Thinking Design and Pedagogy: An Examination of Five Canadian Post-Secondary Courses in Design Thinking

Penser design et pédagogie: analyse de cinq cours canadiens de « design thinking » de niveau postsecondaire

Ann Donar | Sheridan Institute of Technology & Advanced Learning

At the tertiary level today, courses on design thinking can be found in diverse programs in and beyond the realm of traditional design disciplines. Across Canada, design thinking courses feature in communication, culture and information technology, and business and engineering. This paper reports findings from a study that investigated the following question: What is design thinking and how is it being taught? The study surveyed different approaches adopted in five post-secondary programs. Specifically, it examined course emphases, class structures, assignments and other components, in the hope of drawing a matrix from which to analyze their strengths and weaknesses and to examine what they have in common.

Divers programmes proposent de nos jours au niveau tertiaire des cours de « *design thinking* » ou pensée du design, qui sortent du cadre des disciplines traditionnelles de design. Ainsi retrouve-t-on un peu partout au Canada dans des programmes de communication, de culture, de technologie de l'information, d'affaires et de génie, des cours de pensée du design. Cet article résume les conclusions d'une étude portant sur les questions suivantes : qu'est-ce que le « *design thinking* » et comment est-il enseigné ? L'étude cible les diverses approches adoptées dans le cadre de cinq programmes de niveau postsecondaire, plus particulièrement les objectifs maîtres des cours, la structure des classes, les devoirs et travaux et autres éléments, dans le but d'établir une matrice permettant d'analyser leurs forces et faiblesses et leurs points communs.

Introduction

Recently, there has been a display of interest in incorporating design thinking in a range of post–secondary curricula. Courses entitled “Design Thinking” or those emphasizing design thinking can be found in diverse programs in and beyond the realm of traditional design such as graphic design, communication, culture, and information technology, as well as management and business.

It is perhaps in the realm of management and business where design thinking has been given the most attention in recent literature and publicity in media. Publications including, “Tomorrow’s B-School? It Might Be a D–School,” (Merrit & Lavelle, 2005), “Forget That MBA and Other Thoughts” (Siegel, 2006), “Designing Original Business Thinkers” (The Toronto Star, 2006), and “Designers’ Point of View Applied to Business” (Cornell, 2006) are just a few examples in literature that draw attention to the value of how designers think. Citing Daniel Pink, Galadza (2007) states, “Design is a high–concept aptitude that is difficult to outsource or automate—and that increasingly confers a competitive advantage in business (para. 2)."

In even more recently published literature, (see for example, Martin (2009) and Lockwood (Eds.) (2010) design thinking is identified as the key to success in today’s competitive business landscape. Simultaneously, outside of the business realm, design thinking continues to be a popular subject within disciplines in which design is practiced. For example, design thinking is examined as skills and strategies deemed useful in their corresponding disciplines, namely graphic design and interior design (Ambrose & Harris; 2010; Lupton, 2011; Dohr & Portillo, 2011). Likewise, design thinking is examined with a particularly technological focus that is specific to engineering (Meinel & Leifer, 2010).

While design thinking is viewed primarily in two main streams in literature: (a) as a competitive advantage in the business realm and (b) as skills and strategies practiced in isolated design disciplines, there is yet another newly emerging stream found in the study of this subject. In this new direction, design thinking as an interdisciplinary approach is explored. For example, in *This is Service Design Thinking: Basic–Tools–Cases* by Stickdorn and Schneider (2010), 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. Servic*es 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 (p. 19).

Likewise, in *Design Thinking: Understanding How Designers Think and Work*, Cross (2011) attempts to address design thinking as an interdisciplinary approach. Despite his own background in architecture and industrial design engineering, in his most recent publication, Cross (2011) intends 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)

Inquiring into the Idea of Design Thinking

So what is design thinking and how can it be taught? This paper surveys five courses offered in a number of different post-secondary curricula found in the Greater Toronto Area, Ontario, Canada. The courses are entitled "Design Thinking" or have titles or course content similar to it. The methodology used is that of informal, conversational interview. After initially contacting the different professors via email, I arranged to have an informal meeting with each of them. During the 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 participants to comfortably withhold information or materials that they deemed proprietary. For this reason, this inquiry serves as an overview of the subject. The most significant drawback in this inquiry is the lack of a standardized format in terms of collecting and comparing data. For example, the data representing what I teach would naturally be more comprehensive and readily available. This factor of variance ought to be considered when looking at this survey. Nonetheless, I aimed at discovering some basic facts from whatever information shared and gathered. For example, I was interested in how these different educators define design thinking, what their course entails, and how it is taught, including class structure and class assignments. The information gathered is by no means complete, for reasons that have already been identified 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. Participants in this research study included: Keith Rushton, Faculty of Design, Ontario College of Art and Design (OCAD); Susan McCahan,

Faculty of Applied Science and Engineering, University of Toronto; Heather Fraser, Business Innovation Lab, Rotman School of Management, University of Toronto; Mary Ann Maruska, Sheridan College and York University; and myself, Ann Donar Sheridan College and University of Toronto Mississauga. In the following paragraphs, I present a summary of the outcomes of these conversations with the above individuals. Summaries are presented by college /university and course.

