: Mind Map – Charity



Anonymous Student

Artwork 8: Mind Map – Politeness



Student: Sherry Lo

Artwork 9: Assignment One – Toronto Independent Music Festival

Student: Kevin Carey

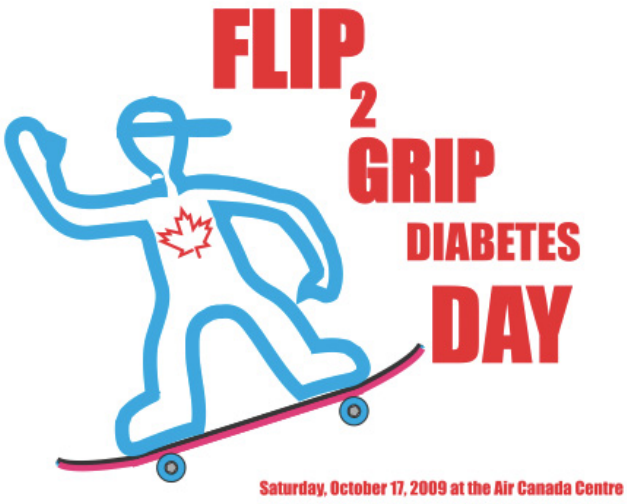
Artwork 10: Assignment One – Fluff Inc.

Anonymous Student

Artwork 11: Assignment One – Stand Up! Stand Out!

Student: Amanda Constantini

Artwork 12: Assignment One – Flip 2 Grip Diabetes Day

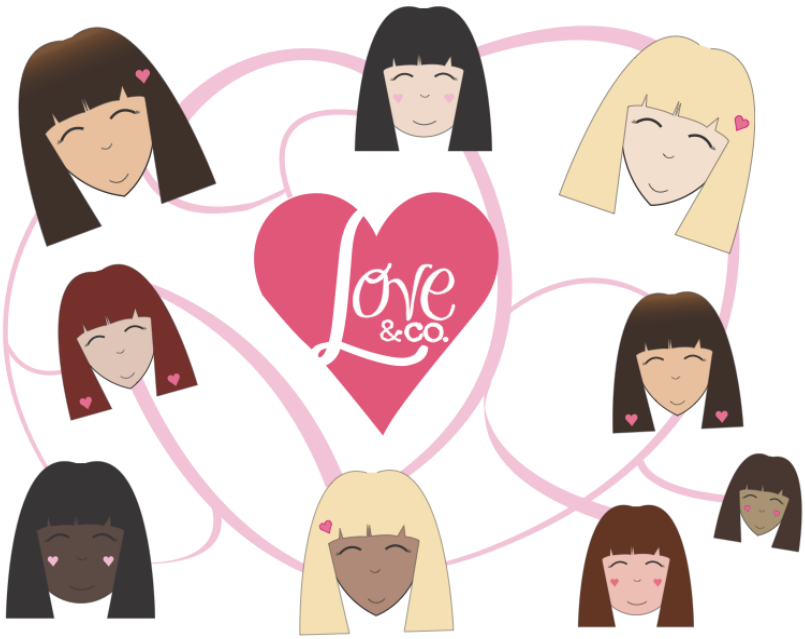


Student: Matthew Lawton

Artwork 13: Assignment One – Silver Smiles

Anonymous Student

Artwork 14: Assignment One – Love & Co.



Anonymous Student

Artwork 15: Assignment One – A Gift From The Heart Foundation

Student: Stephanie Trimboli

Artwork 16: Assignment One – Four Freedom

Anonymous Student

Artwork 17: Assignment One – Ecotech

Student: Amy Luong

Artwork 18: Assignment One – Think Green

Anonymous Student

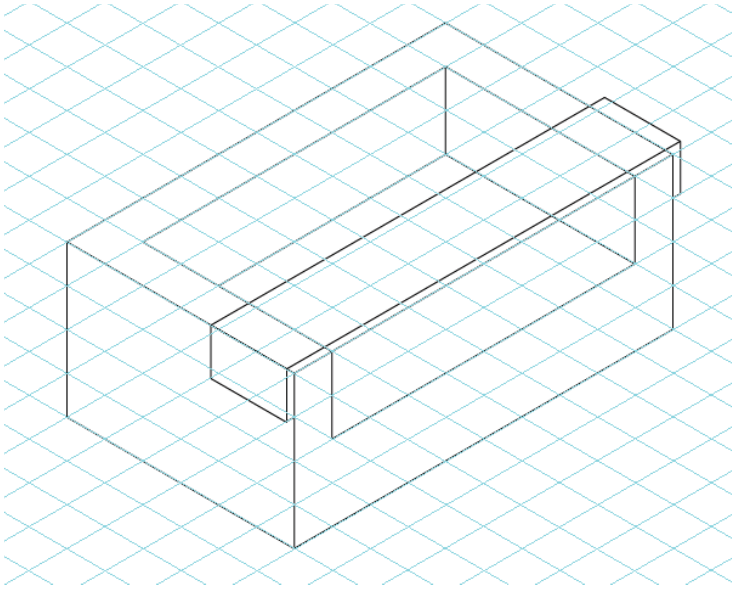
Artwork 19: Assignment One – Nature's Corner

Student: Yasmeen Shubbar

Artwork 20: Assignment One – “Value” T-Shirts

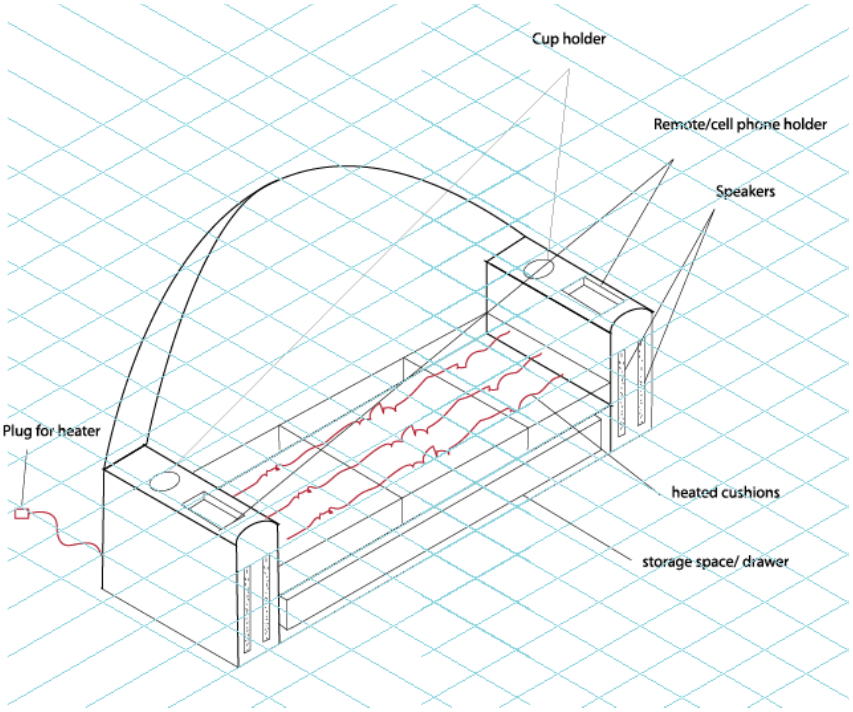
Anonymous Student

Artwork 21: Redesign of Sofa



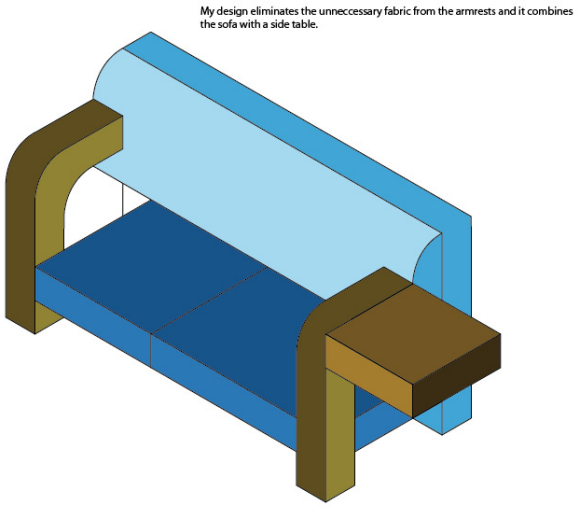
Anonymous Student

Artwork 22: Redesign of Sofa



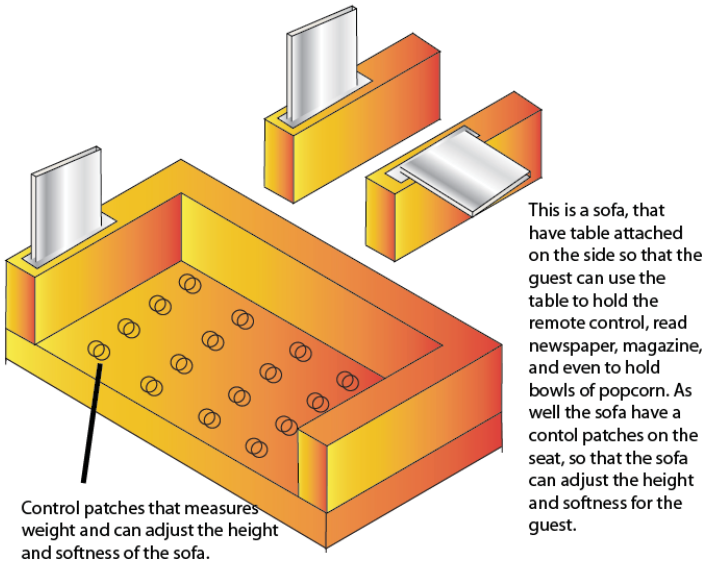
Student: Elizabeth Le

Artwork 23: Redesign of Sofa



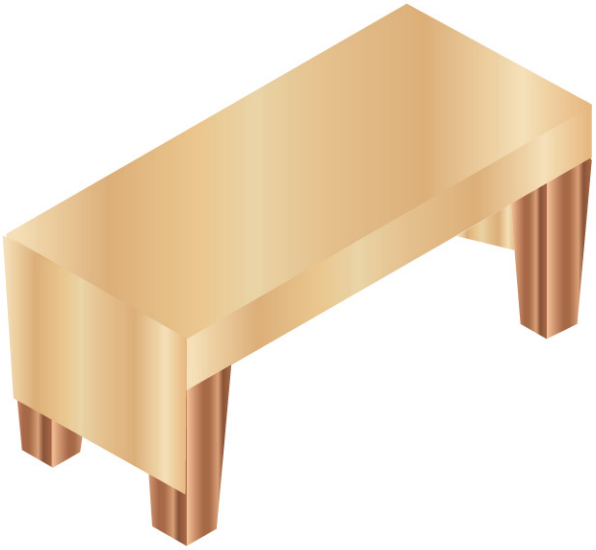
Anonymous Student

Artwork 24: Redesign of Sofa



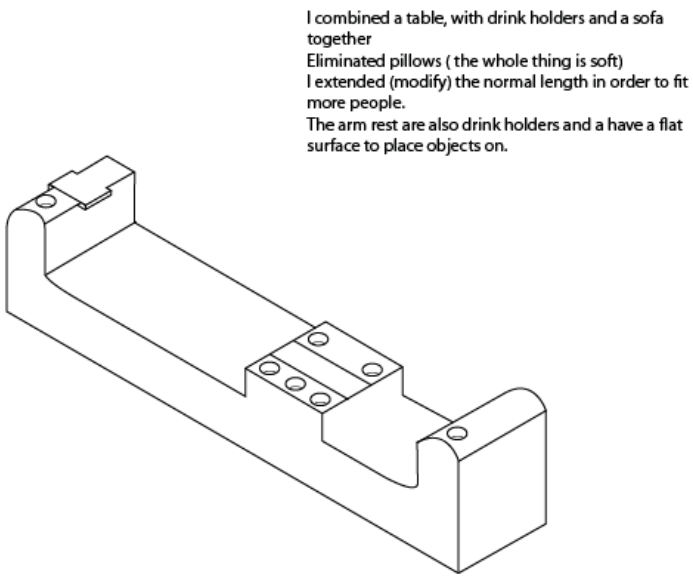
Anonymous Student

Artwork 25: Redesign of Coffee Table



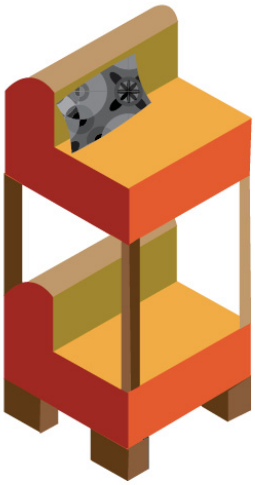
Anonymous Student

Artwork 26: Redesign of Sofa



Student: Kevin Carey

Artwork 27: Redesign of Sofa



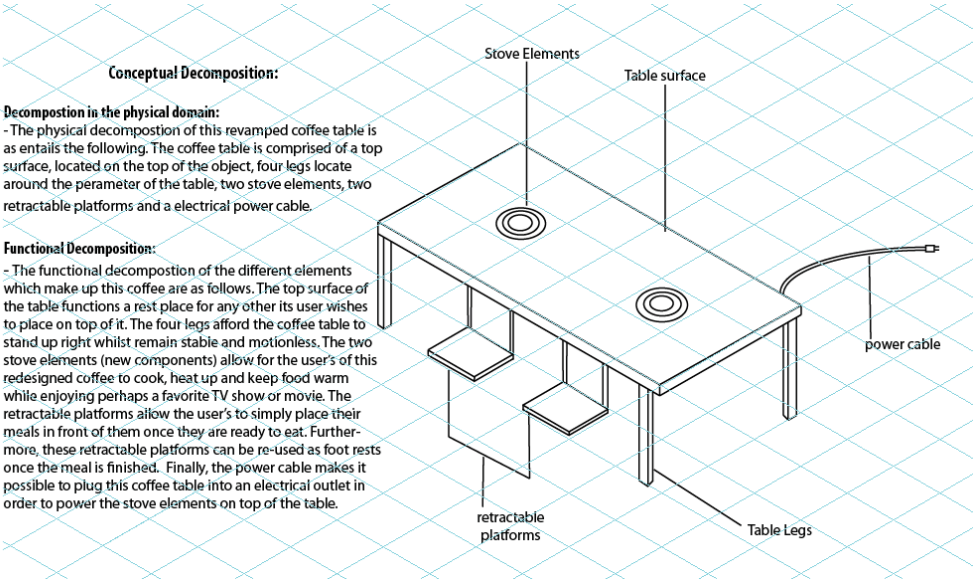
Basically, this sofa goes with the idea of a bunk bed. Probaby this will be a good product to young women and men. It is the idea that you can watch TV as comfortable as if you were in your bed.

I combine the idea that sofa are meant to be a place where one relaxes, a place where one shares. Also, I put the idea of the bunk bed into another use. It no longer is just for sleeping, but also becomes a place where you can share.

I thought of this particularly because nowadays apartments are getting smaller, and thing need to be compact. I wanted to occupy sppace as much as possible.

