LEARNING OUTCOMES:

Design Thinking will allow students to:

- Use critical thinking strategies to gather and process information.
- Create visual/written communication materials that demonstrate engagement in the critical thinking process.
- Apply collaborative and teamwork strategies to an iterative design process.
- Reflect on and articulate role of self as designer.

The course employs the following principles and overall teaching approach:

- lectures
- workshops with hands-on activities
- regular feedback
- weekly readings and assignments
- assignment archiving
- weekly activities that build on skill sets
- guest speakers (TBD) and recorded interviews
- group-based activities and project.

COURSE TEXTS

- Lawson, B. (2005). *How Designers Think*, Oxford: Architectural Press. (primary course text and basis for the final exam)
- Norman, D. (1988). *The Design of Everyday Things*, New York: Basic Books. (supplementary, key text in most design fields)
- Moggridge, B. (2006). Designing Interactions, Cambridge MA, MIT Press. (available online, source of numerous case examples of key designs seen today and interviews with designers in practice)
- Additional readings will be provided that relate to the industry, product and technology contexts of the class.

STUDENT EVALUATION

Team (WEEKS 1-7):

(a) Past to Present Design Analysis & Presentation - 30%

(b) Team Project Post-Mortem and Literature Review – 10%

Individual (WEEKS 9-13):

(a) Iterative Design Activities and Archive 20%

(b) Final Exam, requires completion of item (a), 30%

(c) Attendance and participation (10%)

COURSE OUTLINE

SFU semesters run 15-weeks with the Summer '08 semester starting on the 6th of May 2008 through to 14th August 2008. Classes are twice per week, Tuesdays and Thursdays from 11:30-1:30 in Room 3340 (unless otherwise indicated).

WEEK 1	**May 6/8 2008**	**Culture and History I** • TOPIC: How do we think about "design" today? How did we think about design in the long ago? (+ course intro) • DESIGN LENS: The Storyteller, the Interior Designer, and the Chef • READINGS: Lawson, Chapters 1, 2, 3; Moggridge Chapter 4 (pdf to be provided)
WEEK 2	**May 13/15 2008**	**Planning and Control I** • TOPIC: Building Blocks and Models of Design Problems • DESIGN LENS: The Remix Artist and the Engineer • READINGS Lawson, Chapters 4, 5, 6
WEEK 3	**May 20/22 2008**	**Planning and Control II** • TOPIC: Design Processes and Flows • DESIGN LENS: The Systems Analyst and the Interaction Designer • READINGS: Slack et al. Chapters 4, 5 (to be provided)
WEEK 4	**May 27/29 2008**	**Design and the Individual I** • TOPIC: – Negotiating Physical Things and Spaces • DESIGN LENS: The Architect & the Industrial Designer • READINGS: Norman Chapter 1; Chapter Lawson, Chapter 7

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WEEK 5	**June 3/5 2008**	**Design and the Individual II** • TOPIC: – Negotiating Psychological Things and Spaces • DESIGN LENS: The Scientist & the Fashion Designer • READINGS: Norman, Chapter 2, 3
WEEK 6	**June 10/12 2008**	**Design and Society I** • TOPIC: Recognizing Systems and Ecologies • DESIGN LENS: the Game Designer & the Urban Planner • READINGS: Moggridge Chapter 5 (pdf to be provided)
WEEK 7	**June 17/19 2008**	**Design and Society II** • TOPIC: Social Networks and Added Value • DESIGN LENS: The Service Designer & Open Source • READINGS: Moggridge Chapter 6 (pdf to be provided)
WEEK 8	**June 24/26 2008**	**----------PRESENTATION WEEEK----------** • TOPIC: Face-to-Face Presentation of Team-based project 30% • DESIGN LENS: The Player, the Coach, and the General Manager • READINGS: Lawson 14 ----------
WEEK 9	**July 3** (only) **2008**	**Culture and History II** • TOPIC: Reference and Precedent - Archiving the Past in order to See Into the Future • DESIGN LENS: The Entrepreneur and the Sci-Fi Writer • READINGS: Moggridge, Chapter 7 (pdf to be provided); Lawson 8
WEEK 10	**July 8/10 2008**	**Thinking Wickedly** • TOPIC: The Creative Mind and Creative Abrasion as a Guiding Principle of Design • DESIGN LENS: TBD • READINGS: Buchanan (pdf to be provided); Lawson 9, 10