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[1] 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 with 300 students from all design disciplines. Due to the multi-disciplinary background of the student body, the curriculum is equally appropriate to two–dimensional, three-dimensional, and four–dimensional processes. 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 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, Susan McCahan[2] suggested 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. 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 (see for example, 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 does textile manufacturing in the realm of chemical engineering. In short, to a large extent, engineering is concerned about the functionality but not the aesthetic part of a design. In other words, engineering as a discipline by nature excludes the consideration of aesthetics, look and feel, and graphics, although engineers 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 with 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, p.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 incorporates 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. 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).

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. 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.

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 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.

Mary Ann Maruska[3] suggests 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 (2009), 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 do not offer. 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 paper is the one that I teach at my institution: "Design Thinking", offered by the joint program of Communication, Culture and Information Technology (CCIT) between University of Toronto Mississauga and Sheridan College. 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.

Discussion

To summarize the outcome of this inquiry: The first thing noted as common to all courses is that a design process is always stressed. In fact, in the course offered by OCAD, multiple design processes as adopted by individual designers, is the major focus of the course. In all other courses, a particular design process is always followed. 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.

Even though it is not always explicitly defined or stressed, there is one common theme that suggests what design thinking is throughout all courses surveyed. In all instances, design thinking always involves both analytical thinking and creative thinking. This balanced approach has in fact been a dominant theme found in literature on this subject since the 1980s. In *How Designers Think*, Lawson (1980) claims that both reasoning and imagining are required in design situations in different degrees. In his opinion, reasoning generally involves external needs, external constraints, and design, whereas imagining generally involves internal needs, internal constraints, and art. In "A Structure and Function Based Theory for Design Reasoning", Akin (1992) also 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 in *Design Thinking* (1987). In "Research in Design Thinking", Cross (1992) also emphasizes that research results show that experienced designers rely strongly on intuition and creativity. The theme of balance is again picked up on by Martin (2009). In *The Design of Business: Why Design Thinking is the Next Competitive Advantage*, Martin (2009) 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). This balance empowers what he calls a hybrid leader in a design thinking corporation. Another term that Martin uses for this type of balanced approach is *integrative thinking*, which requires the metaskill to face two (or more) opposing ideas or models. The balanced approach described above is demonstrated most notably in the nature of the assignments set out in the five courses surveyed, such as essays, proposed designs, and team-based projects that could not have been completed without due application of both reasoning and creativity.

In terms of pedagogy, since the courses at OCAD, UT Engineering, and UTM/Sheridan are required fundamental courses within the programs, the class sizes are much bigger. For this reason, there is usually a lecture component followed by tutorials or labs in smaller groups. Since the number of students in the courses at Rotman and York/Sheridan is much lower, the classes are taught in a workshop environment. While all courses involve theory and practice, the ones at Rotman and UT Engineering are uniquely team-based and project-based, with real-life clients. Collaboration as a mindset is therefore more pronounced as a catalyst in design thinking in these two programs.

Some additional characteristics about these courses can be observed upon reflection. The course at OCAD is the most multi–directional in terms of multiple design processes, but it is also more focused on design as a process rather than thinking. The engineering course at UT is extremely thorough, systematic, and organized in terms of how 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 (e.g. aesthetics). On the contrary, Rotman is progressive in 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 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. One additional observation about the Bachelor of Design course is that it is perhaps the most designer—and craftsmanship—oriented course of all. Lastly, The CCIT course is perhaps the most interdisciplinary, with a strong reflection and emphasis on industry practices, and equally an aspiration for innovation utilizing design principles and elements that could be potentially applied across disciplines. It is also a course that has a strong visualization and technology component.

Even though the different courses surveyed do cater to their specific audiences and disciplines in terms of course content and methods of delivery, it also appears that there is 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, one must also take care to infuse and encourage diversity in a design curriculum, particularly in the realm of inspiration, brainstorming, and implementation. Otherwise, any singularity derived would contradict the spirit of design, which is innovation itself.

Table 1 represents a matrix comparing the five courses surveyed and Table 2 represents a cumulative list of components covered in these five courses. Due to the proprietary nature of some of the courses, the information gathered is far from comprehensive. Consequently, any comparisons drawn from this survey remain incomplete or inconclusive. While the creativity methods introduced in the UT Engineering course and the York/Sheridan course are concrete, the main question that remains to be answered is how and where insights and innovative ideas actually stem from. Do they stem from research, observation, and ethnography, or pure figments of the imagination? *In Where Good Ideas Come From: The Natural History of Innovation*, Steven Johnson (2010) explores scenarios such as networking, the slow hunch, and serendipity. It appears that similar efforts in trying to unpack ways through which innovation takes place would greatly enhance the crux of a Design Thinking curriculum. The translation of theories and observations into concrete methods, rather than case studies, are what students need to jump–start their educational experience in design thinking.

Table 1: Matrix Comparing the Five Design Thinking-Related Courses

	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 Labs: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 concept	No	No	No, workshops	Yes, Mac lab, Illustrator	Yes, handwork
Assignments	Essays	Group design project with real client and project management	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: Cumulative List of Components in the Five Design Thinking-Related Courses Surveyed

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

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Endnotes

[1] From the interview conducted with Keith Rushton as part of this research project
[2] From the interview conducted with Susan McCahan as part of this research project
[3] From the interview conducted with Mary Ann Maruska as part of this research