TEACHING STATEMENT

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A heat engine is driven by bringing a substance from a higher temperature state to a lower temperature state to do mechanical work. It is the difference in temperature, directed through an engineered system, that produces the work. Similarly, I think that differences in expertise, directed through the institution and resources of a modern research university, drive innovation, knowledge creation, and learning, simultaneously. I elaborate this view next because it is a window to my teaching philosophy.

Domain experience builds hierarchical neural structures that enable the expert to operate more effectively within their domain, relative to a novice. The neural structures of expertise process subsets of information, combined in somewhat rule-based ways, relative to novices. But an expert's advantage comes at a cost; it is harder for the expert to recognize patterns they are not "tuned" to recognize. They need "fresh eyes." I think that professors need their students at least as much as students need their professors.

When I say that students bring "fresh eyes," I mean they enter the expert's domain without the same hierarchical and rule-based structures of the expert, but quickly develop a common vernacular that enables their fresh eyes to interact with expertise, and to facilitate the growth of their own expertise. E.g., Stanford PhD student Larry Page came to Prof. Terry Winograd with ten research ideas. Winograd advised him to look at link structure on the web.[1] New knowledge was created. And the seeds for Google, also.

Studios, laboratories, project classes, lab meetings, design reviews, group critiques, advising meetings, lectures and lecture receptions, informal interactions in hallways, at the coffee machine, and in the pub, are the convection currents that drive the research university. Class lectures and discussions help build the vernacular between experts and novices. When things go right, I think that this is what universities do that is hard for companies and governments to do.[2] Before I describe my teaching background and teaching plan, I note where mine came from, because their origin illustrates my approach.

Influences

My approach to teaching and research was forged in the fires of artistic, scientific, and engineering innovation across two major research universities and over the course of a decade. My approach is a direct descendent of, and contains DNA from, three integrated teaching-research paradigms that

[1] http://money.cnn.com/galleries/2008/fortune/0804/gallery.bestadvice.fortune/2.html

[2] Calling a research park a "campus" reflects this intuitive understanding, but can never be more than a metaphor, in the same way that running a university like a "business" can never be more than a metaphor. Companies produce goods and services for customers and revenue for shareholders. Universities produce solutions to societies' problems, ideas, discoveries, scientists, scholars, and leaders. Many of these public goods fuel companies, but also non-profit institutions and governments, also. But students are not customers, classes are not a product, and tuition is not the same as revenue. Each are resources and mechanisms that direct domain expertise and domain innocence to produce knowledge, leaders, and solutions to societie's problems.

produced significant artistic, technological, and business innovation in three fields: robotic art, mobile robot design, and virtual worlds.

Using a course to develop a field. The first shred of DNA is Simon Penney's Robotic Art Studio class (RAS). This course served as the primordial soup for at least a dozen groundbreaking art pieces, that were shapers of the electronic media art landscape in the late 1990s, and early 2000 era.[3] This course is where I began the collaboration that lead to my own MFA thesis work, *Project Paradise* (Ars Electronica 98'), and art career under the group pseudonym, *Centre for Metahuman Exploration.*[4]

Using a course to develop a lab and industry. The second DNA shred is William "Red" Whittaker's Mobile Robot Design course (MRD), that Red used to drive the development of two world class research centers for mobile and field robotics: Carnegie Mellon's Field Robotics Center (FRC) and the National Robotics Engineering Consortium (NREC). This class produced at least a dozen advanced technology systems that have been, and are, deployed on the Earth, and in space; on land, sea, and air. This course prototyped projects that sparked millions of dollars of sponsored research projects at CMU and beyond, countless commercial enterprises, and began the careers of some of the most notable engineering scientists and entrepreneurs in robotics. My own sponsored research, the BigSignal Project, one of the first telescience interfaces for education, and the NASA funded EventScope Project, was forged in the skunkworks of FRC.[5] As a scientist in FRC, and PI of multiple projects there, I saw first hand how MRD was an engine that infused fresh ideas, people, and talent into our center. When I formed my own lab, The Remote Experience and Learning Lab (also referred to as "The EventScope Lab") I created my own course, Telepresence Art and Applications ("The Teleclass"), that I used to drive our development.

Teaching Experience

At Carnegie Mellon I taught project classes that were a fusion of these DNA shreds and that typically focused on the general research area of telepresence, virtual presence, or my EventScope Laboratory, which applied virtual presence to education and science exploration. One reoccurring class was "Telepresence Art and Applications" ("The Teleclass").

