2.009 Product engineering processes

powered garden cart automatically follows user
2.009 Product engineering processes

Welcome!

powered garden cart automatically follows user
A mini quiz

Put your name on the top of an index card

Which object is different from all the others?

a

b

c

d

e
2.009 Product engineering processes
A mini quiz

Which object is different from all the others?

b

Congratulations!
The only one with all straight lines
2.009 Product engineering processes

A mini quiz

Which object is different from all the others?

Congratulations!

The only one that is asymmetric
2.009 Product engineering processes
A mini quiz

Which object is different from all the others?

Congratulations!
The only one with no points
2.009 Product engineering processes

A mini quiz

Which object is different from all the others?

Congratulations!
The only one made with line and arc
2.009 Product engineering processes
A mini quiz

Which object is different from all the others?

Congratulations!
The only one that is the projection of a triangle onto a curved surface
Welcome!

to product engineering processes
a place where there are many right answers
Welcome!
to product engineering processes
a place where there are many right answers
Welcome!

there are many right answers

... and even more wrong answers
there are many right answers

... and even more wrong answers
there are many right answers

… and even more wrong answers
it’s not easy, but...
we are here to help you succeed

+ 39 mentors!

information/staff menu

librarians
building a machine for innovation

team recipe

motivation

+ creativity

+ informed craft

+ process

= innovation
Machine for technical innovation

What’s the recipe?

motivation

+ designing

+ process

= innovation
2.009: developing/engineering products

designing

- Creativity to see many unique viewpoints/framing
- Capability to understand/analyze/model/test viewpoints
- Creativity to generate solutions from a viewpoint

C1: lateral thinking (mini quiz: more than one answer)
C2: informed (most of your formal education) + craft
C3: synthesis from a viewpoint (constraints)
2.009 Developing/engineering products
a mini quiz for the ‘3rd C’: generating solutions!

put your name on the top of an index card

think of a way to place a sheet of paper so that when two people stand on it, facing towards each other, it is impossible to touch.

some rules:
cutting or tearing the paper is not allowed
tyling up the people is not allowed

one solution:

another solution? hang …challenge assumptions

another solution? use two people that cannot move
2.009 Developing/engineering products

designing

Creativity to see many unique viewpoints/framing

Capability to understand/analyze/model/test viewpoints

Creativity generate solutions from a viewpoint
Machine for technical innovation

What’s the recipe?

motivation

+ designing

+ process

= innovation
2.009 developing/engineering products

process(es)

a collection of strategies to help ensure that you have a high likelihood of being successful

on time, every time
2.009 Product engineering processes

the class

Develop new product ideas
Provide teams of ~20 students with the opportunity to experience the need/opportunity finding, innovating, prototyping, and business development cycle in a simulated but very realistic environment. Fully functional alpha prototypes are designed and fabricated by the teams.

Improve our 3Cs (designing)
Practice being creative and constructing physical and analytical models for reasoning about creative alternatives.

Processes
Learn strategies for the 3Cs and apply them to product development and working in large teams.
2.009 Product engineering processes

goals for today

how is the course organized?

what will I experience?

what are the milestones (grading)?
# Product engineering processes

## how is the class organized?

### lab (product development activity)

<table>
<thead>
<tr>
<th></th>
<th>2 instructors</th>
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</thead>
<tbody>
<tr>
<td>students</td>
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</tbody>
</table>

- discipline-specific mentors
- 2 course librarians
- 4 lab staff

### class (development process and design methods)

<table>
<thead>
<tr>
<th></th>
<th>1 course instructor</th>
<th>1 course instructor</th>
<th>1 course instructor</th>
<th>1 course instructor</th>
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<th>1 course instructor</th>
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<tbody>
<tr>
<td>1 course instructor</td>
<td>CEO</td>
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<td>course TAs</td>
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<td>aides</td>
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<td>aides</td>
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</tbody>
</table>
Product engineering processes

how is the class organized?

planning  concept  system  detail  testing  production

design  design  design
Product engineering processes
beyond 2.009: opportunities to keep learning!