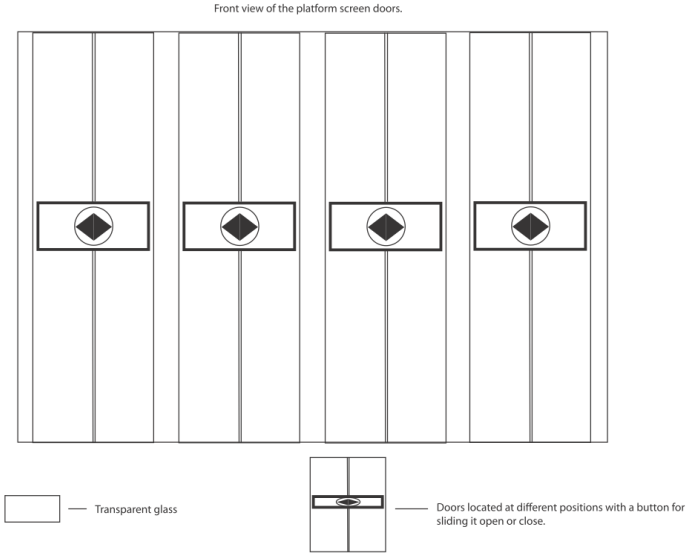
Student: Gabriella Rank Salgado

Artwork 28: Redesign of Coffee Table



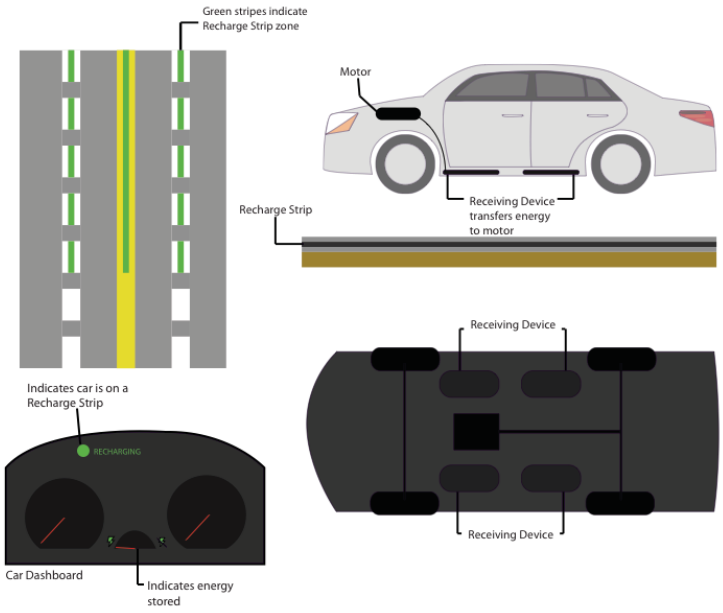
Anonymous Student

Artwork 29: Assignment Two – Subway Platforms



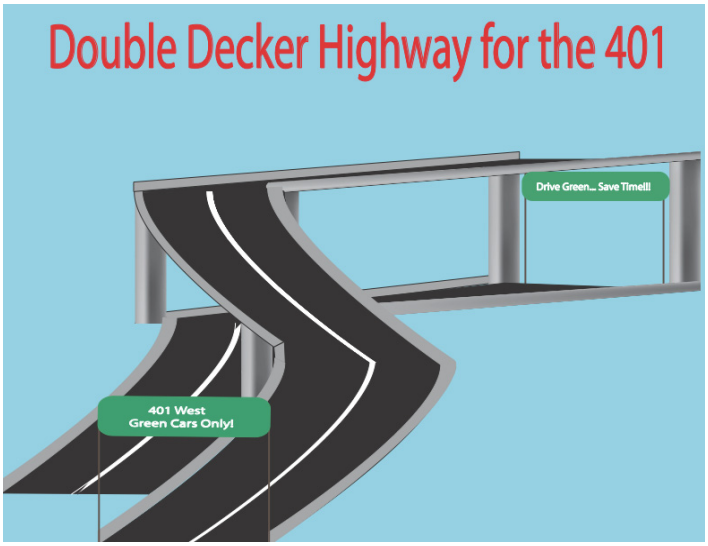
Student: Nefisat Isa

Artwork 30: Assignment Two – Redesign of Cars and Charging Device



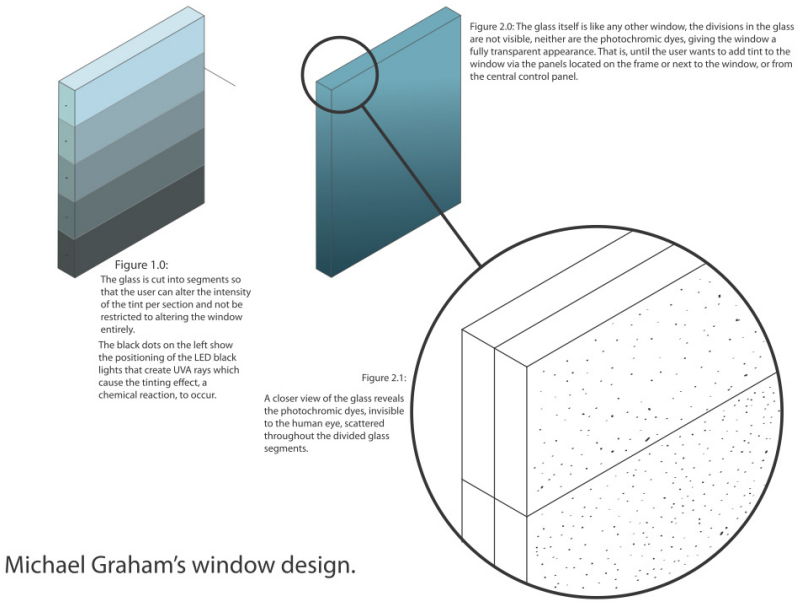
Anonymous Student

Artwork 31: Assignment Two – Double-Decker Highways



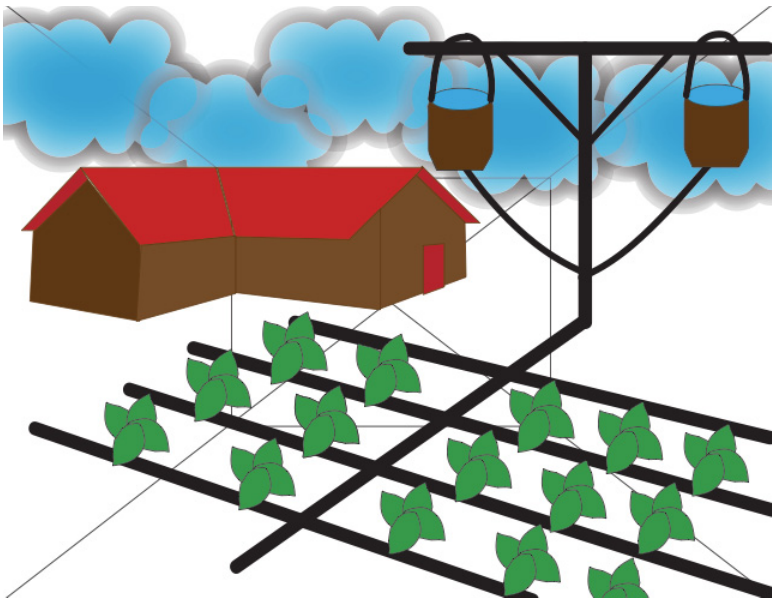
Student: Alexander Grella

Artwork 32: Assignment Two – Redesign of Windows



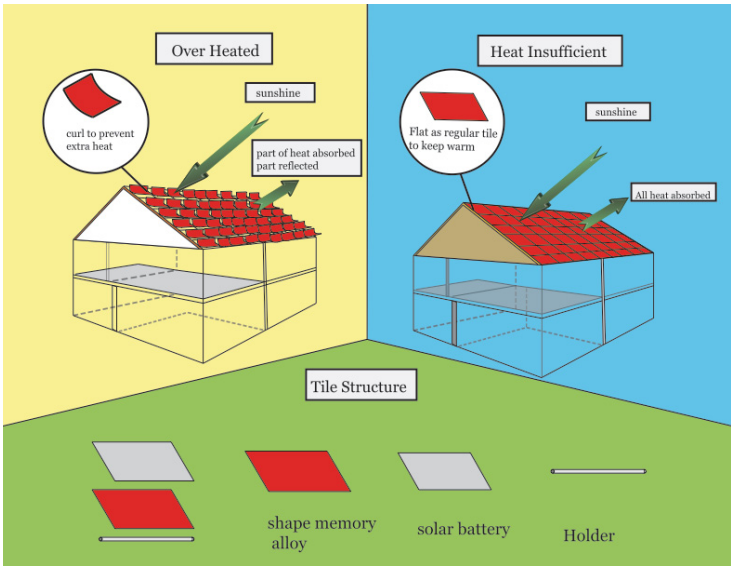
Student: Michael Graham

Artwork 33: Assignment Two – Irrigation System



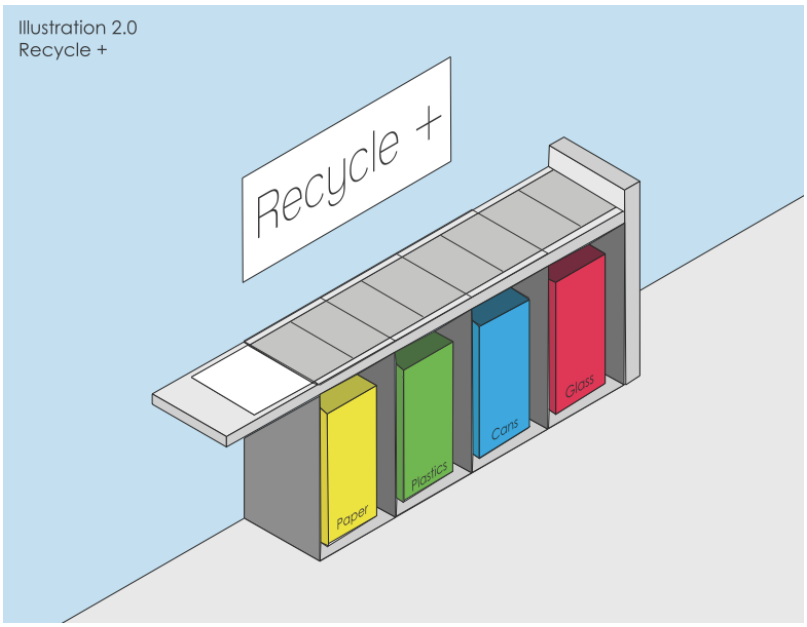
Anonymous Student

Artwork 34: Assignment Two – Solar Roofs with Shape Memory Alloys



Anonymous Student

Artwork 35: Assignment Two – Recycle +

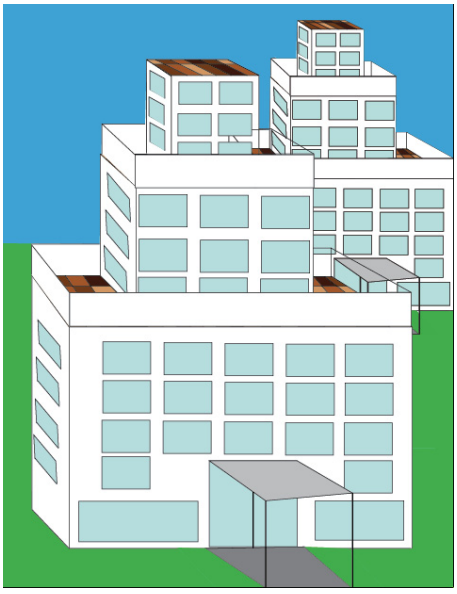


Student: John Spagnolo

Artwork 36: Assignment Two – Interactive Solar-Powered Street Lamps

Anonymous Student

Artwork 37: Assignment Two – Redesign of Low-Cost Housing

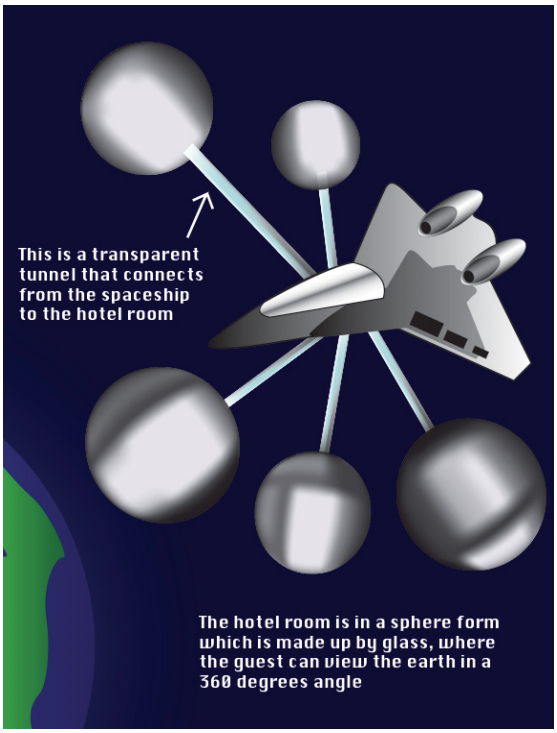


Student: Rebecca Deluca

Artwork 38: Assignment Two – Automatic Noise Sensor Spotlight System

Anonymous Student

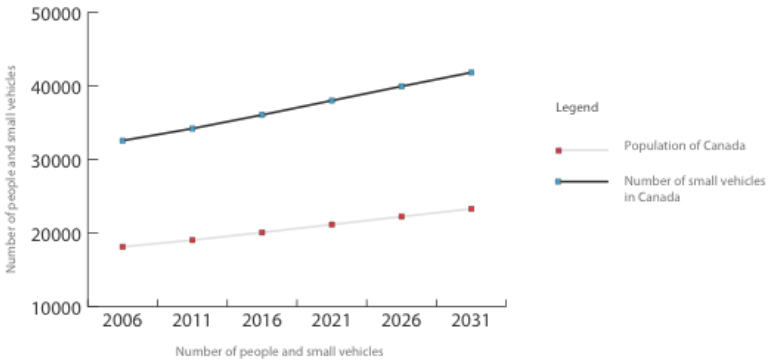
Artwork 39: Assignment Two – Spaceship Hotel System



Anonymous Students

Artwork 40: Assignment Two – The Animal RoadTrip Project

Figure 1. Projected population increase and corresponding swell of small vehicles in Canada.



Note: Each population was multiplied by 0.577 (number of small vehicle for every 1000 people in Canada). The equation of the trendline is y = 1040.9x + 17016.

Anonymous Student

Artwork 41: Assignment Two – The Animal RoadTrip Project

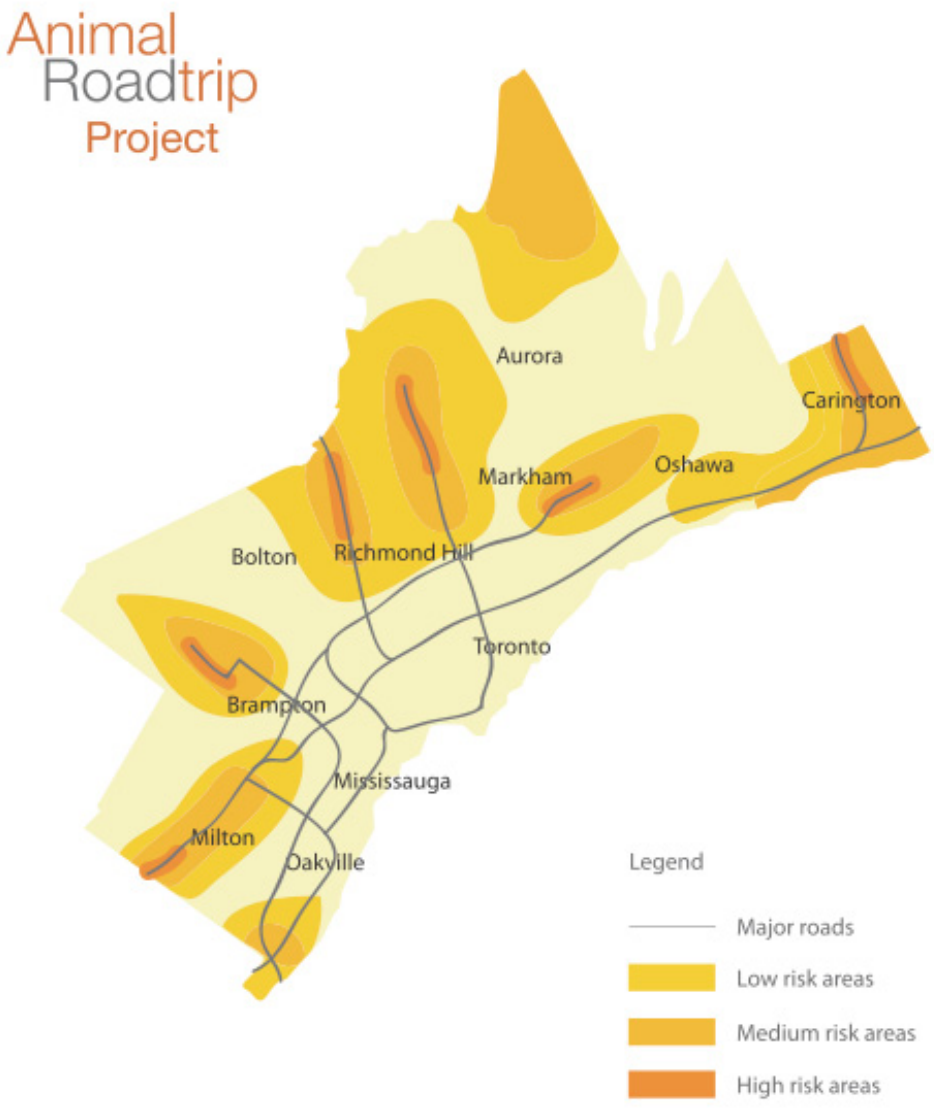
Figure 3. Suggestive prototypes for posters as part of the advertising campaign.

Poster 1 Poster 2

Anonymous Student

Artwork 42: Assignment Two – The Animal RoadTrip Project

Figure 4. Suggestive prototypes for posters as part of the advertising campaign.



Anonymous Student

Artwork 43: Assignment Two – The Animal RoadTrip Project

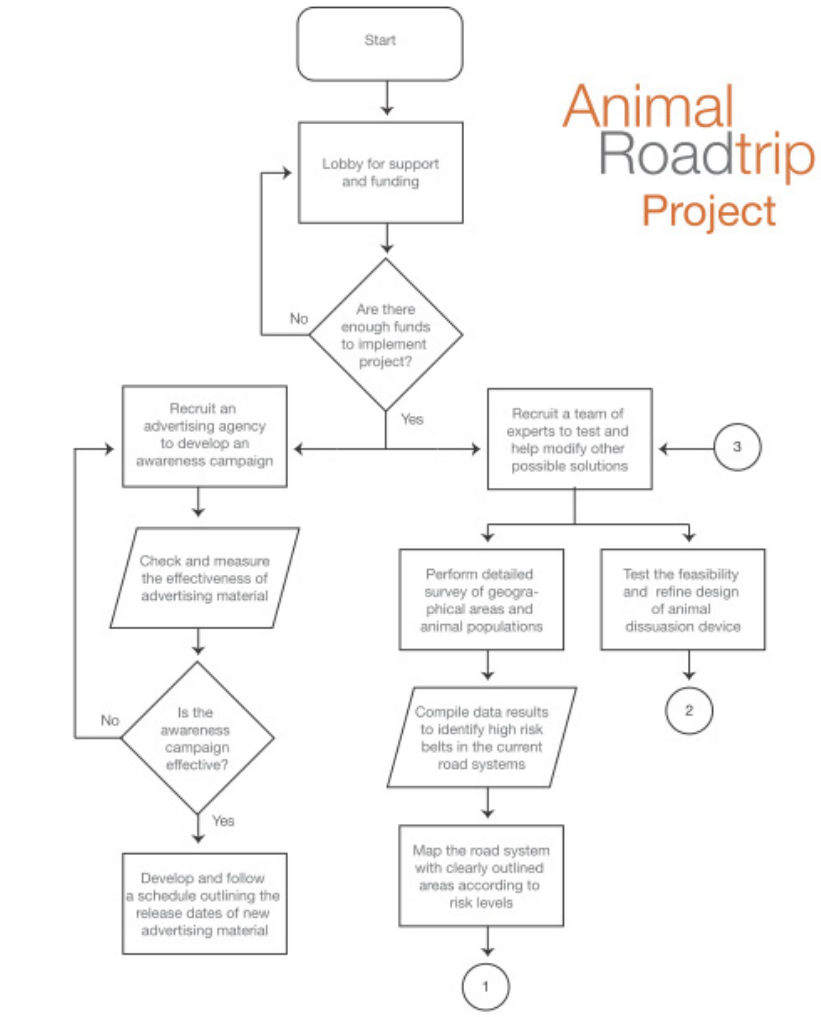
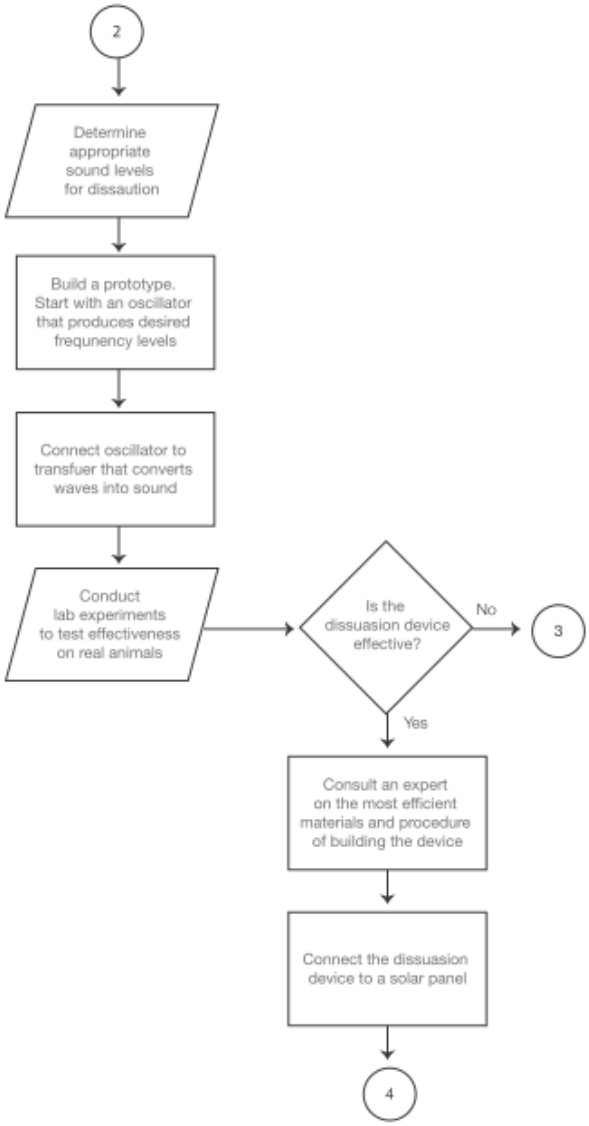


