

# **DESIGN & SOCIETY: A GENERAL EDUCATION EXPERIENCE FOR FRESHMEN**

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## Abstract

As a part of its commitment for continuous program improvement, the Maseeh College of Engineering and Computer Science of Portland State University (PSU), Portland, Oregon, has, in collaboration with the university's Freshman Inquiry Program, developed a year-long general education inquiry course titled Design & Society. This course is part of PSU's University Studies program, which uses a team-oriented, active-learning based approach to general education. In Design & Society students learn and apply design skills to solve real problems while also considering the related societal, cultural, and historical dimensions. The objectives of the course from the college's perspective were to give students an overview of and experience in design and design professions, give students an opportunity to do hands-on design projects, encourage students interested in majoring in design-related professions, including engineering, use pedagogical techniques from engineering, and introduce non engineering students to an engineer's way of understanding and creatively engaging with the world. With its emphasis on critical thinking, communication, diversity, and ethical issues and social responsibility, Design & Society was envisioned as a means of broadening the overview of the profession without needing to expand the current introductory course in engineering offered to engineering majors in an already full schedule. In addition, the course gives an opportunity for learning teamwork in a true multidisciplinary environment which is lacking in an all-engineering freshman course. As the course progresses assessment will be done using surveys and portfolio reviews.

## Why Design & Society?

The current learning community-based freshman experience at Portland State University (PSU) began 10 years ago when University Studies debuted as the university's general education program. The overall goals of the University Studies program are to teach students critical thinking, communication, an understanding of ethical issues and social responsibility, and an appreciation of diversity. University Studies is a four-year general education program offering Freshman and Sophomore Inquiry sequences, junior level Cluster Courses that help students focus on a particular theme of inquiry, as well as the Senior Capstone project. The Freshman Inquiry sequence (FRINQ) is the introduction to University Studies in a 5-credit-per-term, 3-term sequence.

A FRINQ course features moderate-sized main session with a maximum of 36 students plus smaller mentor sections of about 12 students headed by an undergraduate student mentor specially chosen for their intellectual and social skills. Design & Society is one of 9 themes being offered in scholastic year 2004-2005 at PSU. The remaining themes study Chaos &

Community; The Columbia Basin; The Constructed Self; Cyborg Millennium; Forbidden Knowledge; Meaning & Madness at the Margins; Pathways to Sustainability & Justice; and Sex, Mind & the Mask. Themes are developed by a team of three to four instructors and are team taught, with each of the instructors having the primary responsibility for a main session.

Design & Society utilizes the problem posing method, discussion, and writing-intensive nature of the other FRINQ themes - it stands out amongst FRINQ themes with its emphasis on hands-on design projects. Student teams work on a variety of projects, team based and individual, that address the four university studies goals of communication, critical thinking, ethical issues and social responsibility, and an appreciation of diversity in addition to theme specific learning objectives. Students are also challenged with the opportunity to research and design a product of their own choice.

For design-oriented or technical students, Design & Society offers unique opportunities for their general education experience within a project-based learning environment. The course introduces students to current practices and issues facing the design profession and may inspire some of the students to pursue a design oriented career. Students are given the opportunity to explore their own areas of interest in a two term, self selected and defined design project. The course is also intended to soften the barrier of required technical courses that freshman technical students take, by welcoming the student into a learning community of design professionals. Students with interest in science, technology and engineering find Design & Society far more attractive than other FRINQ themes. Technical students, like any other university students, will also benefit from studying in a multidisciplinary setting. For example, engineering courses sometimes discuss social responsibility and ethics, but spending a full year in Design and Society allows freshman the opportunity to analyze those situations in greater depth, view them from different perspectives, and integrate their learning through reflection early in their education.

For the non-technical students, which include liberal arts and business majors, Design & Society offers some unique general education experiences. First, the hands-on design projects, with their emphasis on building models and prototypes, offer a new form of learning in a general education course. Challenging projects that create a rich learning experience are designed to engage students within a wide range of skill levels. Through practicing these skills in open and supportive environment, students who were unsure of their major could gain the confidence to choose science, engineering or technology. While quantitative literacy as a component of critical thinking might be overlooked in general education courses, Design and Society helps students in understanding the basic of data collection, testing and analysis, and reasoning in the context of design activity. Students also develop an understanding of spreadsheet calculations and force vectors, and engage in some computer programming. The emphasis on team techniques and group work allows students to learn from the diverse viewpoints, skills, and interests of their classmates. Through the study of design history and the close relationship to societal context students are able to carefully consider how design is important to today's society. Lastly, design affects the lives of everyone, and this course exposes all students to the ramifications of design in their daily lives.

## Goals of the Course

As a collaborative effort of the Maseeh College of Engineering and Computer Science of Portland State University and the university's Freshman Inquiry Program this course addresses the goals of both programs. It also has theme specific content and skill objectives.