Teleclass. The Teleclass class provided students with the experience of creating functioning technologies. Depending on the semester, students had the option of developing a system within the context of electronic media art, or as an applied technology that had the potential to exist outside of the university and perform a role within society as an entrepreneurial effort. Typically four projects were produced by students from a variety of CMU departments including the School of Art, Human-Computer Interaction Institute, Robotics Institute, or the Entertainment Technology Center. The class

[3] These include: The Centre for Metahuman Exploration, the Carbon Defense League, the Institute for Applied Autonomy, Preemptive Media, the highly acclaimed work of Paul Vanouse, and the work of Beatrice DeCosta. This course was an engine for the "pre-exodus golden years" of electronic media art at Carnegie Mellon

[4] At Carnegie Mellon I met students in Simon Penny's Robotic Art Studio class, and with a few others, lead the formation of *The Center for Metahuman Exploration* (www.metahuman.org). Notable projects included: Petting Zoo (ISEA 97') and Project Paradise (Ars Electronica 98').

[5] In later years, the project was also housed in CMU's STUDIO for Creative Inquiry.

consisted of:

1. *Guided brainstorming.* The class began with brainstorming using specific brainstorming assignments. This enabled students to not only experiment with ideas, but also enabled instructors to work with students to focus their ideas on telepresence concepts and needs in society that could be addressed through telepresence. Dozens of storyboards were produced and evolved over the course of the first few weeks of the class.

2. *Team formation.* Additionally, the brainstorming format enabled students to observe the ideas, aptitudes and personalities of their peers for later team formation. Through this process approximately four teams would be formed.

3. *Presentation proposal.* After teams were formed, students developed their ideas into a simple presentation proposal that they showed in front of the class. This enabled instructors to provide feedback on their ideas before they had invested time into a full written proposal.

4. *Full proposal.* The proposal enabled students to clarify their ideas in a way that could be communicated to others. In the proposal students created milestones, assigned tasks to specific team members, addressed possible problems that the technology could solve in society, and decided on a project budget. The proposal also acted as a tool that the instructors used to gauge students' progress through the semester.

5. *Rapid prototyping.* The second half of the semester was spent in the creation of four functional prototypes that were demonstrated at the end of the semester.

6. *Public demonstration.* The semester would typically conclude with a public demonstration, such as an exhibit, that was open to the campus community.

Here are the specifics for typical versions of the class:

- **Telepresence, Art and Applications, (Course 15-899/05-899, Carnegie Mellon Univ.)**, *Lead-instructor*, Spring 2001, Fall 2002
  Approximately 18-25 students, depending on the semester
  Created advanced course on principles, design, and implementation of telepresence and immersive systems for art and technical applications. Supervised semester-long student projects and final exhibition.

- **Virtual Presence Art and Applications (Course 53-887, Carnegie Mellon Univ.)**, *Lead-instructor*, Spring 2005
  Six students
  Similar to Telepresence, Art and Applications (Course 15-899/05-899), but with a greater emphasis on using 3D virtual environment technologies (such as Google Earth).

Other Teaching Experience

- **Systems Engineering (Course 16-850/17-620, Carnegie Mellon Univ.)**,
  Co-instructor, Spring 2007
  Approximately 28 students
  Co-taught graduate course in systems engineering with Dr. David Wettergreen. Course integrated project conceptualizing, analyzing, designing, and prototyping a physical system.

- **Visual Thinking at KMDI (KMD 1002H Pro_Seminar on Visual Thinking, University of Toronto)**,
  Co-instructor, Spring 2007
  Approximately 25 students
  I applied a variation of my teaching approach from the Teleclass as co-instructor, and chief instigator/architect, of a graduate level seminar course at the University of Toronto. This was a seminar and lecture series to develop new research at the intersection of graphic representation and cognition.[6]

- **Visual Information Design.** At the University of Toronto I run workshops where I teach basic information design skills to non-artists. I have developed an approach to convey a basic approach to graphic representation within a 1.5 hour timeframe. Each workshop contained approximately 10-25 master's students.

- **Teaching Assistant.** From time to time I have worked as a teaching assistant during my PhD in the area of research methods and databases.

I now describe new courses I would like to teach that are formed at the intersection of these experiences and my current research program.

Visual Cognition, Drawing, and Design (VC2D) Course "Phenotype"

VC2D is envisioned as a way to address an underserved niche in academia. In my experience, most university students know how to write, *but few know how to represent their ideas through drawings and other 2D media*. I am developing a way to introduce students from all disciplines to these skills in a semester time period. However, this class does more than teach an art and craft. This course is designed to convey, and enable students to develop, theories of graphic representation that will serve their needs as students, practitioners, and researchers; for the natural, social, biological, and engineering sciences; for business, the non-profit sector, and for the social good.