Figure 1. Flowchart for Animal Roadtrip Project

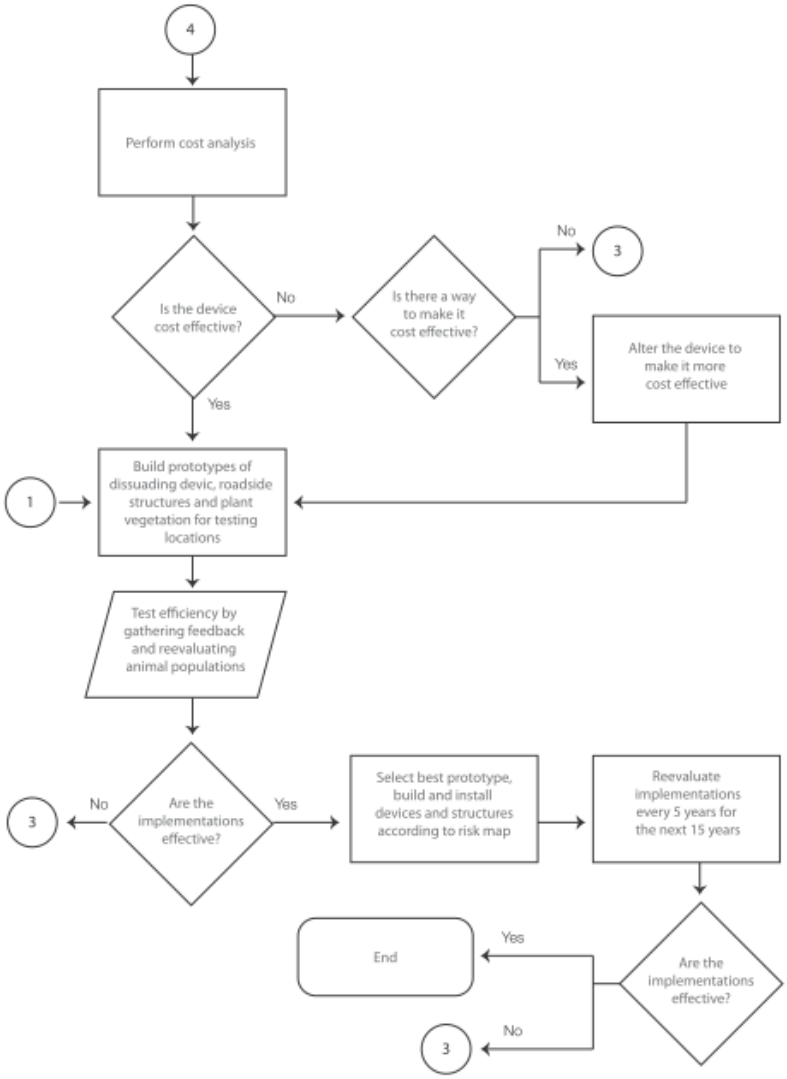
Anonymous Student

Artwork 44: Assignment Two – The Animal RoadTrip Project



Anonymous Student

Artwork 45: Assignment Two – The Animal RoadTrip Project



Anonymous Student

CHAPTER 7: CONVERGENCE

NEXT STEPS

Since the pilot teaching project was conducted in the fall of 2009, more literature on the subject of design thinking has surfaced. In this chapter, a selection of this additional literature will be reviewed and/or summarized, similar to what was done in Chapter 2. The thesis will then be concluded with an interpretation incorporating the reflection obtained from the teaching project and the most recent developments found in literature in this field. Recommendations made in the conclusion would hopefully contribute to an even more accessible and fruitful application and appreciation of design thinking in the years to come.

Design Thinking in the 2010s

2010: ***Design Th!nking: The Act or Practice of Using Your Mind to Consider Design***, by Gavin Ambrose and Paul Harris, provides a practical look at the variety of design thinking involved in a typical design process in the industry. Ambrose and Harris are both involved in the practice of graphic design and are both authors and/or designers of books on branding, packaging, editorial design, and design principles. As stated in the Introduction of the book:

> **Design is an iterative process and design thinking is present in each stage of the journey from client brief to finished work. Different solutions can be produced for any given brief and these can differ widely in levels of creativity, practicality and budget.**
>
> This book aims to present an overview of the design thinking involved at each stage of the design process: the methods used by designers to generate and refine creative ideas, the key considerations that help shape them and the feedback and review elements that allow design teams to learn from each job and contribute to future commissions. (p. 6)

In other words, Ambrose and Harris (2010) define design thinking as methods and considerations in the realm of creative ideas and solutions, generated within jobs and commissions undertaken by designers.

The book is organized in chapters representing the different stages of a typical design process, namely (a) Stage 1 – Define, (b) Stage 2 – Research, (c) Stage 3 – Ideate, (d) Stage 4 – Prototype, (e) Stage 5 – Select, (f) Stage 6 – Implement, and (g) Stage 7 – Learn. Using examples from "leading contemporary design studios" and their "unique and creative design thinking" (p. 8), reasons behind the design choices made in these respective stages are explained. Within each chapter, examples are graphically presented in a layout that not only showcases the design solutions but also occasionally utilizes diagrams to illustrate any design theories and principles applied.

Before elaborating on the independent stages of the design process, Ambrose and Harris (2010) first define the stages of thinking as "a process that turns a brief or requirement into a finished product or design solution" (p. 11), placing their concept of design thinking in a somewhat linear process, with a clear beginning starting with a creative brief that states the requirements of the project to an end, marked by the delivery of the design solution. Given the business perspective of the book, that is, in the running of a creative agency, the ability to generate and select the most unique, creative, innovative solution within the given budget is important. Such considerations necessitate a design process that is highly creative, yet "controlled and…channeled towards producing a viable, practical solution to the design problem" (p. 11). One should perhaps note that the authors also bring up the importance of the creative environment at this point, which is the studio, as a space that "facilitates creative thinking and presents an organised chaos, laden with stimuli…meeting zones [that are] informal, facilitating brainstorming and working space…flexible and adaptable" (p. 11).

A synopsis of the stages of design and their respective methods are as follows:

"Stage 1 – Define" starts with receiving or writing a design brief, which details the client's requirements and expectations for the job, such as its goal/s and objective/s, usage, target audience, medium (e.g. print/web/video), look and feel (e.g. adjectives such as "stylish" and "cool," colours), timelines, locations of usage, budget, and methods of implementation. Where understandings are subject to interpretation, further clarification may be needed, e.g. definition of "stylish" and "cool." In other words, the brief sets out the constraints of the project. Details obtained at this stage should suffice to prepare a general proposition of a design.

"Stage 2 – Research" entails quantitative and/or qualitative background information gathered that would enable designers to form a more educated mental model of the typical target user. Such information may include statistics such as age, education, career, competitor information, or other factors such as lifestyle preferences, tastes and aspirations. Research may be further broken down into primary research, such as that obtained from previous projects done with the same or similar clients, and secondary research, such as consumer market research reports, reference books or magazines. The suggested research techniques include (a) identifying drivers, e.g. market forces and trends, and barriers, e.g. rules and laws, and (b) information gathering, including quantitative and qualitative research as well as a wealth of diagram techniques, e.g. sample scatter plot, Venn diagrams, target user profiles, and character profiles.

In "Stage 3 – Ideate," designers take the particulars drawn from Stages 1 and 2 and come up with potential solutions for the project. Ambrose and Harris (2010) state: "graphic design requires applied creativity directed towards a specific end….[and yet] the scope for inventiveness and novelty is not diminished" (p. 49). Methods suggested in doing so include an extensive variety, including (a) establishing basic design directions, such as point of difference or unique selling point (USP); (b) establishing themes of thinking, such as KISS (Keep It Short and Simple

or Keep It Simple Stupid), Ockham's razor (reductionism, principle of parsimony or law of economy), and Python philosophy (ideas from the *Zen of Python*, e.g. simple is better than complex, sparse is better than dense, practicality beats purity); (c) considering inspiration and references, drawn from diverse sources and styles, past and contemporary, and the richness of art and design history; (d) brainstorming; and (e) establishing or adding value to design. A wealth of strategies are also suggested, including thinking in images, with or without what Ambrose and Harris call *conditioning agents*, such as wit and humour, thinking in signs, appropriation, paradox, personification, visual metaphors, and thinking in design elements such as shapes, proportions, and colours.

In "Stage 4 – Prototype," designers resolve the diverse potential solutions generated earlier, work up a prototype, which is then tested for feasibility technically, functionally, visually, tangibly, physically, and often three-dimensionally. There may be specific elements that need to be tested in a prototype. Some considerations at this stage include (a) design legs, that is, the ability to evolve, (b) adaptability and scalability, (c) narratives that can be broadened, and (d) flexibility. There are many ways in which prototypes can be done: as a (a) sketch, (b) model (actual, reduced, or enlarged scale), (c) maquette (reduced scale), (d) printer's dummy (full scale). Along with the discussion on prototypes, Ambrose and Harris stress the importance of establishing what they call design vocabulary, that is, how design elements and styles appropriately and effectively communicate a message. To Ambrose and Harris, design vocabulary is synonymous with style. Some different styles highlighted include eclecticism, trompe l'oeil, abstraction, and noise.

In "Stage 5 – Select," one of the potential solutions is selected for development. Ambrose and Harris (2010) state: "The key decision criterion is fitness for purpose: does the design meet the needs and goals of the brief, and will it effectively communicate to the target audience to achieve those aims?" (p. 24). In other words, appropriateness is an important consideration.

"Stage 6 – Implement" brings confirmation and clarification of specifications to those producing the final product, such as a fabricator or printer. It is the responsibility of the design team to ensure that what was signed off by the client is produced correctly. Other considerations include standard and non-standard formats, such as in paper sizes, materials and substrates, such as paper stock or alternative materials. Production techniques transcend beyond printing and may include stamping, engraving, carving, etching, cutting, painting, and others. Ambrose and Harris discuss the options in finishing, e.g. folding and embossing, which they refer to as the third element in *implementation thinking* (the first two being format and materials). Lastly, the various forms of digital media, scale, and whether the design could be continued as a series should also be considered.

"Stage 7 – Learn" entails gathering feedback to evaluate the effectiveness of the design, such as audience response. Feedback obtained at this stage could be matched up with the particulars outlined in the brief, to see if there were any inadequacies and find insights that might enhance and contribute to future projects.

Reflection

The design process is an element that has been brought up in the context of design thinking by a number of authors surveyed thus far. For example, Lawson (1980) recognizes the presence of various models and maps of the design process but questions if designers actually follow them (though he acknowledges the stages of creative thinking). Rowe (1987) talks of the design process as a flexible decision-making process guided by logic and theory, while addressing the various staged-process models, e.g. Asimow, Ulm, Archer, Thornley. Akin (1992) records a generalized process and cognitive processes from descriptive studies conducted. Mitchell (1996) talks of the importance of strategic design planning, exceeding the design of the product itself, as demonstrated by the process used by the Doblin Group. However, Ambrose and

Harris are the only ones who link design thinking inextricably with the design process, that is, the book aims to present an overview of the design thinking involved at each stage of the design process. The design process in question is one that is typically followed in the design industry (mainly graphic design), marked in its beginning by a brief and ending with the delivery of the solution along with its evaluation. It is a somewhat linear process with clearly defined stages, each, according to Ambrose and Harris, with its accompanying design thinking, tasks, considerations, activities, and outcomes. It is a professionally accepted process, generally adopted by creative agencies in the industry, a process with specified times for sign-offs, proofing, and delivery. Ambrose and Harris organize the book with a brief introduction of each stage, followed by more detailed descriptions of the considerations involved. The result is a compilation of fine visual examples as well as practical considerations, e.g. in terms of production, in pursuit of creative ideas and solutions. In other words, the book equips the reader with the knowledge and sample projects that one would expect and should be familiarized with if one were to work in a creative agency. Design thinking in this context is fundamentally work-related; it is not discussed or explored as types of thinking, per se, as in schools of psychology, intuition, deductive reasoning, or abductive thinking, but considerations and activities that are supported and enhanced by applicable research tools and creative ideas.

Along with many high-quality, often colour examples, the book provides a wealth of practical suggestions, such as different research techniques and ideas to stimulate creativity and ideation. However, although I find the many ideation-related suggestions helpful and informative, I would probably organize them under slightly different headings:

Firstly, Ambrose and Harris put inclusive design (increasing social equality) under “Basic design directions,” presumably to contrast elitism, for example, as a marketing strategy. However, I personally consider inclusive design more of a philosophy, belief, or principle, to be practiced at all times (if one were to believe in it) and not so much a marketing strategy of

convenience. Similarly, user-centred design (UCD) and Python philosophy are put under "Themes of thinking" when they are philosophies and accompanying practices that follow. Likewise, ergonomics and "Value" (which currently has its own section) or adding value, regardless of how one defines or does it, are principles; just as unity with variety, emphasis, hierarchy, balance, legibility, and readability are principles.

Secondly, white space is listed under "Themes of thinking," when it is a compositional or design element, i.e. space, along with other design elements such as line, colour, value, texture, and shape. Similarly, the concept of scale and the sections "Thinking in images," "Thinking in colour," "Thinking in shapes," "Thinking in proportions," "Words and Language," "Type 'faces'" have to do with the use of compositional or design elements and could be grouped together accordingly.

Thirdly, there are numerous good ideas currently scattered under different sections, such as under the sections "Basic design directions" and "Themes of thinking," or have their own sections under the Ideation stage, that are in fact what I would call design paradigms. In other words, they are established ways, strategies, models, or frameworks of doing designs. The ideas that I propose to be regrouped under design paradigms include the sections "Thinking in signs," "Appropriation," "Humour," "Personification," "Visual metaphors," "Modification," and items including divergence, convergence, transformation, point of difference or unique selling point (USP), clustering, KISS (Keep It Short and Simple), focus, top down and bottom up, Ockham's razor (reductionism), text minimization, word puns, visual puns, and rebuses, as well as the many movements and rich traditions found in art and design history, e.g. Art Nouveau, Arts and Crafts, Abstraction, Expressionism, Cubism, Grid, Surrealism and many others.

Fourthly, the sections "Brainstorming" and "Sketching" could be grouped under activities, which are catalysts and conduits of visualization and creativity.

In the Implement stage, format, materials, and finishes are discussed, but they should have been considered in the Ideate stage as their inherent and/or tactile quality could spark different creative and art directions.

Although this book contains many good ideas, many of which stem from existing, established design paradigms, I am a little concerned that it does not encourage innovation and inventiveness as much as it is intended to do. Innovative abduction, as Habermas calls it, brings about new rules, laws, principles, and theories, and as Peirce comments, is the only way to bring about new ideas. There is no doubt that there is a lot to be inspired by existing design paradigms, but what is the bridge necessary to springboard from these paradigms into something truly innovative? Likewise, there is no doubt that there is merit in learning to do things as they are done in the design industry, for example, to follow the stages of the established design process, but can this process be modified to be more innovative, to address concerns of a more societal or collective nature, and not so much driven by the client? Can the designer or the design firm have a stronger voice and adopt a more influential stance? Can a traditional (graphic) design firm step out of its mould, partner with others, and undertake other endeavours?

The design thinking tips at the end of the book could be considered the mindset or routine that a designer could develop. The creative environment or the set-up of the studio could be laden with stimuli, with a library full of references and inspiration, a flexible space to accommodate brainstorming and other work/play, and resources to inform the designer of other design or non-design-related issues, news, and trends. Along with the new categories proposed above, i.e. philosophies, design principles, design elements, design paradigms, which I would like to propose as the basis of a *design thinking palette*, the designer could establish an appropriate creative and art direction, which is the concept of the design.

One final observation is about a section at the very end of the book, after the Glossary,

Acknowledgements, and Contacts, entitled "Working with Ethics: Publisher's Note" by Elvins and Goulder (2010), who state "AVA Publishing hopes that these **Working with ethics** pages provide a platform for consideration and a flexible method for incorporating ethical concerns in the work of educators, students and professionals" (p. 193). The said platform consists of four sections: the introduction, the framework, a case study, and a list of suggested readings. What I find interesting is the section "Framework," which in turn has four sections or rather, questions, to which the reader/designer has to indicate his/her position from a scale of 1-10. These sections and accompanying questions can be summarized as (a) To what extent do your ethical beliefs affect your decisions? (b) How ready are you to turn down a project on ethical grounds? (c) How ethical are your material choices? (d) Should your work make a positive contribution to society, help save lives, educate, protect, inspire, or solve social or environmental problems rather than make commercial gains? Being a Registered Graphic Designer of Ontario, I am used to being guided by rules of professional conduct, which is By-Law #3, consisting of sections on responsibility to the association and profession, to other members, to clients and employers, to society and the environment. The by-law (The Association of Registered Graphic Designers of Ontario, 1998) states that the rules

> are written to guide Members in their professional practice to ensure a fair balance between the needs of Members, clients, the profession and the government. The rules not only recognize Members' professional responsibility but also the commitment to take a role in those areas of society where graphic designers hold influence. (p. 2)

The questions in the framework proposed by Elvins and Goulder are perhaps intended to steer the reader/designer in the direction of achieving this fair balance and initiating some kind of introspection or commitment to take a stronger ethical stance. By asking questions and using scales, Elvins and Goulder could remain neutral and could refrain from being dogmatic. In a way, I can relate to their position, since as a teacher, I do question how much of, or simply how, my

own ethical stance should be transferred onto my students; how my personal values should or could be shared; how my students' individual values could be fostered, how ethics could be taught, and when I should draw the line if my students' positions and beliefs are deemed inappropriate or wrong. This is definitely an area that requires sensitivity in handling, especially in light of an academic and political environment that stresses political correctness.

2010: *Design Thinking: Integrating Innovation, Customer Experience and Brand Value* is a selection of business- and brand-related articles edited by Thomas Lockwood. Lockwood holds a PhD in design management, is the Editor-in-Chief of the DMI Review and DMI Journal, and President of the Design Management Institute (a professional organization dedicated to design management based in Boston). As Lockwood tells us, he was asked by the publisher to put together a book about design thinking, and "wondered aloud: Hasn't someone already done this? Well, evidently no one has, at least not in the sense of the current meaning" (2010, p. vii). In other words, the articles in this book, according to Lockwood as an editor, define the current meaning of design thinking. The context for design thinking, according to Lockwood, is that of the business world and the consumer market, requiring integrated thinking and a process of collaboration between engineers, designers, and business analysts. It also requires a balance between the workings of the left and the right brain. Just as Martin (2009) emphasizes that a hybrid leader needs to learn to speak both the languages of business and design, Lockwood observes, "Businesses need to be ambidextrous…to think from both sides" (p. ix). The combination of skills or model required is what Lockwood calls *integrated design management*, which is "directly related to design thinking" (p. x).