The overall goals of the University Studies program are these:

- Inquiry and Critical Thinking - Students will learn various modes of inquiry through interdisciplinary curricula—problem-posing, investigating, conceptualizing—in order to become active, self-motivated, and empowered learners.
- Communication - Students will enhance their capacity to communicate in various ways—writing, graphics, numeracy, and other visual and oral means—to collaborate effectively with others in group work, and to be competent in appropriate communication technologies.
- The Variety of Human Experience - Students will enhance their appreciation for and understanding of the rich complexity of the human experience through the study of differences in ethnic and cultural perspectives, class, race, gender, sexual orientation, and ability.
- Ethical Issues and Social Responsibility - Students will expand their understanding of the impact and value of individuals and their choices on society, both intellectually and socially, through group projects and collaboration in learning communities.

Additional goals for the course by the Maseeh College of Engineering and Computer Science are to:

- Increase the percentage of engineering students in the Freshman Inquiry program
- Increase engineering enrollment at PSU
- Increase engineering retention at PSU

The latter two of these goals are overarching goals within the Maseeh College, and are being addressed by more programs than this course. It is expected, however, that the attainment of the first goal will also boost the latter two.

In addition Design and Society has the following theme specific learning objectives:

- Apply the steps in the design process to create original designs.
- Understand the interdisciplinary nature of the design process.
- Understand how designers acting locally can compete in the global marketplace.
- Describe how design can improve social and physical systems and explain the societal responsibilities of the designer in areas such as sustainable development and social justice.
- Demonstrate mathematics skills, including application of basic physical laws to contextual problems, testing the functionality of designs, setting and meeting benchmark requirements.
- Analyze a design in terms of the context of the systems in which it operates - human interaction with the design, cultural context, natural harmony, and technical functionality.
- Design and solve problems in a team-based culture using effective communication, cooperation, trust and respect. Take advantage of individual thinking styles and cultural diversity to strengthen a team.

## Implementation

The course pilot for academic year 2004-2005 is a full size FRINQ theme with four sections and over 120 students. The teaching team is comprised of four faculty members from diverse backgrounds within the university. The faculty team has expertise in architecture and architectural history, art history, landscape design, structural engineering, studio art, theater history, electrical engineering, and semiconductor physics. Other disciplines represented in the course materials include social history, film, economics, business ethics, ecology, product design, and industrial design. Since teamwork is an essential element of the course, all faculty team members have contributed to the course content and assignments. Each team member teaches sections of the other classes to expose the students to different viewpoints and areas of expertise. Thematically this year long course is organized as follows:

Fall term - The Design Process, Innovation and Team-Based Design, The Role of the Designer, Design and Failure

Winter Term - Design for Future Societies (Community, Sustainability, Technology), Design Project Proposal

Spring Term - Global Issues and Design, Case Studies in Design, Design Project Implementation

## First Term Experiences

Fall term emphasizes an understanding the designer, design process and the changes in the roles and techniques of designer. *The Art of Innovation*<sup>1</sup>, by Tom Kelley, was used to teach the design process and techniques used by IDEO, one of the leading design firms today. The students consciously applied IDEO's techniques such as brainstorming and close observation of users to design projects throughout the term. Through a close reading of *Brunelleschi's Dome*<sup>2</sup>, by Ross King, the students learned about the birth of architecture as a profession during the renaissance. Class discussions and research papers were used to examine how the designer's role in society has changed over time, and how teamwork has evolved as a standard practice. A re-creation of renaissance surveying techniques as well as a re-creation of geometric representational techniques like Brunelleschi's perspective allowed the students to understand and apply the techniques in real situations and see how new ideas emerged even with the use of fairly simple tools. Detailed studies of dome of Santa Maria del Fiore in Florence introduced statics concepts such as forces and moments, construction techniques, the social context and the challenges of building very large structures.

The term culminated in a four-week bridge design project, following the steps outlined in *Designing and Building File-Folder Bridges: A Problem-Based Introduction to Engineering*<sup>3</sup> by Stephen Ressler, P.E., and PhD of the United States Military Academy, who also developed the West Point Bridge Designer software. To learn the modeling skills students built a model manila file folder truss of a design specified by the instructor. Simple trusses were analyzed using statics concepts and geometry. They then built and tested the actual strength of sample tension and compression members made of manila paper. Through hands-on activities, the students developed a good feel for compression and tension forces. Working in teams, the classes used the West Point Bridge Designer to simulate an optimized bridge design (Figure 1). They then scaled the sizes and forces to match our experimental set-up and adjusted the designs as needed based on the measured strength of the sample members. Bridges were constructed to the

designed specifications using the manila paper and tested for strength (Figure 2). The design and modeling of a large structure allowed students to apply their knowledge of forces, the design process, and team techniques, and to understand the design process clearly. This activity offered the instructors a challenging scenario in this general education class. With the wide range in mathematical skills exhibited we found it difficult to engage and challenge all our students. For example some students were able to complete the analysis of truss forces in fairly quickly, while others struggled and were unable to calculate sines and cosines and therefore couldn't even begin the analysis.