VC2D builds upon my highly rated workshops on visual information design at the University of Toronto iSchool, my years of experiences as: an applied artist, illustrator, and information designer; as director of my research group on visual information displays at CMU, and its spin-off; and my current research agenda at the intersection of graphic representation and cognition.

[6] https://sites.google.com/site/visualspatialproject/themes.

Though the class will focus on graphic representation and cognition, and will contain more lectures and seminar style discussions than my Teleclass, it will still be organized with the same basic steps describe in my description of the Teleclass. At the beginning of the semester, students propose a final project that they will develop over the course of the semester, and that they can use construct an understanding of graphic representation and cognition from their own world view.

Format and source material. I will use McCloud's *Understanding Comics* (McCloud, 1993) as the basic "text book" for the course, and then after each chapter, students will read scientific, philosophical, and other relevant theoretical literature that I've collected (and/or that they will collect). Colin Ware's *Visual Perception for Design* will also serve as basic resource that is a user friendly overview of perceptual-cognitive literature that is relevant to the design of visual displays, and is accessible to a broad audience.

Coursework. Class discussions and written assignments will focus on bridging the gap between between drawing-design practice, the science and philosophy of perception, and other relevant domains. Studio projects will be hands on drawing and e.g., 2D design projects that make use of the concepts covered in each chapter.[7] Students will be strongly encouraged to tailor the assignments to their current graphic representation needs as students or researchers. The more this class intersects with their individual needs and aspirations, the richer will be the critiques that follow.

Laboratory for graphic representation pedagogy. Where appropriate, students will post their assignments to a public repository, whether these are studio-based drawings or 2D designs, or reaction papers that seek to bridge the art and design of graphic representation for their particular needs. In this way, the class will be a "laboratory" for a new kind of "text book" that will augment or replace materials that I use in the first version of the class.

Connections to university research community more broadly. "New" natural languages, art forms, cultures, sciences, and technologies share a common property; they emerge at the intersections of previously less-connected domains. I use this concept for the curriculum design of this class. Without an overtly bold attempt to do so, a new kind of perceptual-cognitive science of visual graphic representation that is relevant to the needs of our community will begin to emerge. Because the class will be housed at the intersection of several disciplines, we can escape the institutional inertia of the current cognitive science paradigm, that has a tradition of conceiving visual perception and language as less-connected subfields. [8]

Relevance to the design field more broadly. Because graphic representation has fundamental properties that transcend most disciplinary boundaries, but each assignment can be focused to the needs of a student's particular discipline, the course can evolve to meet the graphic representation

[7] This is why McCloud (1993) will serve as an effective format for early versions of the class. The book presents a practical theory of graphic representation, for practitioners, but it is thoughtfully laid out in a manner where I have found that it is easy to reference the science of perception to each section.

[8] Even though the cognitive scientists tried to depart from the ancient philosophers, you can still trace their bias toward language, and neglect of visual art, back to Plato, who famously held visual art in a very low regard. And at the same time, without really going out of our way to do so, developing and teaching these classes would be developing a new kind of visual art-design theory, but that makes use of ideas from the sciences, from the ground floor.

needs of every discipline that intersects with the our department.

The approach I just outlined would also be imminently practical in the applied arts, human computer interaction, and educational technology. Because the designers would have some familiarity with the perceptual-cognitive concepts that can get them closer to understanding the affordances of their designs, we are closer to an approach where the effectiveness or performance of designs can be understood, evaluated, and optimized. And when we discover that a design, based on our theory, is not effective, we can then try to understand why, and correct our theory, which then feeds back into increasing our understanding of design, because we are also trying to understand it, using the same, now updated, theory.

Extending the phenotype. As a gain expertise running this class, I will extend it for advanced classes focused around the same domain area, and/or to develop classes that focus on other issues such a moving images, telepresence, and beyond.

Visual Media Laboratory

Visual Media Laboratory would be a hybrid between the Teleclass phenotype and the Seminar phenotype that I developed via the visual thinking at KMDI lecture series. It would focus on an advanced area of visual media design and cognition, or a specific area of interest that is timely. It would also serve another important function, as a mechanisms to develop a new research area with colleagues at my home department, and the university at large.

References

McCloud, S. (1993). *Understanding comics: The invisible art.* HarperPerennial.