So what is design thinking? Lockwood states:

> Design thinking is essentially a human-centered 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…It is not a substitute for professional design or the art and craft of designing, but rather a methodology for innovation and enablement. (p. xi)

Having set the stage with what Lockwood has outlined as principal ingredients in current design thinking, the articles that follow are organized into four sections: (a) design thinking methods: from innovation to integration to transformation; (b) value: building brands, by design; (c) influence: the hidden importance of service design; and (d) meaning: creating customer experiences that matter. Some of the central issues discussed in these sections will be summarized here.

Section one is entitled "Design Thinking Methods: From Innovation to Integration to Transformation." Despite the title: "Design Thinking Methods," the articles in this section do not directly address design thinking methods per se; rather, the titles in this section range from the evolution of design thinking, to creating the right environment for design, designing business, design management, research and practice, and becoming a design-minded organization. Thus, "design thinking methods" must be implied in these articles. The context of these discussions is design management or design in business.

There are a few recurring themes that run through Section one. First and foremost is the theme of design insights. Vogel (2010), Director of Center for Design Research and Innovation, University of Cincinnati, states: "These design insights are required to effectively respond to constantly changing social, economic, and technical forces (also known as SET factors). The interaction of these three forces results in the emergence of new, 'preferred' states for customers and consumers" (p. 4). Comparably, Clark and Smith (2010) from IBM state the importance of design instincts: "[u]nleashing the power of design thinking is about awakening design instincts and methods in business executives and organizations….The more design thinking is used to

innovate…the more design…will be brought into…decisions that shape our collective future in the business world" (p. 47).

Another key theme in this section is innovation. As Neumeier (2010), President of Neutron, states, "In an era of Six Sigma [a total-quality management movement] parity…[w]e have to get different. Not just different, but really different….So, if innovation drives differentiation, what drives innovation? The answer…is design" (p. 17). Lockwood (2010) also states the objectives of design thinking as "innovation, clarifying fuzzy front end, [and] direction finding" (p. 84), and that its players could include anyone. According to Neumeier, innovation is closely tied to reaping profits. In fact, he clearly articulates this chain reaction: "Design drives innovation, innovation powers brand, brand builds loyalty, and loyalty sustains profits" (p. 19).

Fraser, from the Rotman School of Management, like Roger Martin and Lockwood, suggests abductive thinking as an important mindset for design thinking; what she calls a "leap of inference" (p. 43). Clark and Smith (2010), on the other hand, point out the importance of what they call *innovation intelligence,* consisting of (a) emotional intelligence ("the ability to understand and embrace in the context of culture"), (b) integral intelligence ("the ability to bring together diverse customer needs and business ecosystem capabilities into complete systems," and (c) experiential intelligence ("the ability to understand and activate all five human senses to make innovation tangible") (p. 48). These intelligences involve the head, heart, and gut. Cooper, Junginger, and Lockwood (2010) point out the three qualities of thinking: (a) "thinking *of* with imagining, visualizing, dreaming up," of new roles for design, practices, and applications, (b) thinking *about* "during which one considers, reflects, and deliberates" about different design methods, principles, and system-wide foci, and (c) thinking through, "to understand, to grasp, to figure it out" (p. 57). In this regard, empowering creativity is helpful. As Lockwood (2010) states: "In this age of innovation, business requires a creative spark…from 'creative abrasion' to 'informed play' and the blurring of disciplinary boundaries" (p. 93).

Along with the blurring of disciplinary boundaries, the role of design in corporate management also calls for multidisciplinary collaboration (Fraser, 2010, p. 37). Thus, design thinking must also expand. As Vogel (2010) states, "[T]hat [focused and limited] role [of product and service development] is expanding and the core of the field, design thinking, must expand with it" (p. 4). Not only has the scope of design thinking expanded, so has that of branding and corporate identity. Vogel cites earlier examples such as key designers Peter Behrens and Paul Rand and their design of logos. Today, branding transcends the design of logos. In building brands, Neumeier (2010) suggests that an organization needs to execute a bold idea and "have an enterprise-wide appetite for radical ideas" (p. 15).

Two other themes that have surfaced in this section are that of integrating visualization or visual aspects and that of integrating human factors. In the context of contemporary business education, Fraser introduces the three gears of business design, where the first gear that starts the motion is the gear of empathy and deep user understanding (a deep dive with a broad lens). This gear in turn sets the motion of the second gear: that of concept visualization (ideation, prototyping and user evaluation). The third gear that supports and completes this motion is strategic business design (or activity system design and evaluation). Similarly, Cooper, Junginger, and Lockwood (2010) define thinking *through* design as "the ability to quickly visualize problems and concepts, the development of people-based scenarios, and the design of business strategies based on design research methods" (p. 63).

Another discernable theme in this section is that of the evolution of systems design. Vogel points out earlier examples of modular furniture design systems by George Nelson and Charles and Ray Eames for Herman Miller. Today, systems design is not limited by the use of material objects. It may include human ecosystems. As Jenkins (2010) observes: "a human ecosystem consists of more than the physical environment – it also includes all the social, cultural, and behavioral elements of human interaction, the way people work together and get

things done" (p. 24). Similarly, Fraser (2010) also points out that "[c]ommercial ambitions, political agendas, and social needs are inextricably linked and must be considered as a broader ecosystem" (p. 36). To that end, Fraser calls for new and better models of business design through systems thinking.

Last but not least, an important theme in this section is that of social and environmental responsibility. For example, "In 1976, Victor Papanek published his *Design for the Real World*, asking designers to see the potential of design thinking for social and environmental responsibility" (Vogel, 2010, p. 11). Likewise, Buckminster Fuller believed that "design could be an effective tool to use for environmental and social improvement" (p. 12). A similar sentiment is found in Bruce Mau's project Massive Change. As Vogel further reminds us: "Environmental responsibility and universal design were once an option; now they are becoming a virtual mandate" (p. 13). Likewise, Fraser (2010) acknowledges that "[s]ocial values are shifting and causing higher expectations for corporate social and environmental responsibilities" (p. 36). According to the 2008 Survey of Wicket Problems, addressing the challenge of eco-sustainability is number nine on the list (Neumeier, 2010, p. 16). In the context of business, this may allow more opportunities for innovation. Companies such as Volkswagen, Steelcase, and General Electric are already transforming the commercial landscape by designing with more recyclable materials and renewable energies.

Section two "Building Brands, By Design" consists primarily of case studies and recommendations on how to build successful brands, what Kathman (2010) calls "leadership brands" (p. 99). Central themes in this section revolve again around innovation and leadership, in the context of establishing brands. The brand identity needs to be reinforced and its equity, image, and personality are best sustained through a holistic brand communication program. It is important to note that Best (2010) defines innovation as "opportunity identification for sustained brand/business leadership" (p. 146), through core innovation, product innovation, and commercial

innovation. In asking how innovation can be achieved, Best observes that most articles on this topic consist of case studies or success stories, making it difficult to extract any principles. To that end, Best suggests a list of what he calls ten *Triggers of Innovation*: brand/context, business factors, consumer/end user, customer/seller, competition, client, problems to solve, technologies to leverage, trends, and connections. Best also suggests a short list of innovation capabilities surrounding the design idea, including a robust process of accelerated ideation, holistic rationale for provocation and assessment, multifunctional opportunities, trend assessment, experiential prototyping, rapid research and validation, and experience. Similarly, Abbing and van Gessel suggest a four-step method for brand-driven innovation: (a) brand usability, (b) innovation strategy, (c) design strategy, and (d) touchpoint orchestration. The intended outcome of all these aspects is a harmonious, successful brand story.

In addition, this section highlights two other notable considerations for innovative brand-building: that of humanizing brands and bringing the future into brands. Using the analogy of jazz, Gobé (2010) proposes kindling the instinctive nature of the creative process to create brands that resonate with a customer's senses and emotions: "Brandjamming is the powerful idea that reconnects both worlds…Design, not unlike jazz, is innovation in action, it stimulates people's senses and emotions to create preferences" (p. 111). Like Clark and Smith, Gobé also points out the significance of appealing to the head, heart, and gut.

In "Bringing the Future into Global Brands," Kim uses examples in the South Korean market to demonstrate how innovation could be achieved by identifying opportunity gaps and conducting forward-looking investigations. To keep products and services current, companies need to study trends; trends that motivate customers to have a different lifestyle and expect a different level of service. To that end, Kim suggests identifying what is called the *product opportunity gap* (POG). In doing so, one needs to study the PESTE factors that spur the changes that form trends. PESTE factors are political, environmental, social, technological, and economic

factors that change user expectations, thus creating the product opportunity gap. Kim credit Cagan and Vogel for developing what is called the value opportunity analysis (VOA), broken down into seven categories: emotion, aesthetics, identity, ergonomics, impact, core technology, and quality. Attributes in these categories could richly contribute to aspects of the user's experience.

Section three "Influence: the Hidden Importance of Service Design" comprises articles that attempt to address the scope and principles of the emerging realm of service design. As an introduction, Saco and Goncalves (2010) tell us: "Though manufacturing has been the dominant logic in the business world for most of the twentieth century, this…is changing quickly as the service sector becomes…more prevalent, comprising 70 percent to 80 percent of GDP in many developed countries" (p. 159). Saco and Goncalves also observe that this landscape (of service design) is shifting and that an entirely new language of service may be needed. Løvlie, Downs, and Reason (2010) define service design as "design for experiences that reach people through many different [and multiple] touchpoints and that happen over time " (p. 174). Bedford and Lee (2010) use the term "system of customer experiences" (p. 198), while IBM introduced the term "service science, management, and engineering (SSME)" (Saco and Goncalves, p. 168). Gillespie (2010) also points to the potential in expanding service design through the global gateway of the World Wide Web (p. 209).

As with brand-building, the buzzword in service design is innovation. According to Saco and Goncalves (2010), service innovation means an entirely new business model, not just introducing a new service using an existing business model. Jones and Samalionis of IDEO (2010) inform us that while "more than 70 percent of corporate leaders named innovation as one of their top three priorities [in 2007]…actually getting innovative new services to market is rare, and…radical innovation – new services that dramatically change the marketplace – is even rarer" (p. 185). Nonetheless, Jones and Samalionis attempt to propose a five-stage framework to

facilitate service design: (a) develop insight about the market; (b) create radical value propositions; (c) explore creative service models; (d) bend the rules of delivery; and (e) iteratively pilot and refine the new service (p. 188). While the success of businesses is normally measured by the return on investment (ROI), Løvlie, Downs, and Reason suggest three ways to measure the quality of service design: (a) gross value added (GVA), (b) triple bottom line (sum of the economic, environmental, and social effects of an activity, and (c) the service usability index (SU index), based on the value proposition, experience, usability, and accessibility of the service.

The last and final section of the book is titled "Meaning: Creating Customer Experiences that Matter." Topics range from creating meaning with brand satisfaction to elements of user experience. While the consensus is that customers should be satisfied with the accumulation of experiences that businesses have to offer, how this satisfaction is evaluated and achieved ranges from quantitative to qualitative means. For example, Rockwell comes up with a formula that measures brand satisfaction as the accumulation of brand experiences minus brand expectations, whereas brand meaning is measured by brand satisfaction divided by time. Garrett, being a user experience (UX) expert, advises building and keeping customer loyalty with the five planes of user experience, building from the bottom up: from the strategy, scope, structure, skeleton, to the surface plane. To Lemley (2010), "meaning is the new black." Lastly, Norton (2010) points out the significance of a shift from functional innovation to cultural innovation in what he calls disruptive innovations. Norton's advice is to seize this opportunity – "[t]he opportunity for design today is to go beyond making things convenient for people and start making experiences that people care about….experiences that matter" (p. 241).

Reflection

One of the first and most obvious thoughts that came to mind while reading the selection of articles in this book is that the context of the discussions is clearly that of the business world.

That the concept of using design thinking as a competitive edge, already articulated by Martin (2009), to move ahead in the competitive landscape which is the business world, is undeniable. This aspect is made even clearer in the majority of the articles, reiterating the fact that the bottom line is profit, a return on investment (ROI). As Neumeier (2010) states: "Design drives innovation, innovation powers brand, brand builds loyalty, and loyalty sustains profits" (p. 19). Profit is indeed the premise on which the world of business is built and is a significant drive for economic activities, a foundation of a strong economy. Profit, as the motivation of design thinking, could be both a positive and a negative constraint. On the positive side, it directs the design thinking process within parameters that help attain business successes. On the negative side, design thinking, as defined in this book, could only exist within the confines of businesses and is not likely to venture into a sphere of society that is not related to the corporate world; or simply, where creative ideas might jeopardize the profit margin. To the business executive or business student, this context totally makes sense, but from an interdisciplinary or humanities or social sciences perspective, for example, design thinking as defined in this book, though valid, is perhaps not enough. The reasons for my thinking thus are threefold.

The first and primary reason is that of social and/or environmental responsibilities. It is true that social and environmental issues have been brought up in this book. For example, Vogel has brought up the key figures of Victor Papanek, Buckminster Fuller, and Bruce Mau, in their visionary commitments to using design to improve the conditions of humankind. However, Papanek, Fuller, and Mau are hardly representative of the corporate world. While Vogel has reminded us that environmental responsibility and universal design are now becoming a virtual mandate, Fraser and Neumeier see the shifting of social values as higher expectations for corporate responsibilities and business opportunities for "guilt-free" innovations. Just to what extent is the average corporation ready to commit to social and environmental responsibilities? Does their commitment, if any, truly stem from the motivation to do good, or does it stem from

profit, guised as social and/or environmental commitments and used as marketing or branding strategies? When push comes to shove, and it is impossible to choose both, is the average corporation going to choose profit or what is socially and environmentally ethical and upright? The answer is quite clear; choosing anything other than profit would defy the fundamental premise of business. I am playing the devil's advocate here and I am by no means pointing any fingers at the corporate world, but this goes to show that to be truly innovative, not restricted by the corporate world, there must be gradual but fundamental paradigm shifts, such as socially, culturally, and politically. One important question to ask is, in the study of design thinking and the planning of an interdisciplinary curriculum on design thinking, what difference would it make if the design process is guided or motivated by different values? For example, if you were to design a product, environment, service, or system (or combinations thereof), what would you design and how would you design it if your design thinking process is guided by (a) profit, (b) social equity, or (c) long-term environmental wellness?

Secondly, collaboration is a key component of design thinking as defined in this book. Lockwood's example of the development of Thinsulate and Gore-Tex is used to illustrate what design thinking entails – bringing an innovative idea to fruition by bringing together a team of engineers, researchers, designers, business analysts/strategists and the like. Collaboration in this sense brings together and draws the expertise from different teams or team members, with the assumptions that (a) teams/team members exist and (b) they have their own expertise, not common skills and knowledge. This is fine for the corporate world where such teams often exist and fine for the business student or executive, who understands design thinking as a competitive edge and as a process that involves innovative ideas, collaboration, quick visualizations, rapid prototyping, so on and so forth. In other words, it is more important for business students or executives to have an understanding and appreciation of what design thinking is and to bring together the people with the expertise to collaborate, than to know how to design themselves. To

teach design thinking to these business students or executives, would be to cultivate this appreciation, develop an open-mindedness for design or the value of design, to learn to collaborate, and to practice the design thinking process involving the stages, as a team, as stated above. However, in an alternative setting, what if such teams do not exist? What if the student will work as a free-lance designer? What if the student will work in a small business or start a small business (but with great ideas)? In such cases, it would be more beneficial to acquire some of the common knowledge and skills required in design thinking.

Thirdly, Lockwood implies in the foreword that the book sheds light on the current meaning of design thinking, when it is actually part of the current meaning. *Design Th!nking* by Ambrose and Harris published in the same year, for example, provides a different version or interpretation of design thinking.

Nonetheless, there are a number of components mentioned in Lockwood's book that could be incorporated as part of an interdisciplinary curriculum on design thinking:

1. Deep user understanding, ethnography, fieldwork research, collaboration with users, codesign concepts, human factors
2. Concept of radical innovation (previously mentioned by Fraser as breakthrough thinking) as opposed to incremental improvement or thinking
3. Innovation intelligence, consisting of (a) emotional intelligence (the ability to understand and embrace in the context of culture), (b) integral intelligence (the ability to bring together diverse customer needs and business ecosystem capabilities into complete systems, and (c) experiential intelligence (the ability to understand and activate all five human senses to make innovation tangible); head, heart, gut
4. Shift from functional to cultural innovation

5. Visualization, quick prototyping, sketching, storyboards, mock-ups
6. Conceptual new product, service, experience
7. Business analysis and strategies
8. Shaping of the future, future state, forward thinking, trends, product opportunity gaps
9. Studying PESTE factors
10. Value opportunity analysis (VOA) in these seven categories: emotion, aesthetics, identity, ergonomics, impact, core technology, and quality
11. What is branding and aspects of branding, humanizing brands
12. Thinking of, about, and through design
13. Systems thinking, human ecosystems, systems design, cults, touchpoints
14. Service design, SSME, measurements of success, e.g. triple bottom line (economic, environmental, social), service usability index
15. Social and environmental responsibilities, universal design, accessibility
16. Imagination and creativity

One final note is that I agree with Best's observation that most readings on design thinking in the business context consist of case study after case study, without telling you how to innovate. Although Best has attempted to suggest a list of ten triggers of innovation, they are neither innovation methods nor principles of innovation; rather, they are foci on which one could think about design, such as business factors, client, or technology. Though creativity and imagination are frequently mentioned as inseparable from design thinking, by the same token, not much has been said about creativity methods or how one goes about being imaginative by the authors in Lockwood's book. In this respect, authors in the fields of architecture, e.g. Lawson and Rowe, and graphic design, e.g. Ambrose and Harris, are more solid in their contributions.

