SYLLABUS / SEMESTER PLAN

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Office Hours</th>
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| Dr. Scott Ferguson  
3244 EBIII  
scott_ferguson@ncsu.edu | Tuesdays and Thursdays  
8:30 pm – 9:30 pm  
or by appointment |

Course time / location

Schedule: Tuesdays and Thursdays from 10:15 am – 11:30 am  
Room: 2213 Engineering Building III

Office hours

While I can be reached by email or by phone (919-515-5231), office hours will be held virtually using Collaborate (https://collaborate.wolfware.ncsu.edu/). This will allow multiple students to be accommodated at the same time and allow for increased interaction.

Course description

Many think of design as more of an art than a science. However, the growing body of research in the engineering design community teaches us ways to navigate the design of consumer products using interdisciplinary design tools and rational decision making.

This course introduces students to scientific design techniques that are more effective than “ad hoc” tactics. By exploring how engineering principles integrate with “real world” design challenges, students will learn to solve product design problems that encompass heterogeneous markets, multiple disciplines, and complex systems.

Learning objectives

At the end of this class, you will have learned to approach design in a systematic way and will be able to:

- Identify and address customer needs in product design
- Select and apply appropriate techniques for capturing and representing the heterogeneous preferences of a consumer market
- Leverage customer preferences and requirements in models of demand
- Generate alternative solutions in a way that promotes creativity / innovation and usefulness
- Identify and establish the core components of a product
- Systematically compare alternative solutions and scientifically identify the best candidates
- Account for, and model, uncertainty in the design process
- Design a product when dealing with multiple disciplines and multiple objectives
- Identify and leverage the most effective product design strategies when designing for variety

Text

There will be no required textbook. Additional readings and references will be provided by the instructor. These optional textbooks will also be used as references throughout the course:

Course website

Moodle: http://wolfware.ncsu.edu
Piazza: https://piazza.com/ncsu/spring2016/mae495589/home

Course topics

- Introduction to product design and systems-level thinking
- Capturing customer needs and preferences
  - Kano model
  - Customer needs as requirements
  - Discrete choice theory as a means of representing customer preferences
- Conceptual design
  - Innovation and creativity
  - Brainstorming techniques
  - Challenges of concept selection
- Embodiment design
  - Establishing a product architecture
  - Understanding functional relationships
  - Establishing a product platform
- Limitations of existing design theories and methodologies
  - Mathematical validity / provability of techniques
  - Impact of scales (cardinal, ordinal, etc)
- Advanced design concepts
  - The role of uncertainty in engineering design
  - Design for the developing world
  - Design for variety
  - Product customization

Grading

<table>
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<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Homework</td>
<td>20%</td>
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<tr>
<td>Final</td>
<td>30%</td>
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<tr>
<td>Design project (multiple deliverables)</td>
<td>35%</td>
</tr>
<tr>
<td>Research paper</td>
<td>15%</td>
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Homework

Homeworks are to be completed individually. All assignments are to be submitted at the beginning of class the day they are due. Late assignments will not be accepted unless there is a compelling reason as to why the assignment is late.

Exams

The final exam will consist of a take-home portion and an in-class portion. Take-home portions of the final exam are to be completed individually. The in-class portion will be closed notes.

Course design project

Deliverables for the course project will be assigned as the semester progresses. The focus of the project will be to apply the techniques learned in this class toward a real-world design problem. Working in groups, students will pick a product or concept (or be assigned one by the instructor) and go through the design process using the theory / techniques we have learned in class. This is a chance for students to do a “deep dive”, and submission checkpoints will be established throughout the semester.
Graduate research paper

Students enrolled in the 589 section of the course will be expected to complete a research paper that will be due on the last day of class. No late submissions will be accepted. Further details will be given as the semester progresses. The research paper will require students to conduct a literature review on a topic from the class while also proposing interesting research opportunities that exist for that topic.

Other rules and regulations

Academic Integrity
I encourage you to work with others on homework assignments and before exams. Cheating of any kind (copying, plagiarism, etc.) however, will not be tolerated and will result in an F for the course. Students are required to comply with the university policy on academic integrity found in the Code of Student Conduct found at [http://policies.ncsu.edu/policy/pol-11-35-1](http://policies.ncsu.edu/policy/pol-11-35-1). See [http://policies.ncsu.edu/policy/pol-11-35-1](http://policies.ncsu.edu/policy/pol-11-35-1) for a detailed explanation of academic honesty.