WEEK 11	**July 15/17 2008**	**Managing Wickedness** • TOPIC: Strategies, Tactics, and Traps of the Design Process & submit Individual Deliverable (20%) • DESIGN LENS: TBD • READINGS: Lawson 11, 12, 13
WEEK 12	**July 22/24 2008**	**Questioning Design... "Tell me, are you really a problem?"** • TOPIC: Design as Conversation and Perception • DESIGN LENS: TBD • READINGS: Lawson 15
WEEK 13	**July 29/31 2008**	**Wrapping Up the Pieces in a Nice Tidy Box?** TOPIC: Synthesizing and Evaluating an Analytical Approach for Design Problems and Design Thinking DESIGN LENS: TBD READINGS: Lawson 16
WEEK 14	**August 5/7 2008**	**Final Exam (date, time, and room TBD)**
WEEK 15	**Aug. 12/14 2008**	**Final Exam (if not in WEEK 14)**

ASSIGNMENTS OVERVIEW

Team Assignment – starting in WEEK 2, groups will prepare and present one mini-case during the course. The aims of the presentations are to develop presentation skills and to integrate theory and practice, by examining a design situation of the past and applying relevant theory to the situation in order to see evaluate the design's development and relevance in today's world. Specifically, we are concerned with a design's "life cycle" from invention to adoption to disuse.

Individual Assignment – beginning in WEEK 9 students will begin the process of developing a portfolio of design artifacts that begin in a physical format and are then transformed into building blocks of a digital archive. Students will be required to sketch and draw their initial artifacts as a basis for refined digital copies. They will be introduced to basic digital tools that will upload and manipulate their artifacts while considering the affordances and constraints designers face in the move from analog to digital (and back).

Individual Examination – students will be required to take an open-book, in-class exam in the final week of the course in order to demonstrate their ability to apply key course concepts and terminology to their work. Students will therefore need to have completed their individual and team assignments in order to effectively speak to this work and show evidence of their understanding of key course ideas.

EVALUATION CRITERIA

All assignments are evaluated in terms of:

- **Engagement** with the course ideas, i.e. how a student *attempts* to show comprehension and understanding by engaging relevant course ideas in the completion of assignments, exams, presentations, etc. (Key Question: "Can I talk in the language of the course?")

- **Application** of the above ideas in concrete examples, such as case examples or with respect to the students own experiences. The ability to successfully apply relevant course ideas in this way shows strong understanding of the material (Key Question: "How does this course idea make sense in my world?")

- **Clarity and Format of Communication** relating to how well a student can communicate clearly, without error, and with a firm understanding of *audience*. The student will use form and conventions of communication appropriate to this audience, e.g. APA references, files that can be opened easily, structured arguments involving intro/body/conclusion, etc.

Evaluation is done with a baseline average score that is then added to or subtracted from based on performance with respect to the above criteria. WILD CARD: Bonus points can be given for creative ideas and solutions seen in student work (Note: there's no criteria for creativity otherwise it wouldn't be very creative, right? Discuss.).

COURSE INSTRUCTOR

Joel Flynn is a key member of the TechOne team and leads the development of the Design Thinking course while also teaching other courses such as Technology in Everyday Contexts and Foundations of Teamwork and Collaboration. He has an undergraduate degree in International Business (B.Comm, UBC, 1996), certification in multimedia design (Senior Management Certificate, BCIT, 2000), as well as a Masters degree in Interactive Arts (MaSc, SFU, 2006). He is currently investigating even deeper aspects of art, commerce, technology, and design through an MBA program at SFU. His interests – not to mention his thesis - primarily relate to the remixing of digital content in the production of new and innovative works and ideas.