Table 5: Evolution of Literature – Scope of Ideas

1980s	TOPICS/THEMES
Chemical Engineering (Institution of Chemical Engineers at Aston University, Design '79, 1980)	Energy inflation and perspectives, economic prospects, rational economic criteria for engineering designs and decisions, environmental impact analysis, synergistic co-siting of industrial activities, micro-processors and manufacturing processes, design and project management, reduction of human error and safety considerations, cost effectiveness, design for maintainability, waste disposal strategies, hazard assessment and control, emerging technologies, incremental vs. novel, radical innovation.
Architecture (Lawson, 1980; Rowe, 1987)	Theories and styles of thinking, e.g. schools of psychology, productive thinking (convergent/divergent), design processes, creativity, reasoning vs. imagining, design philosophies, design strategies, heuristics, and tactics, design as language, hunches and guiding visions, shifting of perspectives in designer's mind, evolutionary vs. revolutionary innovation, individualistic innovation, modes of representation, concept of style, aesthetic considerations and newness, expression of inner beliefs and social purpose, consideration of user needs
1990s	TOPICS/THEMES
Industrial Design Engineering (Cross, Dorst, Roozenburg, 1992)	Natural intelligence vs. artificial intelligence, problem and solution formulation, cognitive strategies, design reasoning or abductive reasoning (formerly productive reasoning) vs. inductive and deductive reasoning, design reasoning vs. design intuition, design processes, innovation
Multi-disciplinary (Mitchell, 1996)	Infusing meaning, increasing scope, metadesign, involving users, enhancing perception, considering context, strategic design planning process, fail-safe designs
Industrial Design (Balaram, 1998)	Nature, human perspectives and concerns, new dimensions and the future, semiotics, training, policies and politics, global vision, socially well-integrated humane designers, the barefoot designer
2000s	TOPICS/THEMES
Business (Martin, 2009)	Design thinking as competitive advantage, knowledge funnel (importance of algorithms), exploitation vs. exploration, reliability vs. validity, innovative/imaginative breakthroughs, abductive reasoning vs. deductive and inductive reasoning, integrative thinking, personal knowledge system of stance, tools, and experience
2010s	TOPICS/THEMES
Graphic Design (Ambrose & Harris, 2010)	Design thinking based on the different stages of a typical design process, strategies, creative/art directions, examples
Business (Lockwood, 2010)	Innovation, abductive thinking, innovation intelligence: head, heart, gut, building brands, multidisciplinary collaboration, design management, brand building, human ecosystems, ROI, VOA, customer experiences, PESTE factors, service design
Service Design (Stickdorn & Schneider, 2010)	Service design tools, strategies, principles, case studies
Graphic Design (Lupton, 2011)	Graphic design strategies, process, examples
Interior Design (Dohr & Portillo, 2011)	Interior design strategies, process, examples
Engineering (Meinel & Leifer, 2011)	Engineering-specific processes and technologies
Interdisciplinary (Cross, 2011)	Case studies and interviews with designers, working styles, forms of intelligence

Interpretation

Other than the two publications reviewed in this chapter, a few more titles on design thinking have been published since. They are *Graphic Design Thinking (Design Briefs)* by Ellen Lupton (Ed.), *Design Thinking for Interiors: Inquiry, Experience, Impact* by Joy H. Dohr and Margaret Portillo, *Design Thinking: Understand – Improve – Apply (Understanding Innovation)* by Christoph Meinel and Larry Leifer, *Design Thinking: Understanding How Designers Think and Work* by Nigel Cross, and *This is Service Design Thinking: Basic – Tools –Cases* by Marc Stickdorn and Jakob Schneider. There are also a good number of recent publications that are closely related to this subject, most notably in the field of business, such as *Change by Design* by Tim Brown, *Designing for Growth* by Jeanne Liedtka and Tim Ogilvie, and *Design Driven Innovation* by Roberto Berganti.

Looking at the literature on this subject over the last few decades, it is apparent that design thinking is becoming a very popular, published subject especially in the last two years. It also appears that there are two main thrusts in the development of this subject: (a) one that almost equates design thinking with business, a field where design thinking is becoming more and more visible and valued as a competitive edge, and (b) one that is introspective of a specific design discipline, to help practitioners in that particular discipline to acquire more strategies and skills. For example, Lupton, like Ambrose and Harris, focuses on design thinking in graphic design, Dohr and Portillo focus on design thinking in interior design, and Plattner, Meinel, and Leifer focus on technologically specific design thinking in engineering. Hence, in this discipline-specific direction, the study is more of an insular or isolated nature. The two thrusts could also overlap, since business management is also studied as a discipline. However, since the promotion of design thinking as a competitive edge is gaining impetus, recognition, and therefore more public attention, the perception and understanding of the term "design thinking" is to a large extent geared towards how it is defined in the business community today.

In other words, up till now, it is still rather challenging to give meaning to the term "design thinking" in an interdisciplinary manner. There have been attempts, however, as can be found in *This is Service Design Thinking: Basic – Tools – Cases* by Stickdorn and Schneider (2010), where service design is presented as interdisciplinary:

> Why must we confuse the audience even more with a title like "This is Service Design Thinking"? The service design community still struggles with exact formulations. Some want to find a completely new name for the things we do, some want to show that this is not new at all; some consider themselves as service designers, some as design thinkers and others as design strategists or new service marketers. However, we all share a certain approach. Services can be designed from various perspectives, using different methods and tools of various disciplines and thus also using different terminology. Service design is interdisciplinary and therefore it cannot be a discipline in itself.

As the argument above implies, even though an interdisciplinary approach is relevant, the context of this investigation is still confined to that of service design.

Other than Stickdorn and Schneider, Nigel Cross is perhaps the only other scholar who attempts to address design thinking as an interdisciplinary approach. Despite his own background in architecture and industrial design engineering, in his most recent publication in 2011, *Design Thinking: Understanding How Designers Think and Work*, Cross attempts to

> help anyone interested in design to develop their understanding of how designers think and work. Anyone so interested might be a design student, a design researcher or teacher, a manager in a design-oriented company, or even a designer who still finds their own processes mysterious or difficult....My aim is to reveal and articulate the apparently mysterious (and sometimes deliberately mystified) cognitive and creative abilities of designers, that are common across many design domains. (p. 1)

Based on this statement, Cross appears to be the one who is most intent on finding an approach that could be deemed interdisciplinary. To that end, Cross compiles a selection of case studies, such as Formula One racing car design, and interviews with designers in hopes of shedding some light on how designers think and work. Cross also attempts to outline the common features shared by creative designers and innovators, in the form of personality traits such as persistence and courage, and working style consisting of alternating periods of intense activity and periods of reflection, though not necessarily with systematic methods. A look at design intelligence, as identified by Howard Gardner, with its six forms of intelligence: (a) linguistic, (b) logical-mathematical, (c) spatial, (d) musical, (e) bodily-kinaesthetic, and (f) personal, concludes Cross's discussion.

If the observations stated above represent the contemporary directions in the study of design thinking, then they can be summarized as (a) the promotion of the concept of design thinking as a competitive edge in the realm of business; (b) the exploration of discipline-specific design paradigms and skills in their respective disciplines; and (c) the understanding of design thinking as an interdisciplinary approach. So if one were to ask me today, "So what is design thinking?," I could summarize and synthesize from the three directions stated above, to say that design thinking is the type of thinking that is innovation-driven, that combines both creative and analytical thinking, that aims at applying innovative design strategies and paradigms to develop innovative products. Without a doubt, this explanation applies to all three directions.

Despite peripheral differences in overall emphases and topics covered in literature, scholars in all three directions laud creativity and innovation, i.e. radical innovation in particular, as indispensable in design thinking. However, few scholars go into detail in terms of suggesting concrete creativity or innovation methods. Instead, case studies are generally used to illustrate working styles and mindsets adopted by designers. This lack in concrete suggestions in terms of techniques and methods is, in my opinion, is the biggest void to be filled in contemporary

research in this subject. If the process of design thinking is unanimously considered as a balanced process combining both creative and analytical thinking and activities, then techniques and methods in both these categories are best to be included. To further the interdisciplinary approach that anyone who is interested in design could benefit from, techniques and methods that could be applied in diverse situations and disciplines should also be ideally considered and developed. Although Cross observes from his case studies that designers, for the most part, do not work systematically in terms of methods, I would argue that in the context of design education, it would only be beneficial to equip students with a repertoire of creativity and innovation methods that they can systematically work through. Table 6 presents a list of potential creativity and innovation methods extracted from Design Thinking literature.

As discussed in the previous chapters, other ideas in design thinking that have been brought up in literature but are not necessarily deemed important by all scholars should not be ignored or forgotten. To that end, I have attempted to raise the emphasis of such ideas by incorporating them into my pilot teaching project: namely, (a) teaching design thinking as a holistic approach, (b) values-based design, (c) integrated design principles, (d) foresighting/futures-thinking, (e) integrated design process, and (f) complex visible and invisible systems. As analyzed in the previous chapter, while students had demonstrated positive learning results from these ideas on the whole, they were definitely more interested in applying creativity methods in isolated contexts or exercises. One might surmise that these exercises are more fun, immediately rewarding, and less taxing, in terms of following through a lengthy, thoughtful, argumentative design process, e.g. as demonstrated in the final essay. As most students do have an awareness of issues that are worthy of attention, in particular environmental, energy-saving, and/or sustainability-related issues, they are naturally able to initiate relevant design solutions, especially if they are made part of the requirements of an assignment. As for consciously applying integrated design principles and foresighting techniques, this seems to be the weakest

area when it comes to explicitly integrating them in a major assignment, e.g. an essay, though students seem to be quite capable of doing so in smaller, isolated exercises or activities. These observations in concert would indeed help me come up with recommendations in modifying a design thinking curriculum that might be more effective and beneficial, and hopefully more updated and relevant to the 21st century.

Table 5 represents an attempt to trace the evolution of literature on design thinking, summarizing the scope of ideas explored and/or emphasized from the 1980s to the present.

Recommendations and Conclusion

As mentioned in the previous chapter, although there were visible, positive results on the whole in the pilot teaching project, one of the major changes that I would recommend would be in the weighting of the components in the curriculum, from an interdisciplinary perspective, in three main categories:

a) The majority of the emphasis would be placed on equipping students with solid design skills and knowledge, including theories and principles, thus building up a repertoire of design language and paradigms, and in enabling them to better appreciate design. These include activities on
    - Visualization and sketching – semiotic drawings/designs, flow charts, perspective and axonometric drawings;
    - Aesthetics – use of visual design elements such as line, colour, shape, form, value, texture, as well as humanistic aesthetics, an attention to the mind, body, and soul;
        - Innovation intelligence, involving the head, heart, and gut

- Design principles – integrated design principles as proposed in Chapter 3;
- Design process – integrated design process as proposed in Chapter 3; as well as a comparative look at other established processes;
- Design paradigms – diverse examples from various disciplines demonstrating existing ways of designing, e.g. Warren Wake's design paradigms, biomimicry, styles found in design history, strategies used in design practice, e.g. examples found in design books such as Ambrose and Harris's (presented earlier in this chapter); values-based designs, e.g. Leong's, metadesign or designing as systems, encompassing the visible and invisible realms;
- Theories – readings on multi-disciplinary design issues.
    - In particular, aesthetics and design paradigms (as stated above) could form a resourceful designer's palette that one could design from.

b) A secondary emphasis would be placed on creativity and innovation methods and other techniques, such as foresighting techniques. These include both creativity and analysis techniques to foster students' prowess and readiness in creativity and analysis:

- Creativity methods – e.g. bisociation, analogies, Dieter's creativity methods, applying design paradigms differently;
- Innovation methods – e.g. making divergent leaps, such as asking "what if," using foresighting techniques, such as backcasting; (A list of creativity and innovation methods is presented in Table 6);
- Analysis methods – identifying drivers and barriers, information

gathering, environmental impact analysis checklists and matrixes, foresighting techniques and approaches (e.g. as presented by Evans and Sommerville, and Margolin);

- Creative or project brief – writing a brief that clearly states the goals and parameters of the project in qualitative and quantitative terms, and addressing the questions in the Integrated Design Process.

c) Finally, the least emphasis would be placed on becoming visionaries and formulating their own philosophy and direction:

- Role models and case studies, e.g. Buckminster Fuller;
- Integrated design process, e.g. starting the process with guiding values.

The proposition stated above could be understood and visualized in the shape of a pyramid, with "vision" at the top, "methods and techniques" in the middle, and "skills and knowledge" at the bottom (Diagram 1).

Since the pilot teaching project in the fall of 2009, I have taught this course a few more times in the regular term as well as in the summer. I find that sticking to the concrete, e.g. looking at examples, applying creativity methods repeatedly but in different situations, and only sneaking in the more abstract ideas, so to speak, such as designing as systems, guiding values, and other theories only occasionally and where appropriate, yield the most crowd-pleasing results. The evaluations collected in these terms overwhelmingly reflect the excitement and pleasure that the students have in taking the course. In a 12-week, 200-level introductory course in design thinking in particular, one that is catered to a large number of students with little or no design experience, and from diverse cultural and academic backgrounds, it is after all unrealistic to expect to achieve a lot. Perhaps a more careful planning and allocation of components, as proposed above, in an

optimal fashion so as to make the 12-week course more fun and practical, and yet inspiring and empowering, is the best course of action to take for now.

This thesis has given me some insight in pinpointing some potential areas of further research: (a) additional creativity and innovation methods and techniques, (b) new definitions of innovation and intelligence, and (c) techniques of visualization and visual thinking. Hopefully, further work in these areas would make the understanding and teaching of design thinking even more holistic and accessible as it evolves.

Alternative Scenarios and Strategies

The target audience of CCT204 is atypical for a design program. The class size is large, with a maximum of 160 students. The mode of delivery is constrained by the format of class structures, i.e. weekly two-hour lectures with the entire class followed by one-hour lab sections with 40 students each. The duration of the course is 12 weeks or 0.5-credit. As a result, the delivery and organization of content have to be compact yet comprehensive and interesting enough to retain the audience. The learning outcomes are theoretically based for lectures and technically based for labs, with the teaching of software such as Adobe Illustrator as part of the package. In fact, almost all of the CCIT courses offered at Sheridan are associated with the teaching of specific software programs and charted progressively and accordingly – concrete, industry-related skills for which students have consistently expressed appreciation. With enrollment being a vital concern, students are accepted without any formal screening process, e.g. portfolio review or interview – typically in place in most studio art or design programs – other than the fulfillment of prerequisite courses. The academic and cultural backgrounds, aptitudes, inclinations, interests, skills sets and design experience or lack thereof, are therefore erratic; and so are the performance and results.

Conversely, in a typical studio-based art or design program, even though there is still some degree of variance in terms of performance, enrollment is comparatively select, often with a screening process. The result is a much lower teacher-student ratio, typically under 20 students per class in a studio or seminar setting. Of course, there are exceptions, where certain fundamental courses are still conducted in lectures. Supposing that the proposed ideas of design thinking presented in this thesis are transposed into such a context, how would I teach it? To begin with, there would be a few presuppositions:

1. Students who take the course would have a basic understanding and training in design, e.g. the use of vocabulary, application of traditional design elements and principles, drawing skills by hand and computer skills, such as Adobe Creative Suite. Alternatively, it is understood or expected that students would further these skills on their own or in workshops or online tutorials, such as Lynda.com, offered outside of the course. With this understanding, the focus of the course could be more conceptual and experimental. In other words, the expectation on the part of students would not be so much as the acquiring of technical skills, e.g. Illustrator skills, as the exploration and sharpening of their conceptual, imaginative, creative, experimental, and problem-solving calibre in research and implementation.
2. There is a higher than average degree of interest and commitment in design. At the very least, students should be committed to come to class and participate. Where, for example, attendance in a lecture with an enrollment of 160 students is 50% to 60%, all students in a class with an enrollment of 20 students would be expected to be committed to come to class every week, unless there is an exceptional situation. A stipulation in the course outline could be written to this effect: “Due to the participatory nature of the course, attendance is mandatory.

> All absences are to be reported in writing to the instructor and program coordinator." For example, as per the policies of the University of Toronto Mississauga, students must declare their absences on ROSI. The reduction in numbers and the selection of students could hypothetically translate to having the top 10% of the class of CCT204 in this alternative mode of delivery.

With the number and inherent qualities of the students thus presupposed, and considerations of funding presumably taken care of, there are some scenarios in which the proposed ideas of design thinking as presented in this thesis could be explored.

Firstly, if design thinking is to be introduced as a holistic approach, there could be a push towards greater partnerships and collaboration between specialists from different disciplines, so that all facets of the individual psyche, e.g. emotional, rational, and sensory, are considered and represented. Without having to precisely dissect or designate which traditional discipline represents which facet/s of the individual psyche, it would be a reasonable assumption to select students with different strengths and/or from different backgrounds in a somewhat balanced manner. For example, when screening applicants, applicants could be asked to indicate their strengths and weaknesses, experiences, achievements, and interests in a broad manner. Sample questions could include

- Other than design, which academic subject/s are you most interested in?
- What do you consider your biggest achievement/s?
- In which areas do you feel the strongest, weakest?
- What colour/s do you like best? Why?
- When you first meet a person, what do you notice about them first?
- What are your hobbies/interests?
- What are the two most important criteria for you when you purchase an item?

- When you walk into a room, what do you notice first?

By gauging the applicants' responses, a mix of individuals with different sensitivities and abilities could be brought together who would likely complement each other, in the collaborative practice and critique of design. An important experience here is not simply to work together but to learn from each other's strengths in nurturing the whole psyche. In this context, enrollment could be extended to students outside of the program, in attracting diverse students who are already strong in their discipline but have the potential to embrace design thinking as a holistic approach. To have the ability to attract such students, the course should have a well-defined and agreeable brand image. To that end, having a prize such as the Gilbert's LLP Prize in Design Thinking, which is currently offered in CCT204 each semester is an attractive bonus. As creativity is evident in many disciplines, having students from Art, Music, Engineering, Textiles, Architecture, to name a few, would enhance the holistic, transdisciplinary approach in the course, especially when they are encouraged to apply the principles and creativity methods that they have already learned elsewhere in an alternative discipline or setting.

In the following pages, I will suggest a number of strategies that might assist the development of lesson plans in this regard. These strategies are in turn inspired by literature that I have come across in this project.

Breakthrough Thinking

The idea of breakthrough thinking has been presented many times by different scholars under different terminologies: radical changes, innovative breakthroughs, revolutionary thinking are some of the terms that allude to the idea of breakthrough thinking. The concept of breakthrough thinking vs. incremental thinking should be introduced early on in the course. The key in directing the design thinking process here is in framing the design question accordingly.

For example, there is a difference between asking "How can bottled water be redesigned?" and "How can water be supplied accessibly when one's on the road?". The former focuses on two things: the bottle and its content, i.e. water. Any ideas generated from this question would revolve around the incremental changes associated with the visible/tangible realm: (a) the bottle, e.g. its packaging, shape, material, colour, size, features, details, components and placement thereof, and (b) the water, e.g. the source, treatment, additives, flavour, and the invisible/intangible realm, such as the processing, management, distribution, marketing and advertising, which involves the visible realm to an extent, e.g. presence in media such as ads, commercials, and social media. A discussion in this context is normally limited to traditional models of industrial design and operations management in the corporate realm, controlled by traditional industries and conventional brands.

On the other hand, the latter way of framing the question assumes that one can disregard (at least temporarily) any preconceived or established modes of thinking and business models from the get-go. The question "How can water be accessible when one's on the road?" can open up numerous possibilities and ideas, including traditional concepts, e.g. bottled water, and many wild ideas that could be considered and then weeded out later on if need be. For example:

- Water coolers could be installed on buses, bus shelters and subway stations;
- Rain water could be collected and treated for potability in public locations;
- Vehicles could be redesigned to include a built-in cooler for water storage;
- Signage could be incorporated in regional planning to include availability of potable water, such as public taps to obtain municipally treated water;
- Private businesses could offer free water to the public (e.g. Wall Drug, in the town of Wall, South Dakota, is well known for providing free, icy-cold water to travellers; billboards to that effect can be seen for many miles around);

- More water fountains could be installed in easier-to-find public places.