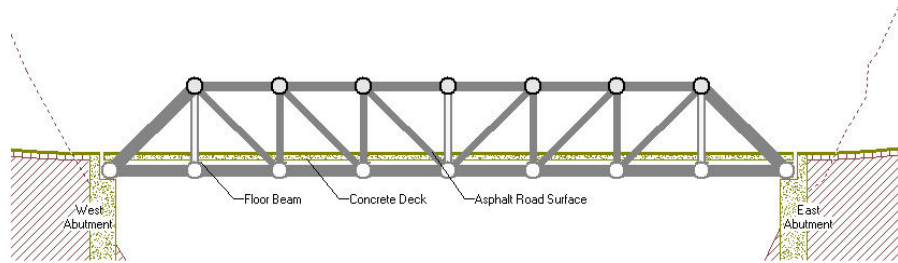


Figure 1: Example of Bridge Designed with West Point Bridge Designer



Figure 2: Testing the bridge from Figure 1

## Second Term

The societal forces and technological changes which drove the movements from Arts and Crafts to Modernism and Industrialism were examined and compared to changes happening today. The student's studied how unbridled growth and limited resources are posing great challenges to our society and how our future well-being will be influenced by choices we make today. Ecological design techniques from William McDonough, Sim Van der Ryn and others offered positive and innovative approaches to these challenges. Students visited LEED certified buildings in Portland

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and the toured the LEED gold-certified Honda warehouse facility in Gresham, Oregon. Writing activity was centered around using the case study method to explore sustainable design solutions. Students will spend the last four weeks of the term designing and programming Lego robots to meet a series of challenges. This activity will focus on the design process and team work. Students will design websites to document progress and record their reflections on the design problem, solutions and the experience of building the robots. Early in the term the students selected an individual design project; researched the problem and its history using patent searches, technical journals and user observations; defined benchmarks to measure success; documented the results; and planned the completion of the design in the spring quarter.

### Third term

The third term of the pilot will emphasize the social responsibilities of the designer through stakeholder analysis and case studies such as the Narmada Sagar hydroelectric project in India and the failure of the Playskool Travel-Lite crib. The ethical challenges that designers face will be illustrated with case studies such as engineer Le Messurier and the Citicorp building and the Ford Pinto case. In the case studies, issues of diversity in relation to design professions, and ethical and social responsibilities of the designer will be studied in detail and discussed during class. Design projects will be completed and displayed and the students will share their drawings and prototypes with the university community.

### Assessment Plan

The assessment in this course includes formative and summative assessment that utilizes student's self reporting on their experience as well as a portfolio review of work samples. Early term assessment is conducted in the third week of each quarter and asks the students to give examples of what is helping them as well as making them more difficult to learn in the class. Students are also asked for suggestions for how the class may be improved. The results of this assessment are formative and are used only to assess areas of improvement and strength and provide feedback to the instructor.

The end of term assessment is conducted at the end of each term and is formative and summative in nature. While the survey results are retrospective in nature and are seen as a documentation of student's self reporting of their experience they also have a formative function in year long course. The survey instrument questions specific to Design & Society theme are shown in Table 1. In addition to prior learning and post learning surveys, students design electronic portfolios to show the relationship between their work and University Studies goals. A review of portfolio is conducted at the end of spring quarter for program and team review.

Table 1. Design & Society themes specific assessment questions.

1. What is your major?
2. Did interest in design influence the choice of this class for your freshman inquiry?
3. Would you recommend this course to students of any major?
4. In this course I had the opportunity to:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Apply the steps in the design process to create original designs.					
Develop my design interests.					
Learn societal responsibilities of the designer in areas such as sustainable development and social justice.					
Analyze a design in terms of the context of the systems in which it operates - human interaction; cultural context; natural harmony; technical functionality					
Understand how the design process might apply to methods of inquiry in other disciplines.					

## Conclusion

Our preliminary experiences with Design and Society have been very encouraging. Students have demonstrated the ability to use team based design techniques to solve problems. Participation and engagement in the projects and discussions has been uniformly excellent. Mastery of the more advanced technical skills such as force vectors has been mixed, but all students have learned the more fundamental quantitative literacy and graphical analysis skills. Students are beginning to see designing as a form of inquiry and are making connections between ideas learned in this general education class and their majors. While full conclusions will have to await our final assessments, it appears the course is on track to meet the stated goals. We believe that that Design and Society offers a rich, deep and exciting learning experience to freshman students at Portland State University.

## Bibliography

1. Kelley, Tom, *The Art of Innovation*, New York, Doubleday, 2001
2. King, Ross, *Brunelleschi's Dome: how a Renaissance genius reinvented architecture*, New York: Penguin Books, 2001

3. Ressler, Stephen, *Designing and Building File-Folder Bridges: A Problem-Based Introduction to Engineering*, available from the West Point Bridge Design Contest website, <http://bridgecontest.usma.edu/manual.htm>

#### Biographical Information

Carol Hasenberg has been a faculty member of the Civil and Environmental Engineering Department at Portland State University since 1997, after working for seven years as a structural engineering consultant. Her teaching and research interests include seismic hazard assessment, the design process at a variety of undergraduate levels, and sophomore mechanics courses.

Betsy Natter joined the Electrical and Computer Engineering department at Portland State University in 2004 after working for ten years in the semiconductor industry. Her teaching interests include semiconductor devices, microelectronic fabrication, and freshman design.

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