Use of Online Exchanges
Students may be required to disclose personally identifiable information to other students in the course, via electronic tools like email or web-postings, where relevant to the course. Examples include online discussions of class topics, and posting of student coursework. All students are expected to respect the privacy of each other by not sharing or using such information outside the course.

Policies on Incomplete Grades
If an extended deadline is not authorized by the instructor or department, an unfinished incomplete grade will automatically change to an F after either (a) the end of the next regular semester in which the student is enrolled (not including summer sessions), or (b) the end of 12 months if the student is not enrolled, whichever is shorter. Incompletes that change to F will count as an attempted course on transcripts. The burden of fulfilling an incomplete grade is the responsibility of the student. The university policy on incomplete grades is located at [http://policies.ncsu.edu/regulation/reg-02-50-3](http://policies.ncsu.edu/regulation/reg-02-50-3).

Accommodations for Disabilities
Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, student must register with the Disability Services Office ([http://www.ncsu.edu/dso](http://www.ncsu.edu/dso)), 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation at [http://policies.ncsu.edu/regulation/reg-02-20-1](http://policies.ncsu.edu/regulation/reg-02-20-1).

Non-Discrimination Policy
NC State University provides equality of opportunity in education and employment for all students and employees. Accordingly, NC State affirms its commitment to maintain a work environment for all employees and an academic environment for all students that is free from all forms of discrimination. Discrimination based on race, color, religion, creed, sex, national origin, age, disability, veteran status, or sexual orientation is a violation of state and federal law and/or NC State University policy and will not be tolerated. Harassment of any person (either in the form of quid pro quo or creation of a hostile environment) based on race, color, religion, creed, sex, national origin, age, disability, veteran status, or sexual orientation also is a violation of state and federal law and/or NC State University policy and will not be tolerated. Retaliation against any person who complains about discrimination is also prohibited. NC State's policies and regulations covering discrimination, harassment, and retaliation may be accessed at [http://policies.ncsu.edu/regulation/reg-04-25-2](http://policies.ncsu.edu/regulation/reg-04-25-2) or [http://www.ncsu.edu/equal_op](http://www.ncsu.edu/equal_op). Any person who feels that they have been the subject of prohibited discrimination, harassment, or retaliation should contact the Office for Equal Opportunity at 919-515-3148.

NC State Policies, Regulations, and Rules (PPR)
Students are responsible for reviewing the NC State University PRR’s located at [http://oucc.ncsu.edu/course-rights-and-responsibilities](http://oucc.ncsu.edu/course-rights-and-responsibilities) which pertains to their course rights and responsibilities.

Updated: January 6, 2016
Teaching philosophy

“The lasting measure of good teaching is what the individual student learns and carries away.”
Barbara Harrell Carson, 1996, Thirty Years of Stories

This course may be quite different than most of the classes you have taken during your engineering career. To get the most out of this course, I strongly encourage your participation during lecture. I will always be available during office hours and by appointment (unless otherwise specified). I will also try my best to answer all email questions in a timely manner. If you experience problems with the material, please come see me for help.

Course outline (dates, topics, and assignments all subject to change)

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Assignment</th>
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| 1    | Introduction  
What is product design? What is systems-level thinking?  
Exploring the product development process | |
| 1-5  | Marketing / Engineering domains  
Relating needs, preferences and demand  
Customer needs, Kano Model, Requirements lists  
Modeling demand and estimating market size  
Discrete choice theory in engineering product design | HW 1  
HW 2 |
| 6-8  | Engineering domain  
Conceptual and early embodiment design  
Principles driving innovation and creativity  
Brainstorming techniques  
Establishing a product architecture  
Understanding functional relationships  
Concept selection and limitations  
Decision traps  
Multi-attribute utility theory | HW 3  
HW 4 |
| 9    | Engineering domain  
Limitations of existing design tools  
Limitations of modeling  
Impact of model scales (cardinal, ordinal, etc) | |
| 10-13| Engineering / Manufacturing domains  
Late embodiment  
Establishing a product platform  
Complex system design  
Modeling uncertainty in engineering design problems  
Ramifications of uncertainty in engineering design problems  
Multiple designers, multiple disciplines, multiple objectives  
Game theory in engineering design | HW 5  
HW 6 |
| 14-16| Emerging areas  
Design for variety  
Sustainable product design  
Design for the developing world | HW 7 |

Final Exam  
(During assigned final window)