Using the ideas above as points of departure, design as systems incorporating visible and invisible realms could be explored and turned into individual tasks or projects and then combined into a collaborative system. Positive and negative constraints would be addressed and resolved along the way. For example:

- Existing and new forms of water coolers would be conceptualized and/or modified to be fitted on buses; exploring possibilities in shape, size, colour, features, technologies, and placement.
- Alternative methods of collecting, treating, and storing rain water would be researched, with attention paid to the invisible, such as the process and health concerns, and the visible, such as the possible designs of containers.
- Automotive design could be explored and industries could be interviewed and/or solicited as partners in addressing this issue.
- Traditional and non-traditional signage and wayfinding solutions, including social media and GPS apps, could be designed to increase the presence and accessibility of municipally treated water.
- Business plans and marketing strategies could be drawn up to promote the idea of accessible water to private businesses:
    - Sponsorships from industries and governmental agencies could be sought;
    - Advertising and marketing could be consolidated as benefitting the collective society vs. individual corporations or businesses, e.g. each participating business would be given the same sign put forth by the joint organizing committee. The sign could bear a logo, slogan, and/or tagline

identifying the business as a participant of the collaborative, non-profit initiative. The city could be promoted to travellers as the city with free, accessible water.

- The idea of water fountains could be redesigned, not limiting to the traditional concept of stand-alone units, e.g. a redesigned faucet coming out of the wall of a building, decorative models, covered, more hygienic designs.
- Other considerations of design could be explored, e.g. in terms of policies and services, but most importantly in the impact of design on changing people's behavior and lifestyle. For example, instead of manufacturing more plastic bottles, the concept of receptacles could be revisited or even eliminated.
    - With efforts in recycling and sustainability, more designs of paper cups could be explored, e.g. collapsible, foldable designs.
    - To recuperate the costs of production, donations could be made in support of this initiative. Donations do not necessarily have to be in the form of monetary donations, but in the contribution of creative ideas as an ongoing, sustainable endeavour.

In other words, the course could be project-based, involving team work within the group as well as real-life investigations with potential, external partnerships in various profit and non-profit sectors of the society. The course is ideally run in a seminar/workshop setting, for 3-4 hours per class, for the duration of two half terms, in order to allow time for research, design concepts, solicitation of partners, and the preparation of proposals. Not all projects have to be as ambitious as the example above, nor do they have to be fully materialized at the end of the course, but they do need to be embraced fully in multiple directions and aspects of design as real potential agents of positive change. Where possible and appropriate, the proposed systems of design should be pursued and followed through outside of the course.

Bisociation as a Creativity Method

A significant concept that stood out in all the literature reviewed is that of Koestler's idea of bisociation (1964). Rowe (1987) points out that the concept of bisociation, i.e. the bisociation of two mutually incompatible contexts, or bisociation of matrices, could explain creativity. Rowe states: "[C]reating involves relating two normally independent frames of reference" (p. 46). In my opinion, bisociation could be applied as a fundamental creativity method. It can be used in endless possibilities by combining attributes from a multitude of designs in a multitude of ways from normally independent frames of reference or disciplines. For example, the design of the Sno Wovel™ (a snow removal device) combines the concepts of a snow shovel and a wheel barrel. It uses zero fuel, and converts the power and motion of the big wheel traditionally found in a wheel barrel to shovel snow. Since the user does not have to bend while shoveling as one would with traditional snow shovels, the device is also easy and safe to use. Instead of investing in unsustainable energies, the Sno Wovel™ is an intelligent design that is creatively inspired by existing, simple, sustainable technologies.

While attending the SIGGRAPH conference in Vancouver last year (SIGGRAPH is short for Special Interest Group on Graphics and Interactive Techniques), my husband picked up a set of coasters given out by Disney Animation Studios. Each of the coasters features a design that incorporates characters in a Disney movie, executed in the style of Haida art. The consciously selected art direction is well defined and appropriate for the target audience, comprised of professionals in the field of computer graphics, as well as for the setting, the Pacific Northwest Coast of North America where Haida art originates. The bisociation of Disney characters and Haida art is a good example of combining two normally independent frames of reference to come up with a fresh and creative design.

To apply bisociation in the context of design, one could mix and match attributes from two (or more) disciplines or design paradigms. In order to maximize the potential of this method, it would be beneficial to have built up a repertoire of knowledge and experiences, in as many streams as possible. For example, having exposed to different styles and periods of art history, having travelled abroad and made friends from different cultures, having read and seen different types and forms of literature, arts and entertainment, would all contribute to one's visual and technical vocabulary and insights. Being able to apply artistic or aesthetic styles and expressions and utilize diverse techniques and technologies, however simple or complex, inexpensive or costly, would broaden and enhance one's creative potential. The educator would be the instigator, prompter, and if need be, the conductor in this regard. A holistic curricular model in design thinking should include and emphasize activities that remind students of the importance of such a consciousness. For example, the beginning of each class could be dedicated to a short show-and-tell session where students succinctly present the uniqueness or attributes of an art form, material object, technology, media, or any other meaningful experience that they have encountered. Students can then quickly come up with some ideas as to how these observations could be furthered and/or combined to become new, creative designs.

Developing Minds for the Future

The curricular model that I am proposing, regardless of its target audience, is one that prepares designers for the future. In *Futures Thinking, Learning and Leading*, Irving H. Buchen (2006) posits that multiple intelligences (MI), that taps into learning diversity, "may be precisely the quantum jump needed to meet 21st-century global challenges" (p. ix). Buchen recognizes that a future training direction would always focus on "three major relationships: self, others, and teams" (p. 107). The five items that help direct this focus can be given futures-directed dimensions:

1. Current: This is who I am. Future: This is who I want to be.
2. Current: This is what I value. Future: This is what I want to value more.
3. Current: This is how I relate. Future: This is how I wish to relate differently.
4. Current: This is how I learn. Future: This is how I unlearn and change.
5. Current: This is how I work. Future: This is how I work more productively.

These five questions could be questions that students ask in the beginning of the course, making a commitment and resolution to themselves, with a future direction in mind and in an atmosphere of positive change that sets the tone for the course.

With the assumption that everyone is multiply talented (Buchen, 2006, p. 213), there is tremendous capacity for innovation in a collaborative learning environment. As Buchen states: "Innovation should be…surrounded by multiple and reinforcing approaches…Innovation eludes the grasp of singular or linear-sequential approaches. But it can be accessed by ideas, questions, and multiple intelligences" (p. 207). Thus, while it is invaluable to structure the course around a project, and it is inevitable that the project follows or transpires in a design process, it is equally important to include smaller tasks and activities – motivational sessions – frequently and regularly in the course to amplify student learning. The term, *cross-pollinator*, one of the ten faces of innovation (Kelley & Littman, 2005), is perhaps a befitting expression for this approach.

In *5 Minds for the Future*, Howard Gardner proposes the cultivation of "the kinds of minds that people will need if they – if *we* – are to thrive in the world during the eras to come…the operations of the minds that we will need…that…we *should* develop in the future" (2008, p. 1). These minds are

1. The *disciplined* mind – that has "mastered at least one way of thinking – a distinctive mode of cognition that characterizes a specific scholarly discipline, craft, or profession" (p. 3);

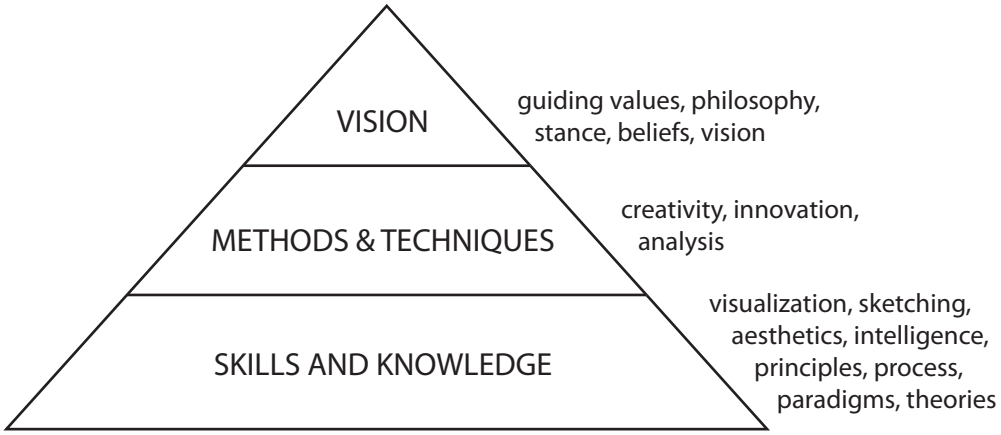
2. The s*ynthesizing* mind – that "takes information from disparate sources, understands and evaluates that information objectively, and puts it together in ways that make sense…" (p. 3);
3. The *creating* mind – that "breaks new ground. It puts forth new ideas, poses unfamiliar questions, conjures up fresh ways of thinking, arrives at unexpected answers" (p. 3);
4. The *respectful* mind – that "notes and welcomes differences between human individuals and between human groups, tries to understand these 'others', and seeks to work effectively with them" (p. 3); and
5. The *ethical* mind – that "conceptualizes how workers can serve purposes beyond self-interest and how citizens can work unselfishly to improve the lot of all" (p. 3).

Gardner's proposal precisely coincides with the vision and goals of this thesis.

Table 6: List of Potential Creativity and Innovation Methods Suggested in Design Thinking Literature

- Seven categories of invention methods: simple or multiple combination, labour-saving concept, direct solution to a problem, adaptation of an old principle to an old problem to achieve a new result, application of a new principle to an old problem, application of a new principle to a new use, serendipity
- Brainstorming as an activity to counter the mechanical effect of applying old solutions to new problems; SCAMPER checklist for brainstorming: substitute, combine, adapt, modify/magnify/minify, put to other uses, eliminate, rearrange/reverse
- Synectics with its four types of analogy: personal, direct, symbolic, and fantasy analogies, especially fantasy analogy (fantastic and seemingly impossible ideas)
- Force-fitting methods (forcing the mind to make creative leaps, e.g. what if, attribute listing)
- Conceptual decomposition: decomposition in the physical domain, functional decomposition
- Morphological chart: arranging the functions and subfunctions in logical order and for each, list the possible hows
- Avoiding traps: category, puzzle, number, icon, and image traps
- Constraints: turning negative constraints into positive constraints
- Bisociation of two mutually incompatible contexts, relating two normally independent frames of reference
- Five classes of heuristics, analogies, solution images, or form-giving rules: anthropometric analogies, literal analogies, environmental relations, typologies, and formal languages
- Applying existing design paradigms or positions, e.g. functionalist position, populist position, conventionist position, formalist position
- Work on the language: the "how" or the formal component of visual language, the "what" or the figural component
- Bricolage: recombining, reusing, reconstructing past forms, fragments (the conception between the purpose and the form of the designed object ought to start from scratch)
- Divergence (expanding from a central point or traditional theme), convergence (contracting to a more basic or generalized point); clustering (blending in/converging in the cluster or standing out/diverging from the cluster)
- Transformation (substantial redesign)
- Point of difference or unique selling point (USP)
- KISS (Keep It Short and Simple or Keep It Simple Stupid)
- Focus (selecting only the key message elements)
- Top down and bottom up (from system perspective to basic details or vice versa)
- Ockham's razor (reductionism, principle of parsimony or law of economy)
- Python philosophy (ideas from the *Zen of Python*, e.g. simple is better than complex, sparse is better than dense, practicality beats purity),
- TIMTOWTDI (There Is More Than One Way To Do It)
- Appropriation
- Personification
- Metaphors
- Foresighting techniques, e.g. backcasting

Diagram 1: New Curricular Model in Design Thinking



NEW CURRICULAR MODEL IN DESIGN THINKING

REFERENCES

680 News (2009). Police identify victim of fatal Highway 407 crash into drainage bay. Retrieved October 8, 2009, from http://www.680news.com/news/headlines/more.jsp?content=20091008_102839_6824

Abbing, E. R., & van Gessel, C. (2010). Brand-driven innovation. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 131). New York, NY: Allworth Press.

Akin, O. (1992). A structure and function based theory for design reasoning. In Cross, N., Dorst, K., & Roozenburg, N. (Ed.), *Research in design thinking: proceedings of a workshop meeting held at the Faculty of Industrial Design Engineering, Delft University of Technology, the Netherlands, May 29-31, 1991.* The Netherlands: Delft University Press.

Ambrose, D. (2009). *Expanding visions of creative intelligence*. Cresskill, NJ: Hampton Press, Inc.

Ambrose, G., & Harris, P. (2010). *Design th!nking: the act or practice of using your mind to consider design.* Switzerland: AVA Publishing.

Arnheim, R. (1993). Sketching and the psychology of design. In V. Margolin, & R. Buchanan (Ed.), *The idea of design* (p. 70). Cambridge, MA: The MIT Press.

Association pour la Pensée Complexe. (1998). Le petit lexique des termes de la complexité. Retrieved February 27, 2009, from http://www.mcxapc.org/static.php?file=lexique.htm&menuID=lexique

Balaram, S. (1998). *Thinking design.* India: National Institute of Design.

Baofu, P. (2009). *The future of post-human creative thinking*. UK: Cambridge Scholars Publishing.

Bedford, C., & Lee, A. (2010). Would you like service with that?. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 197). New York, NY: Allworth Press.

Berleant, A. (2004). *Re-thinking aesthetics: Rogue essays on aesthetics and the arts*. Burlington, VT: Ashgate Publishing Company.

Berman, D. (2009). *Do good: how designers can change the world*. Berkeley, CA: New Riders.

Best, P. (2010). Branding and design innovation leadership: what's next?. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 145). New York, NY: Allworth Press.

Biomimicry Institute (2007-2011). What is biomimicry?. Retrieved September 9, 2011, from http://www.biomimicryinstitute.org/about-us/what-is-biomimicry.html

Boekraad, H., & Smiers, J. (1998). The new academy: uniting visual intelligence with ethics and research. Retrieved February 13, 2009, from http://74.125.95.132/search?q=cache:6OQUT_wp3uMJ:www.elia-artschools.org/_downloads/publications/EJAE/1998/BOEKRAAD.pdf+the+new+academy+uniting+visual+intelligence+with+ethics+and+research&hl=en&ct=clnk&cd=1&client=safari

Breen, B. (2005). The business of design. *Fast company*, April, 68-69.

Briggs, J. (2003). Re: blue-sky thinking. Retrieved September 23, 2008, from http://www.phrases.org.uk/bulletin_board/20/messages/1431.html

Buchanan, R. (1992). Wicked problems in design thinking. In V. Margolin, & R. Buchanan (Ed.), *The idea of design* (p. 3). Cambridge, MA: The MIT Press.

Buchanan, R. (2004) Human-centered design: Changing perspectives on design education in the east and west. *Design Issues*, 20(1), 30-39.

Buchen, I. (2006). *Futures thinking, learning, and leading: Applying Multiple Intelligences to Success and Innovation*. Lanham, MD: Rowman & Littlefield Education.

Clark, H., & Leong, B. D. (2003). Culture-based knowledge towards a new design thinking and practice – a dialogue. *Design Issues*, 19(3), 48-58.

Clark, K., & Smith, R. (2010). Unleashing the power of design thinking. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 47). New York, NY: Allworth Press.

Constable, G. E. P., & Parkes, D. (1980). Design for maintainability. In The Institution of Chemical Engineers, Midlands Branch (Ed.), *Current design thinking: a symposium organized by the Midlands Branch of the Institution of Chemical Engineers at Aston University, September 12-14, 1979* (p. 7/3:1). Birmingham: Midlands Branch, The Institution of Chemical Engineers, I.H.D. Department, University of Aston in Birmingham.

Cooper, R., Junginger, S, & Lockwood, T. (2010). Design thinking and design management: a research and practice perspective. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 57). New York, NY: Allworth Press.

Cornell, C. (2006). Designers' point of view applied to business: Rotman puts new twist on educating executives. *National post*, special report: financial post. Retrieved May 22, 2007,

from http://www.rotman.utoronto.ca/businessdesign/nationalpost.htm

Cross, N. (1992). Research in design thinking. In Cross, N., Dorst, K., & Roozenburg, N. (Ed.), *Research in design thinking: proceedings of a workshop meeting held at the Faculty of Industrial Design Engineering, Delft University of Technology, the Netherlands, May 29-31, 1991.* The Netherlands: Delft University Press.

Cross, N. (2011). *Design thinking: understanding how designers think and work.* New York, NY: Berg.

Cross, N., Dorst, K., & Roozenburg, N. (Ed.) (1992). *Research in design thinking: proceedings of a workshop meeting held at the Faculty of Industrial Design Engineering, Delft University of Technology, the Netherlands, May 29-31, 1991.* The Netherlands: Delft University Press.

Dewberry, E., & Sherwin, C. (2002). Visioning sustainability through design. *GMI 37*, Spring, 125-138.

Dick, B. (1993) You want to do an action research thesis? Retrieved April 21, 2009, from http://www.scu.edu.au/schools/gcm/ar/art/arthesis.html

Dieter, G. E. (2004). *Engineering design: a materials and processing approach (custom version for University of Toronto)* (Third Edition ed.) Toronto, ON: McGraw-Hill Ryerson Limited.

Dohr, J. H., & Portillo, M. (2011). *Design thinking for interiors: inquiry + experience + impact*. Hoboken, NJ: John Wiley & Sons, Inc.

Elvins, L., & Goulder, N. (2010). Working with ethics: publisher's note. In Ambrose, G., & Harris, P., *Design th!nking: the act or practice of using your mind to consider design* (p. 193). Switzerland: AVA Publishing.

Evans, M., & Sommerville, S. (2007). A design for life: futures thinking in the design curriculum. *Futures Research Quarterly*, Fall, 5-19.

Ferenc, J. (2008). Working on your green-building education. *HPAC Engineering*, January, 5.

Fergusson, K. J. (1980). Evaluation of future processes. In The Institution of Chemical Engineers, Midlands Branch (Ed.), *Current design thinking: a symposium organized by the Midlands Branch of the Institution of Chemical Engineers at Aston University, September 12-14, 1979* (p. 2/1:1). Birmingham: Midlands Branch, The Institution of Chemical Engineers, I.H.D. Department, University of Aston in Birmingham.

Findeli, A. (1990). Moholy-Nagy's design pedagogy in Chicago (1937-46). *Design issues*, 7(1), 4-19.

Findeli, A. (1991). Design education and industry: The laborious beginnings of the institute of design in Chicago in 1944. *Journal of design history*, 4(2), 97-113.

Findeli, A. (2001). Rethinking design education for the 21st century: theoretical, methodological, and ethical discussion. *Design Issues*, 17(1), 5-17.

Franciscono, M. (1971). *Walter Gropius and the creation of the Bauhaus in Weimar: the ideals and artistic theories of its founding years*. Chicago: University of Illinois Press.

Frascara, J. (2001). A history of design, a history of concerns. In S. Heller, & G. Ballance (Ed.), *Graphic design history* (p. 17). New York, NY: Allworth Press.

Fraser, H. (2006). Turning design thinking into design doing. *Rotman magazine*, Spring/Summer, 24-28.

Fraser, H. (2007). Rotman's design Studio opens its doors to new learning. *Rotman magazine*, Winter, 26-27.

Fraser, H. (2010). Designing business: new models for success. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 35). New York, NY: Allworth Press.