RESOURCES

There will be a collection of resources at the course website site. Format TBD (e.g. WebCT, google docs, Sharepoint, etc.)

Appendix II

Spatial thinking and communicating: A course for first-year university students

Spatial Thinking and Communicating: A Course for First-Year University Students

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***Abstract*- This paper describes a course on *spatial thinking* and *communicating* designed by an interdisciplinary team and offered to first-year university students. An important goal was to introduce spatial thinking while accommodating the needs of the students from diverse backgrounds, educational goals and career pathways. Students in a first-year interdisciplinary cohort of 340 represented Mechatronics Systems Engineering, Business, Interactive Arts, Communications, and Computing Science. A major feature of the course design was an integrated laboratory, which served to amplify lecture content via practicing exercises aimed at developing their abilities to think and work spatially in 2D and 3D using tools including pencil and paper, digital and physical Lego, and a computer-aided design system. We describe our course design and team-teaching processes, realities that constrained our choices, the tools we use to assist our decision making during course design and delivery, and the structure and function of the teaching team. We also present selected student artifacts to demonstrate how students learned to think spatially. We then identify lessons-learned and revision plans.**

Introduction

The role of spatial thinking and communicating in understanding and shaping our environment has been a focus in the last two decades, evidenced by efforts to characterize the nature of spatial thinking by cognitive psychologists, scientists, engineers, and designers with different foci ranging from exploring its role in learning to problem solving, to its influences on behavioral patterns. Some of the research focuses on 'learning' and 'teaching' a particular set of spatial thinking skills in different contexts; for example, geographic information management, psychology, data mining, visualization, and design [1][2][3][4][5]. We agree with the National Academies that "…spatial thinking is at the heart of many great discoveries in science, that it underpins many of the activities of the modern workforce, and that it pervades the everyday activities of modern life." [1, p. 1].

New trends in university education are emerging as we understand human cognition and cognitive aspects of learning. In early university education, for example, academia has started to understand the importance of spatial concepts and they are becoming more emphasized, particularly for problem discovery and problem solving. The most explicit course offerings related to spatial thinking are graphical communication courses offered by engineering, architecture, and art departments [2][6][7][8]. The University of Southern California in the USA is one of the few universities offering dedicated courses in spatial thinking at the graduate level and in geographic information context [9]. However, we have yet to see a course explicitly devoted to spatial thinking particularly in the early university education. To the best of our knowledge, the Georgia Institute of Technology is one of a few institutions that introduces 'visual reasoning' for first-year college students [6]. We believe enhancing the ability of all students to think spatially and communicate visually will equip them with important problem solving and process skills required in addressing ever emerging new design challenges and tensions.

In this paper, we present an undergraduate course solely designed to raise awareness of and establish foundation skills for spatial thinking and communication among a diverse group of students.

We begin with a brief introduction to spatial thinking followed by a short description of the course design and delivery process. We analyze one team project to demonstrate student learning. We include some initial reflections on the course effectiveness and conclude with recommendations for revisions.

Importance of Spatial Thinking

Human cognition has two basic and complimentary styles of information processing: a linear, step-by-step style that analyzes parts that make up a pattern (left hemisphere) and a spatial, relational style that synthesizes and constructs patterns (right hemisphere) [10][11]. The latter is most dramatically displayed in creative discoveries and other breakthroughs [12]. Spatial and visual skills are important in both problem solving and in developing insight into underlying phenomena [13][14].

Spatial thinking is particularly important in two basic forms of cognition: analyzing and describing what exists, such as in nature, and formulating what is needed, as in design and craft. Examples of the first are the study of planetary systems and the molecular structure of a material. The latter involves designing environments and objects, entailing complex cognitive tasks for defining and shaping parts, part-whole relationships, topological structures, and spatial interactions of the parts. The complexity and scale to which spatial thinking applies varies widely, for example from a child stacking

wooden blocks to representing and analyzing a geographical region incorporating regional information.