Braille label maker
“the home”

inexpensive, high quality printing, fast
after 2.009: patents
started company (6dot)
Product engineering processes

how is the class organized?

process

design techniques

product definition

physical modeling
What will I experience?

**idea development**

**Modeling activities**

**idea generation/sketches**

**market and customer estimates**

**sketch models**

**feasibility estimates**
Idea generation
4 minute exercise
write your name on a sheet of paper

generate as many ideas as possible to mitigate...

your ideas will be collected at the end of 4 minutes
What will I experience?

**idea development**

Modeling activities

**idea generation**

market and customer estimates

sketch models

**feasibility estimates**

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
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</thead>
<tbody>
<tr>
<td>2</td>
<td>To meet activity constraint of less than 30 lbs</td>
<td>For</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>To meet cost constraint batteries must be lead-acid</td>
<td>For</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>8</td>
<td>Assume 12.5 mph</td>
<td>165 lbs</td>
<td>100%</td>
<td>100%</td>
<td></td>
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<tr>
<td>9</td>
<td>with user weight of</td>
<td>takes 0</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>10</td>
<td>and counterweight</td>
<td>with energy 1</td>
<td>1</td>
<td>1</td>
<td></td>
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<tr>
<td>12</td>
<td>Rolling resistance of 1.5% (including wheels and bearing)</td>
<td>Total</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>14</td>
<td>Wind resistance of 7.5 square feet with frontal area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Minimum drivetrain efficiency allowable</td>
<td></td>
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</tr>
</tbody>
</table>
What will I experience?

concept development

Mockups

Market analysis

Feasibility analysis

Modeling activities

concept development
What will I experience?

detailed development

making it really work

Modeling activities
detail design
detailed analysis
user testing
prototype fabrication
A set of modeling activities
rigor in breadth and depth

estimation to detailed analysis

sketching to solid modeling and CAE

soft, sketch models to alpha prototypes
the experience/process is gated by milestones

**What are the milestones?**

3-ideas presentation (September 24)

4 minutes for 6 ideas

defines team's focus area for the rest of the term!
What are the milestones?

**sketch model presentation (October 5)**

6 design concepts, quick and dirty technical, market, and customer needs data

efficient exploration of concepts
What are the milestones?
mockup presentation (October 18)

4 product concepts per team
technical feasibility/operational principles

identify and resolve critical issues
Process check!
Oct. 18! the term is half over and we still have not made our final idea selection?

Why waste all this time exploring ideas? Just tell us what the design problem is and we will do the detailed engineering.

One of the 3 Cs

The C that is also being outsourced!
see the “creativity crisis” link on the course home page

Creative thinking is key to technical innovation

A series of exploration, experiments and learning that develops the insight to know what to do
What are the milestones?

- technical review (November 15)
- demonstrate functional alpha prototype
- discuss remaining areas for improvement
- detailed engineering assessment
What are the milestones?

final public presentation (December 10)

presentation to a wide audience: classmates, academics, and industry

a complete package: presentation quality, product design, business case

product launch
What are the milestones?