Fry, T. (2008). *Design futuring: sustainability, ethics and new practice*. Oxford, England: Berg.

Galadza, S. (2007). Trends: design business. *Contract magazine*, February. Retrieved May 22, 2007, from http://www.contractmagazine.com/contract/magazine/article_display.jsp?vnu_content_id=1003547610&&imw=Y

Gardner, H. (2008). *5 minds for the future*. Boston, MA: Harvard Business Press.

Garland, E. (2007). *Future, Inc.: how businesses can anticipate and profit from what's next*. New York, NY: AMACON.

Garrett, J. J. (2010). Customer loyalty and the elements of user experience. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 251). New York, NY: Allworth Press.

Gillespie, B. (2010). Service design via the global web: global companies serving local markets. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 205). New York, NY: Allworth Press.

Gobé, M. (2010). Let's brandjam to humanize our brands. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 109). New York, NY: Allworth Press.

Green, C. (1980). Designing with others. In Lawson, B., *How designers think*. Westfield, NJ: The Architectural Press Ltd: London Eastview Editions, Inc.

Gregory, S. A. (1980). Design strategies and tactics. In The Institution of Chemical Engineers, Midlands Branch (Ed.), *Current design thinking: a symposium organized by the Midlands Branch of the Institution of Chemical Engineers at Aston University, September 12-14, 1979* (p. 6/3:1). Birmingham: Midlands Branch, The Institution of Chemical Engineers, I.H.D. Department, University of Aston in Birmingham.

Hoffman, E. (Ed.). (1996). *Future visions: the unpublished papers of Abraham Maslow*. Thousand Oaks, CA: Sage Publications, Inc.

Irkdas, D. (2006). Dancing with disorder: design, discourse & disaster: EAD07 authors. Retrieved February 27, 2009, from http://fadf.ieu.edu.tr/ead07/authors/author%206.html

Jen, L. (2008). Everything's gone green. *Canadian Architect*, 01/08, 22-25.

Jenkins, J. (2010). Creating the right environment for design. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 23). New York, NY: Allworth Press.

Jones, M., & Samalionis, F. (2010). From small ideas to radical service innovation. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 185). New York, NY: Allworth Press.

Kathman, J. (2010). Building leadership brands. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 99). New York, NY: Allworth Press.

Kelley, T., & Littman, J. (2005). *The ten faces of innovation*. New York, NY: Doubleday.

Kim, T. (2010). Bringing the future into global brands. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 121). New York, NY: Allworth Press.

Koberg, D., & Bagnell, J. (1991). *The universal traveler: a soft systems guide to creativity, problem solving and the process of reaching goals*. Menlo Park, CA: Crisp Publications Inc.

Krampen, M. (1989). Semiotics in architecture and industrial/product design. In V. Margolin, & R. Buchanan (Ed.), *The idea of design* (p. 89). Cambridge, MA: The MIT Press.

Laseau, P. (2001). *Graphic thinking for architects & designers* (3rd edition). Canada: John Wiley & Sons, Inc.

Lawson, B. (1980). *How designers think*. Westfield, NJ: The Architectural Press Ltd: London Eastview Editions, Inc.

Lee, H. T. (2007). Storied objects: Design thinking with time. (Ph.D., Massachusetts Institute of Technology, U.S.A.). Abstract, retrieved June 9, 2009, from http://0--proquest-.umi-.com-.mercury-.concordia-.ca:80/pqdweb-?did=1306873271-&sid=3-&Fmt=2-&clientId=10306-&RQT=309-&VName=PQD

Lemley, D. (2010). The road to authentic brand is littered with design. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 243). New York, NY: Allworth Press.

Lewis, B. J. (1999). Talking to text and sketches: the function of written and graphic mediation in mechanical engineering design. (Ph.D., Rensselaer Polytechnic Institute).

Lindenmayer, D., Hobbs, R. (Ed.). (2007). *Managing and designing landscapes for conservation: moving from perspectives to principles.* Malden, MA: Blackwell Publishing Ltd.

Linder, S., & Gordon, R. (1974). *A consultant's action research handbook for adult educators*. New York: Humanistic Educational Research Publications.

Lockwood, T. (Ed.). (2010). *Design thinking: integrating innovation, customer experience, and brand value.* New York, NY: Allworth Press.

Lockwood, T. (2010). Transition: becoming a design-minded organization. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 57). New York, NY: Allworth Press.

Løvlie, L., Downs, C., & Reason, B. (2010). Bottom-line experiences: measuring the value of design in service. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 173). New York, NY: Allworth Press.

Luescher, A., & Kutz, K. S. (2005). Working it out by hand: construction as a creative act. *Technology teacher,* 64(5), 10-13.

Lupton, E. (Ed.). (2011). *Graphic design thinking: beyond brainstorming.* New York, NY: Princeton Architectural Press.

Mapes, J. (2003). *Quantum leap thinking: an owner's guide to the mind*. Naperville, Il: Sourcebooks, Inc.

Margolin, V. (2007). Design, the future and the human spirit. *Design Issues*, 23(3), 4-15.

Markman, A., Wood, K. (Ed.). (2009). *Tools for innovation.* New York, NY: Oxford University Press, Inc.

Martin, R. (2009). *The design of business: why design thinking is the next competitive advantage*. Boston, MA: Harvard Business Press.

McAlhone, B. (1982). The graphic craft. *Crafts*, (56), 36-39

McNiff, J., & Whitehead, J. (2006). *All You Need to Know about Action Research*. Thousand Oaks: Sage Publications.

Meinel, C., & Leifer, L. (Ed.) (2010). *Design thinking: understand – improve – apply*. Berlin: Springer.

Merritt, J., & Lavelle, L. (2005). Tomorrow's B-school? it might be a D-school. *Business week*, (3945), 80-81.

Miller, J. P., & Seller, W. (1990). *Curriculum perspectives and practice*. Toronto, ON: Copp Clark Pitman Ltd.

Mills, G. (2007). *Action Research: a Guide for the Teacher Researcher* (3rd edition). Upper Saddle River: Pearson Merrill Prentice Hall.

Mitchell, T. C. (1996). *New thinking in design: conversations on theory and practice*. New York, NY: Van Nostrand Reinhold.

Mitchell, W. J. (n.d.). Switching on the seven lamps. Retrieved August 15, 2011, from http://www.edra.org/component/docman/doc.../230-edra-01-mitchell-116-126

Moldoveanu, M. (2009). Hunches, heuristics, and algorithmics: a quick note. In Martin, R., *The design of business: why design thinking is the next competitive advantage* (p. 10). Boston, MA: Harvard Business Press.

Moldoveanu, M. (2009). Reliability versus validity: a note on prediction. In Martin, R., *The design of business: why design thinking is the next competitive advantage* (p. 55). Boston, MA: Harvard Business Press.

Mollerup, P. (2003). *Marks of excellence: the history and taxonomy of trademarks.* New York, NY: Phaidon.

Nagai, Y., & Noguchi, H. (2003). An experimental study on the design thinking process started from difficult keywords: Modeling the thinking process of creative design. *Journal of engineering design*, 14(4), 429-437.

Neeley, W. (2007). Adaptive design expertise: a theory of design thinking and innovation. (Ph.D., Stanford University, U.S.A.).

Neumeier, M. (2010). The designful company. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 15). New York, NY: Allworth Press.

Norman, D. (2002). *The design of everyday things*. New York, NY: Basic Books.

Norton, D. (2010). Will meaningful brand experiences disrupt your market?. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 231). New York, NY: Allworth Press.

Papanek, V. (1985). *Design for the real world: human ecology and social change*. Chicago, IL: Academy Chicago Publishers.

Papantonopoulos, S. (2004). How system designers think: A study of design thinking in human factors engineering. *Ergonomics*, 47(14), 1528-1548.

Riel, J. (2009). Building a design thinking organization from within. In Martin, R., *The design of business: why design thinking is the next competitive advantage* (p. 83). Boston, MA: Harvard Business Press.

Rockwell, C. (2010). The mathematics of brand satisfaction. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 221). New York, NY: Allworth Press.

Roozenburg, N. (1992). On the logic of innovative design. In Cross, N., Dorst, K., & Roozenburg, N. (Ed.), *Research in design thinking: proceedings of a workshop meeting held at the Faculty of Industrial Design Engineering, Delft University of Technology, the Netherlands, May 29-31, 1991.* The Netherlands: Delft University Press.

Rothman, H. (1980). Environmental impact analysis: foundation of social costs. In The Institution of Chemical Engineers, Midlands Branch (Ed.), *Current design thinking: a symposium organized by the Midlands Branch of the Institution of Chemical Engineers at Aston University, September 12-14, 1979* (p. 2/3:1). Birmingham: Midlands Branch, The Institution of Chemical Engineers, I.H.D. Department, University of Aston in Birmingham.

Rowe, P.G. (1987). *Design thinking*. Cambridge, MA: The MIT Press.

Saco, R. M., & Goncalves, A. P. (2010). Service design: an appraisal. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 159). New York, NY: Allworth Press.

Schmenner, R. (1987). *Production/operations management: concepts and situations* (third edition). Science Research Associates, Inc.

Schön, D. (1983). *The reflective practitioner: how professionals think in action*. New York, NY: Basic Books.

Schön, D. (1987). *Educating the reflective practitioner: toward a new design for teaching and learning in the professions*. San Francisco & London: Jossey-Bass Inc., Publishers.

Schroeder, R. (1989). *Operations management: decision making in the operations function* (third edition). Singapore: McGraw-Hill Book Co.

Siegel, R. (2006). Forget that MBA and other thoughts. *Communication arts*, 47(8), 30-34.

Slack, J. D., & Wise, J. M. (2005). *Culture & technology: a primer*. New York, NY: Peter Lang Publishing, Inc.

Slaughter, R. (Ed.). (1996). *New thinking for a new millennium*. New York, NY: Routledge.

Stairs, D. (2005). Altruism as design methodology. *Design Issues*, 21(2), 3-12.

Stevens, T. (2008). Green/sustainable practices. *American School and University*, June, 23-26.

Stickdorn, M., & Schneider, J. (2010). *This is service design thinking: basics – tools – cases*. The Netherlands: BIS Publishers.

Stone, C. (2005). Design as a tool for leadership and social change. Cornell University, March, 2-

5.

Stratton, A. (1980). Future organic chemical feedstocks: an energy perspective. In The Institution of Chemical Engineers, Midlands Branch (Ed.), *Current design thinking: a symposium organized by the Midlands Branch of the Institution of Chemical Engineers at Aston University, September 12-14, 1979* (p. 1/2:1). Birmingham: Midlands Branch, The Institution of Chemical Engineers, I.H.D. Department, University of Aston in Birmingham.

Stringer, E. (2007). *Action Research* (3rd edition). Thousand Oaks: Sage Publications.

The Institution of Chemical Engineers, Midlands Branch (Ed.). (1980). *Current design thinking: a symposium organized by the Midlands Branch of the Institution of Chemical Engineers at Aston University, September 12-14, 1979.* Birmingham: Midlands Branch, The Institution of Chemical Engineers, I.H.D. Department, University of Aston in Birmingham.

The Association of Registered Graphic Designers of Ontario (1998). By-law #3: rules of professional conduct. Retrieved July 18, 2011, from http://www.rgdontario.com/pdf/bylaw3.pdf

The Rotman School of Management (2006). Curriculum. Retrieved May 22, 2007, from http://www.rotman.utoronto.ca/businessdesign/curriculum.htm

The Toronto Star (2006, September 21). Designing original business thinkers. *The Toronto Star*. Retrieved May 22, 2007, from http://www.rotman.utoronto.ca/businessdesign/businessthinkers.htm?pagename=thestar/Layout/Article_Type1&c=Article&cid=1158702614006&call_pageid=970599119419

Tversky, B., & Suwa, M. (2009). Thinking with sketches. In Markman, A., Wood, K. (Ed.), *Tools for innovation* (p. 75). New York, NY: Oxford University Press, Inc.

Vogel, C. (2010). Notes on the evolution of design thinking: a work in progress. In Lockwood, T. (Ed.), *Design thinking: integrating innovation, customer experience, and brand value* (p. 3). New York, NY: Allworth Press.

Wake, W. (2000). *Design paradigms: a sourcebook for creative visualization*. Canada: John Wiley & Sons, Inc.

Wells, S. (1998). *Choosing the future: the power of strategic thinking*. Woburn, MA: Butterworth-Heinemann.

Welter, B., & Egmon, J. (2006). *The prepared mind of a leader: eight skills leaders use to innovate, make decisions, and solve problems*. San Francisco, CA: Jossey-Bass.

Wick, R. K. (2000). *Teaching at the Bauhaus*. Ostfildern-Ruit, Germany: Hatje Cantz Verlag.

Wigum, K. S. (2004). Human and ecological problem solving through radical design thinking: analyses and development of design theory and design framework based on long-term human needs. (Ph.D., Norges teknisk-naturvitenskapelige universitet, Norway). Abstract, retrieved June 9, 2009, from http://0--proquest-.umi-.com-.mercury-.concordia-.ca:80/pqdweb-?did=828402611-&sid=3-&Fmt=2-&clientId=10306-&RQT=309-&VName=PQD

Zaccai, G. (1996). Art and technology: aesthetics redefined. In R. Buchanan, & V. Margolin (Ed.), *Discovering Design: Explorations in Design Studies* (p. 3). Chicago, IL: The University of Chicago Press.

Zheng, Q. (2008). Software UX design. Presentation at Sheridan College.

APPENDIX A: COURSE OUTLINE

University of Toronto Mississauga
Sheridan Institute of Technology and Advanced Learning
CCIT Program
CCT204H | Design Thinking | Fall 2009

Course Description

An introduction to the role of design thinking in the communication of information. Emphasizes creative and critical thinking in the design process; provides the student with the theory and operational skills necessary to improve design process and problem-solving abilities.

Prerequisite: CCT100H, 101H, or P.I. Only the Director of the CCIT program has the authority to give permission to waive course prerequisites. The UTM calendar states that students who lack the prerequisites for a course can be deregistered at any time.

At the end of this course, students will be able to

- develop an awareness of how guiding values motivate the design process
- explore a set of integrated design elements and principles that can be applied to the areas of visual communication, space/environment, material objects, and organized services and activities
- apply a range of foresighting techniques to identify design problems
- apply a range of creativity methods and design paradigms to solve design problems
- generate innovative solutions to design problems, substantiated by research
- conceptualize design prototypes using visualization skills and render computer-generated illustrations
- develop creative and critical thinking skills as design visionaries
- evaluate a variety of design thinking approaches and processes

Course Structure and Hours

Required attendance each week at both:
2-hour lecture weekly, J102, Thursdays, 1-3 pm and
1-hour lab, J318, Thursdays, 4-5 pm, 5-6 pm, 6-7 pm, or 7-8 pm

As per UTM policies, students are required to attend the lab session at the specific time for which they are pre-registered. Changes of lab session must be made in ROSI. No exceptions.

Course Outline

Intended for students with little design experience, this course provides an introduction to the central issues and approaches in the study of design as an interdisciplinary subject. With an emphasis on the creative thinking process, students will look at examples drawn from diverse design disciplines, examine the likely scenarios in production, and explore personal problem-solving abilities and visions in the realm of design.

This course is divided into five modules:

Module One (classes 1-2: September 10-17) will explore what design thinking entails, in particular in the realm of values-based design, that is, how guiding values can initiate and motivate all design activities.

Module Two (classes 3-6: September 24-October 15) will explore a set of integrated design elements and principles that can be applied to the areas of visual communication, space/environment, material objects,

and organized services and activities, with an understanding of the traditionally unique and compartmentalized practices within these disciplines.

Module Three (classes 7-8: October 22-29) will explore foresighting and its techniques, enhancing the concept of problem-identifying and encouraging design as a proactive and preventive approach.

Module Four (classes 9-10: November 5-12) will explore design thinking in the realm of complex, visible and invisible systems, affecting the macrocosm of design.

Module Five (classes 11-12: November 19-26) will conclude with a look at design as intellectual property and designers as visionaries.

Adobe Illustrator CS4 is the application used in this course and will be explored in lab activities.

Evaluation

Attendance, professional etiquette, participation, and progress.	5%
Random in-class assignments	5%
Lab exercises, due Sep. 15, 22, 29, Oct. 6, 13, 27, Nov. 3, 10, 17, 24	10%
Assignment 1 (values-based design project), due October 15	25%
Quiz 1, October 22	15%
Assignment 2 (research essay supported by designs in Illustrator), due November 19	25%
Quiz 2, November 26	10%
Lab test, November 26	5%
Total	100%

Lab exercises are marked for completion of required tasks. Quizzes include 30 multiple choice questions only. Questions are drawn primarily from material covered in lectures and labs but also from required readings. Quizzes are 45 minutes long and are held during the first half of lectures. Lab test takes place in the lab during respective lab times and consists of a creative activity executed in Illustrator, applying the knowledge and skills learned in the course.

Required Textbooks

The Design of Everyday Things
Author: Donald A. Norman
New York: Basic Paperback, 2002
ISBN: 0-465-06710-7

The Idea of Design
Edited by Victor Margolin and Richard Buchanan
MIT Press, 1996
A Design Issues Reader
ISBN 0-262-63166-0

Required Readings

Week 1, September 10:
The Idea of Design: *Sketching and the Psychology of Design* by Rudolf Arnheim (p. 70)

Week 2, September 17:
The Idea of Design: *Shaping Belief: The Role of Audience in Visual Communication* by Ann C. Tyler (p. 104)

Week 3, September 24:
Johnson Banks website: http://www.johnsonbanks.co.uk

Week 4, October 1:
The Design of Everyday Things: Chapters 1-3

Week 5, October 8:
The Design of Everyday Things: Chapters 4-6

Week 6, October 15:
The Design of Everyday Things: Chapter 7

Week 7, October 22: N/A

Week 8, October 29: N/A

Week 9, November 5:
The Idea of Design: *Semiotics in Architecture and Industrial/Product Design* by Martin Krampen (p. 89)

Week 10, November 12:
Jack Lo's and David Pressman's How to Make Patent Drawings: A Patent It Yourself Companion

- Chapter 1: General Introduction to Drawing
- Chapter 5: Patent Drawings in General
    - Access from Access Sheridan, Sheridan Library Online Resources https://access.sheridaninstitute.ca/
    - Books 24x7

Week 11, November 19:
A Guide to Patents, A Guide to Trade-marks, A Guide to Industrial Designs
Glossary of Intellectual Property Terms: http://strategis.ic.gc.ca/sc_mrksv/cipo/help/glos-e.html

NOTE: Additional required readings may be announced throughout the semester. Consult SLATE for weekly updates.