Spatial thinking involves definition of space (as a frame of reference to locate spatial entities), identification of objects and their relationship to each other (parts and whole, proximity, containment, location, etc.), manifestation of spatial concepts in particular contexts (contextualization), and representations to identify and communicate about space and spatial entities (Figure 1).

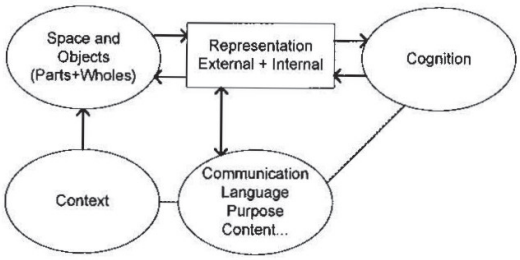

Figure 1. Components of Spatial Thinking.

Representation is inseparable from thinking and communicating spatially and the main form of representation in spatial thinking is visual. For example, the blue prints of a building or schematic diagrams of a natural phenomenon visually describe objects of interest incorporating spatial elements and their representations. It is with these conceptions of spatial thinking in mind that we began our course design process.

Course Design and Context

The TechOne Program and Students

The Spatial Thinking and Communicating course was designed and offered as part of the TechOne [15] academic program at Simon Fraser University whose goal is to provide first-year university students with a cohort experience currently serving programs in Interactive Arts and Technology, Business Administration, Computing Science, Communications, and Mechatronics Systems Engineering. The Spatial Thinking course is one of the six core courses, from which students choose four. At the time of the first course offering, 340 out of 375 students were registered. The students have no prior university learning experience. The students in Engineering are expected to acquire a level of proficiency in some aspects of this course in order to allow them to continue seamlessly into an Engineering Science major focused on Mechatronics

Description and Course Goals

This introductory course provides students with the foundational knowledge and technical skills required to envision three dimensional structures, visualize and think in three dimensions and to analyze and solve specific spatial thinking problems using a range of tools including: sketching, physical models and computer-based modeling software. The 14-week course prepares students to communicate their thinking to themselves and others and upon completion are expected to;

- Describe spatial thinking and the use of graphical representation and communication in engineering, business, art, and design.
- Visualize, examine, and interpret 3D representations and problems and proposed solutions.
- Create and manipulate 2D and 3D representations by sketching and using computer modeling software.
- Work in a team to build digital and physical models.
- Communicate spatial thinking in different (design) contexts to others.

Based on the assumption that achieving these objectives requires learning spatial thinking within a problem-solving context [1], the team designed a series of context-sensitive and practice-based learning activities that provided students opportunities to develop their confidence in spatial thinking. Activities moved from simple to complex building students' analog (sketching and physical models) and digital (computer models) representational capabilities. These are discussed in the following sections.

Course Design Team

The interdisciplinary course team consisted of 5 faculty, an instructional designer and graduate students. The faculty provided deep content expertise representing engineering, architecture and education. The role of the instructional designer was central to the process providing facilitation, support, and consultation on aspects of course design. Four graduate student teaching assistants (TAs) contributed to the course development. One TA in particular had considerable experience teaching engineering graphics at the college level.

This strong team worked closely together for over one year in what has been a once in a lifetime opportunity to incorporate their deep content knowledge, drawing upon their extensive years teaching engineering, product, and architectural design and integrating their research interests in spatial cognition and visual analytics.

Design Approach and Process

To illustrate the nature of the activities and outcomes associated with the final project, our course design approach focused on defining a coherent relationship between learning goals, learning activities and authentic assessments, yielding an engaging student experience. Beginning with a course concept map the team collectively produced a course map illustrating coherence between the course objectives, lectures and integrated lab activities and assessments. The weekly practice activities and assessments became the focal points for both teaching and learning spatial thinking.

The course development began five months prior to delivery and continued throughout course delivery over the academic term. An evolving *course map* helped the team to reflect upon and fine-tune the course in real-time (Appendix A). This was particularly useful for allowing the instructional team to reflect on the goals of the course to inform the teaching process. Adjustments and refinements were frequently made,