Contact Information

Professor: Ann Donar (née Szeto), e-mail: 2009CCT204anndonar@gmail.com (this Gmail account is only checked for the duration of the course; backup: ann.donar@sheridanc.on.ca)
Tel. 905-845-9430 ext. 8734

Office hours: S319, Thursdays, 3-4 pm as well as by appointment

Technologist: Graham Gentleman, e-mail: 2009CCT204grahamgentleman@gmail.com (backup: graham.gentleman@sheridanc.on.ca)

Academic Misconduct

Honesty and fairness are considered fundamental to the University's mission, and, as a result, all those who violate those principles are dealt with as if they were damaging the integrity of the University itself. When students are suspected of cheating or a similar academic offence, they are typically surprised at how formal and seriously the matter is dealt with – and how severe the consequences can be if it is determined that cheating did occur. The University of Toronto treats academic offences very seriously. Students should note that copying, plagiarizing, or other forms of academic misconduct will not be tolerated. Any student caught engaging in such activities will be subject to academic discipline ranging from a mark of zero on the assignment, test or examination to dismissal from the university as outlined in the UTM calendar. Any student abating or otherwise assisting in such misconduct will also be subject to academic penalties.

Students are assumed to be informed about plagiarism and are expected to be familiar with the handout, titled "Plagiarism and Reference Format." *How not to plagiarize* at http://www.utoronto.ca/writing/plagsep.html, written by Margaret Procter, is a valuable and succinct source of information on the topic. You are also supposed to be familiar, and considered as being familiar, with the *Faculty Rules and*

Regulations, *Code of Behaviour on Academic Matters* (see *2009-2010 UTM Calendar*) and *Code of Student Conduct* (see *2009-2010 UTM Calendar*), which spell out your rights, your duties and provide all the details on grading regulations and academic offenses at the University of Toronto.

Please be advised that it is an academic offence for a student to knowingly (examples are not limited to the following):

- Use any unauthorized aids on an exam or test (e.g., "cheat sheets," etc.)
- Represent someone else's work or words as your own – plagiarism
- Falsify documents or grades
- Purchase an essay
- Submit someone else's work as your own
- Submit the same essay, report, or design in more than one course (without permission)
- Look at someone else's answers during an exam or test
- Impersonate another person at an exam or test or having someone else impersonate you
- Make up sources or facts for an essay or report

Due Dates and Lateness

It is important that you submit assignments (both digital files and printouts) on the specified due dates in person or by proxy. All digital files must be tested on a Sheridan Mac Lab computer prior to submission. Make sure you are aware of due dates. Late assignments without medical evidence will be marked with the following penalty: 5% reduction per day of lateness. If you hand in a late assignment on a Monday, the Saturday and Sunday prior to that will also be counted as days. **An assignment will be considered late if any component of the assignment is late**.

Where to drop off late assignments: Late assignments must be date-stamped by Diane Janzen in A100. A100 closes at 5 pm. It is advised that you arrive earlier than 5 pm. If Ms. Janzen is not at her desk, you must leave your assignment on her desk with a note indicating your intent of dropping off a late assignment, the date and time of the drop-off, and your printed name and signature. Ms. Janzen will date-stamp your assignment when she returns to her desk. You may also have it date-stamped by Hetty Urie in the Pro Shop when it is open on Tuesdays and Thursdays. Do **not** leave late assignments in the mail room or the professor's office; these assignments will be date-stamped whenever they are picked up. No late assignments will be accepted after the end of the Final Examination Period.

Travel arrangements have to be made around important dates of the course. Missing a test or other deadlines due to travel will not be accepted as legitimate reasons. Some exceptions apply, as per professor's discretion, e.g. death in a family, for which official documentation is required.

Medical evidence: The student provides to the professor an original copy of the UTM medical certificate, proving that events beyond his/her control prevented the submission of the assignment on the given due date (No scanned or photocopied documentation or generic doctor's notes accepted). There is no penalty, and the late work is accepted **until the length of time the evidence warrants**. Please contact professor immediately if you find yourself in this position.

Missed lab exercise: Lab exercises cannot be made up.

Missed Tests

The Faculty policy on term tests is presented in the Erindale College 2009-2010 Calendar. To summarize:

Students who miss a term test will be assigned a mark of zero for that test unless they can document a compelling reason for missing it. Students in that position must submit a written request to their professor with appropriate documentation within one week of the missed test. If the request is accepted, a makeup test will be scheduled.

Accessibility

The University accommodates students with disabilities who have registered with the AccessAbility Resource Centre. Please let me know in advance, preferably in the first week of class, if you will require any accommodation on these grounds. (2009-2010 UTM Calendar Section 6.3 AccessAbility Resource Centre).

Academic Skills Centre

The Robert Gillespie Academic Skills Centre offers both individual appointments and workshops for students having difficulty with reading and writing skills.

Classroom Management

You are expected to come to class on time, turn off cell phones and pagers, use laptops in class for note-taking only (not for web surfing, email etc.). For security purposes, you must use your utoronto e-mail address for contacting the instructor or TAs (as opposed to other addresses such as hotmail/gmail addresses.)

APPENDIX B: ASSIGNMENT BRIEF FOR ASSIGNMENT ONE

CCT204 Design Thinking
Assignment 1
Due October 15, 2009

Instructions (all designs to be done in Illustrator in original vector graphics, designed and executed by you, NO placed bitmap images or images converted to vector graphics using LiveTrace. Beware of plagiarism. Any images used as models or references must be cited clearly in your bibliography):

1) This is a values-based design activity. You will do the following in a Word document (Include a title page with your name, student number and course code/name). Name this Word document "YourLastName_FirstNameA1.doc," e.g. "Donar_AnnA1.doc":
    a. Determine what values are most important to you. In about 200 words, describe what these values are and explain why you believe they are important to you. Examples of values are efficiency, convenience, profit, environmentalism, humanitarianism, innovation, beauty, luxury. These are examples only, you may think of others. "Values" can be defined as "a person's principles or standards of behaviour; one's judgment of what is important in life" (Apple Dictionary).
    b. From the values that you just stated, pick one or two that you would like to promote. Come up with an endeavour that would help promote this/these values. An endeavour would include starting a business, profit or non-profit organization, event, association, product, service, place, or any project at the local, national, or international level. In about 200 words, give this endeavour a name and describe what it is, e.g. What does it aim to achieve? What is the target audience? What are the logistics in running this endeavour? Are there any other pertinent details about it that you feel are important to share? If a similar endeavour already exists, you should have researched it and must state it clearly in this write-up. You may also want to state the difference/s between your endeavour and the one that already exists.
    c. In about 200-300 words, describe your design thinking process. Cite any theories that you may have learned in class and/or from readings that you have applied in your design, including the design of your endeavour and the design of your illustration.
    d. List of references (use MLA or APA styleguide in the writing of your write-up and references)
2) You will do the following in Illustrator. Name this Illustrator (.ai) document "YourLastName_FirstNameA1.ai," e.g. "Donar_AnnA1.ai":
    a. Letter-size, landscape or portrait orientation, do an illustration (pictorial) of this endeavour. The idea is to communicate the nature of your endeavour effectively to the viewer. Consider the use of semiotics. Does this illustration reflect the value/s that you want to promote appropriately? Integrate the name of your endeavour in this one-page illustration. Convert type to outlines.

Format and Items to be handed in:
Due at the beginning of your Lab session.

Please package all items neatly in a manila envelope, with your name written bold and legibly on the envelope.

i) Digital

Electronic files must be contained in a folder named "YourLastName_FirstNameA1," e.g. "Donar_AnnA1" and submitted on the **Elara** server: Ann Szeto's "Hand In" folder, no later than 7:50 pm on October 15, 2009:

a. "YourLastName_FirstNameA1.doc"
b. "YourLastName_FirstNameA1.ai"

ii) Hard Copy in a manila envelope:

1) Title page with your name, student number and course code/name
2) Colour printout of the Illustrator file
3) Printout of the Word file including References

Ensure that i) all files are compatible and can be opened with Illustrator CS4 on one of the Mac computers in J318; ii) all type (text) is converted to outlines (Type > Create Outlines).

Criteria for Evaluation:

Overall concept:
Value and originality of the endeavour 10%
Appropriate art direction and consistency in look and feel 20%

Concept of the illustration:
Appropriateness (e.g. ability to capture the activity) 20%
Clarity (e.g. legibility, handling of details) 20%

Execution of design:
Effective use of design elements and principles 10%
Effective use of Illustrator skills 10%

Write-up (e.g. organization, flow, grammar, theories applied) 5%
Presentation of the project (e.g. neatness, quality of printout) 5%

TOTAL: 100%

Refer to Course Outline for policies on lateness.

APPENDIX C: CONSENT FORM

CONSENT FORM FOR VOLUNTEERS TO PARTICIPATE IN RESEARCH

Please note – participants are given two copies of the consent form – one to keep, and one to sign and return.

CONSENT TO PARTICIPATE IN "Design Thinking: a New Undergraduate Curricular Model on Design Thinking (Doctoral Dissertation)"

This is to state that I agree to participate in a program of research being conducted by Ann Donar (née Szeto), PhD candidate in the Department of Art Education at Concordia University.

Contact:
Professor Ann Donar
Communication, Culture & Information Technology
Sheridan Institute of Technology & Advanced Learning
School of Animation, Arts & Design
1430 Trafalgar Road
Oakville, ON L6H 2L1
Email: ann.donar@sheridanc.on.ca
905-845-9430, ext. 8734

A. PURPOSE

I have been informed that the purpose of the research is to investigate what happens when contemporary ideas in design thinking that focus on guiding values are integrated in an undergraduate curricular model in design thinking. This research is conducted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Art Education at Concordia University.

B. PROCEDURES

This research will be conducted in the course: CCT204 Design Thinking, offered by the University of Toronto Mississauga and delivered on location at Sheridan Institute of Technology and Advanced Learning, Trafalgar Campus. Students of the course will be required to take the course normally, that is, by attending classes, doing assignments and tests, and completing student surveys. Classes will continue as usual, but those who have consented to participate will have their coursework included in the analysis. Students who volunteer to participate are asked to sign this consent form, which will be directly returned to and kept in confidence by Professor Michael Jones, coordinator of the CCIT program. The completed forms will only be returned to the researcher after final marks have been submitted. All data will be analysed throughout the semester with non-participants' information being excluded afterward.

C. RISKS AND BENEFITS

Students are required only to take the course as they normally would, and their status as participants would be kept confidential until after final marks have been submitted. Participation in the research will benefit the researcher's teaching practice and will help with the progress, development, and innovation of a design thinking curriculum, which will be a significant contribution to the field of design education.

D. CONDITIONS OF PARTICIPATION

- I understand that I am free to withdraw my consent and discontinue my participation at anytime without negative consequences. (To withdraw my consent, I need to contact Professor Michael Jones, J321, ext. 5555, michael.jones5@sheridanc.on.ca to make an amendment on my consent form.)

- I understand that my participation in this study is: (Please check **one** of the following)

  _____ CONFIDENTIAL (i.e., the researcher will know, but will not disclose my identity in study results – a pseudonym may be used when presenting data that is individually linked to me.

  OR

  _____ NON-CONFIDENTIAL (i.e., my identity may be revealed in study results)

- I understand that the data from this study may be published. (Please check the following **where applicable**)

  I hereby give permission to the researcher to reproduce any of my visual and/or written assignments – in whole or in part – as examples to be included in the dissertation and/or other scholarly or professional publications, in print or electronic form, with no private or commercial gain.

  _____ My identity remains CONFIDENTIAL. Reproduction of my visual and/or written work will be attributed to a pseudonym (i.e., my identity as the author/creator will not be revealed).

  OR

  _____ My identity is NON-CONFIDENTIAL. Reproduction of my visual and/or written work will be attributed to me individually (i.e., my identity as the author/creator will be revealed).

- I understand that I will be able to access the results of this research when the dissertation is published by emailing the researcher at ann.donar@sheridanc.on.ca.

I HAVE CAREFULLY STUDIED THE ABOVE AND UNDERSTAND THIS AGREEMENT.
I FREELY CONSENT AND VOLUNTARILY AGREE TO PARTICIPATE IN THIS STUDY.

NAME (please print) _____

SIGNATURE _____

For immediate questions about your participation, please contact the supervisor of this research project: Dr. Lorrie Blair, Department of Art Education, Concordia University, at (514) 848-2424 x4604 or by email at lblair@alcor.concordia.ca. If at any time you have questions about your rights as a research participant, please contact the Research Ethics and Compliance unit, Concordia University, at (514) 848-2424 x2425 or by email at kwiscomb@alcor.concordia.ca .

CCT204 Design Thinking
Assignment 2

Due November 19, 2009

Addendum added October 28, 2009 re: teamwork

TOPIC:

Foresighting to Aid the Betterment of Humanity

BRIEF DESCRIPTION:

Using Donar's integrated design process, write an essay of 1,600-2,000 words on how your proposed design may aid the betterment of humanity. Do a minimum of one graph and one drawing or diagram using Illustrator to show the effectiveness of your proposed design.

REQUIREMENTS:

- Choose an area or aspect of humanity that you believe needs improvement.
- Propose a design that can better this aspect of humanity.
- Build your essay by following Donar's integrated design process, as follows (the order of these steps may be modified or combined to enhance the flow of your argument):

1. What values are to be promoted?
2. This introduction is not unlike what you have already done in Assignment 1 – discuss what values are most important to you, hence values that you would most like to promote.
3. How can these values be promoted through designs?
4. Generally discuss how these values can be promoted through designs – consider a broad range and types of designs.
5. What is the thing that needs designing or redesigning?
6. Shift and transition the discussion to your chosen area or aspect of humanity that you believe needs improvement. What exactly needs to be improved in your opinion? Identify the thing/s that need designing and/or redesigning in order to bring about the desired improvement/s.
7. What impact does this design (or the lack thereof) have on our world presently?
8. Transition the discussion to your proposed design. (*Note*: *Your proposed design may include a combination of "things," visible or invisible, tangible or intangible*). If your proposed design pertains to redesigning something that already exists, discuss what impact this existing (old) design has on our world presently. If your proposed design pertains to designing something totally new (nothing like this ever existed before), then discuss the likely impact the lack of this design has on our world presently (that is, without this new design, these things are suffering; without this new design, these things are not possible or cannot happen).
9. What would the world likely be like with (or without) this design in 50 years?
10. Using foresighting techniques and research, educated speculation and analysis, estimate what the world would likely be like with or without this design in 50 years.
11. What options are there in designing or redesigning this thing?
12. This section pertains to brainstorming. What are some of the ideas that you can come up

with in designing this thing?

13. How can the integrated design elements, principles, and strategies be applied in the design or redesign of this thing?
14. Apply some of the integrated design elements, principles, strategies, and/or methods in the visualization of your proposed design.
15. How effective does this design function as a collaborative system in the visible and invisible realms?
16. Transition your discussion from the initial concepts of your design to a more concrete, modified, final iteration. On what grounds are the features in the final iteration selected? Address how your proposed design function as a collaborative system in the visible and invisible realms.
17. What is/are the prototype/s?
18. Continue your discussion with a description of the prototype of your design. How is the design configured? If you choose to do multiple prototyping, describe the prototypes.
19. How will this design be tested to ensure that the integrated design principles are met?
20. Propose ways to ensure that the design has been properly completed and tested, and that all applicable integrated design principles have been appropriately considered.
21. How will this design be delivered?
22. If applicable, discuss how you foresee your proposed design is to be deployed.
23. What post-delivery services will there be and what post-delivery actions will be taken?
24. Make recommendations as to what post-delivery services and/or actions may be taken to enhance the effectiveness of your design.
25. How will this design be evaluated in the long-term, especially in leaving minimum waste, toxins and carbon footprint?
26. Suggest ways to ensure that the impact and effectiveness of your proposed design will be monitored, evaluated, and further adjusted as needed.

Format and Items to be handed in:

Due at the beginning of your Lab session.
Please package all items neatly in a manila envelope, with your name written bold and legibly on the envelope.

Digital

Electronic files must be contained in a **folder** named "YourLastName_FirstNameA2," e.g. "Donar_AnnA2" and submitted on the **Elara** server: Ann Szeto's "Hand In" folder, no later than 7:50 pm on November 19, 2009:

- "YourLastName_FirstNameA2.doc" including your essay and References (This is a research essay, please use proper academic language and cite your sources appropriately as per MLA or APA styleguide).
- "YourLastName_FirstNameA2_graph.ai"
- "YourLastName_FirstNameA2_illustration.ai"

Hard Copy in a manila envelope:

- Title page with your name, student number and course code/name
- Printout of the Word file including References
- Colour printouts of the Illustrator files

Ensure that i) all files are compatible and can be opened with Illustrator CS4 on one of the Mac computers in J318; ii) all type (text) is converted to outlines (Type > Create Outlines).

Instructions (all designs to be done in Illustrator in original vector graphics, designed and executed by you, NO placed bitmap images or images converted to vector graphics using LiveTrace. Beware of plagiarism. Any images used as models or references must be cited clearly in your bibliography):

Criteria for Evaluation:

Concept:

- Depth of questioning and insight into topic 10%
- Depth and accuracy of research into topic 10%
- Appropriateness of new solution, substantiated by research 10%
- Innovation in conceptualization and ideation 10%

Execution of design:

- Effective use of design elements and principles 10%
- Effective use of Illustrator skills 10%

Written skills:

- Clarity and organization 10%
- Development of thesis 10%
- Integration of theories (e.g. from lectures and readings) 10%
- Proper use and citation of references, spelling and grammar 10%

TOTAL: 100%

Refer to Course Outline for policies on lateness.

ADDENDUM

Optional Teamwork:

You may work in pairs for the entire assignment. Some students find that this is a very gratifying option especially if they plan to explore a subject in a more in-depth manner. **The deliverables will be doubled**, i.e. essay (**minimum** of 3,900 words), visuals (**minimum** of 2 graphs, 2 illustrations of your design). A separate page containing the students' names and a detailed report of the division of labour must also be attached to each assignment, e.g. who did what.
(Both students will share the same mark)

IMPORTANT: If you choose to work in this option, both students must be present when submitting the assignment and signatures of both students must appear on the sign-in sheet. Both students are equally responsible for the timely submission of the assignment.

At least one week before the due date of the assignment, please email professor if you choose to work in pairs.

APPENDIX E: END-OF-COURSE SURVEY

This is an anonymous survey that is part of Ann Donar's PhD research project. Your participation would be greatly appreciated. Thank you.

Part 1:
Please circle from a scale of 1-5 for the following three statements (1, strongly disagree; 2, somewhat disagree; 3, neither agree or disagree; 4, somewhat agree; 5, strongly agree):

Statement 1
After taking this course, I am more aware of how values can guide the design thinking process.

1, strongly disagree; 2, somewhat disagree; 3, neither agree or disagree;
4, somewhat agree; 5, strongly agree

Statement 2
After taking this course, I feel more empowered that my design actions taken today can help shape the world that we will live in tomorrow.

1, strongly disagree; 2, somewhat disagree; 3, neither agree or disagree;
4, somewhat agree; 5, strongly agree

Statement 3
After taking this course, I am more equipped with the knowledge and skills necessary to undertake a broad range of design activities.

1, strongly disagree; 2, somewhat disagree; 3, neither agree or disagree;
4, somewhat agree; 5, strongly agree

Part 2 (Open-ended question):
What idea/s do you have to help make this course more fulfilling and effective?