**schedule and details**

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Date</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab section preferences due</td>
<td>Saturday, September 8</td>
<td>5 PM</td>
</tr>
<tr>
<td>Project idea fair</td>
<td>Monday, September 10</td>
<td>7-8 PM</td>
</tr>
<tr>
<td>3 ideas presentation</td>
<td>Monday, September 24</td>
<td>during class</td>
</tr>
<tr>
<td>Sketch model review</td>
<td>Thursday, October 4</td>
<td>7-10 PM</td>
</tr>
<tr>
<td>Mockup review</td>
<td>Thursday, October 18</td>
<td>7-10 PM</td>
</tr>
<tr>
<td>Selection of final product idea</td>
<td>Week of October 22</td>
<td>during team lab</td>
</tr>
<tr>
<td>Assembly review</td>
<td>Wed. Oct. 31 and, Fri. Nov. 2</td>
<td>during class</td>
</tr>
<tr>
<td>Technical review</td>
<td>Thursday, November 15</td>
<td>7-10 PM</td>
</tr>
<tr>
<td>Final design review</td>
<td>Monday, November 19</td>
<td>1-5 PM</td>
</tr>
<tr>
<td>Thanksgiving</td>
<td>Thursday, November 22</td>
<td>all day long!</td>
</tr>
<tr>
<td>Final presentation practice session</td>
<td>Friday, December 7</td>
<td>5-9 PM</td>
</tr>
<tr>
<td>Final presentation</td>
<td>Monday, December 10</td>
<td>7:00-10:30 PM</td>
</tr>
</tbody>
</table>
What are the milestones?
the point: feedback to improve the design!

all course staff review each team
results discussed in class
## Milestones grading

<table>
<thead>
<tr>
<th>Deliverable</th>
<th>% Course Grade</th>
<th>Assigned To ...</th>
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<tbody>
<tr>
<td>Brainstorming</td>
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<td>Individual</td>
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<tr>
<td>Design notebook</td>
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<td>Individual</td>
</tr>
<tr>
<td>Peer review</td>
<td>10</td>
<td>Individual</td>
</tr>
<tr>
<td>Instructor leverage</td>
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<td>Individual</td>
</tr>
<tr>
<td>3-Ideas review</td>
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<td>Section</td>
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<tr>
<td>Sketch model review</td>
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<td>Section</td>
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<tr>
<td>Mockup review</td>
<td>15</td>
<td>Section</td>
</tr>
<tr>
<td>Assembly model</td>
<td>5</td>
<td>Team</td>
</tr>
<tr>
<td>Technical review</td>
<td>20</td>
<td>Team</td>
</tr>
<tr>
<td>Final presentation</td>
<td>10</td>
<td>Team</td>
</tr>
</tbody>
</table>
Where do I find course information?

Welcome class!

Week 1 in 2.009! **Key 2.009 dates for fall 2018**

This site/home page is updated daily, and is where you can quickly see what needs to happen at any given time.

We don’t use stellar.

For Friday
- obtain your **design notebook**
- read chapters 1&2 in the **course textbook**. If you don’t have the text, you can download chapters 1&2 (**certs** and class registration required)

Of interest: (**archive**)  
- **sketching tutorial**: 5 PM this Friday to help with project brainstorming  
- **secret of success**: **grit**  
- **creativity crisis**

Labs

There are no labs in the first week of class.

**due 5 PM Saturday (8th)!** Signup with your lab time preferences — absolutely, most positively, required by **all students in the class** — we do not use the registrar’s lab sections. Lab assignments will be posted on the website no later than 8 PM Sunday.

Labs start next week (on the 11th)!

**Products from 2017**
- Silver team: **fireSense**
- Red team: **Blink**
- Green team: **tachi**
- Pink team: **Volti**
- Blue team: **Robin**
- Yellow team: **Coordinate**
- Purple team: **Animo**
- Orange: **Rhino**
## Where do I find course information?

### schedule and details

<table>
<thead>
<tr>
<th>Date</th>
<th>Class</th>
<th>Lab</th>
<th>Assigned</th>
<th>Due, or on this day</th>
<th>Due in your lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wed, Sept. 5</td>
<td>2.009 Introduction (.pdf)</td>
<td>No lab this week</td>
<td>Lab section signup (absolutely required: registrar section assignments are not used!)</td>
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<td></td>
<td>Failed prototype test (.mpeg)</td>
<td></td>
<td>Design notebook</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Reading: Read chapters 1 and 2 in textbook (introduction and development processes)</td>
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<tr>
<td>Fri, Sept. 7</td>
<td>Creativity and product theme (.pdf)</td>
<td></td>
<td>Brainstorming</td>
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<td></td>
<td>Creativity strategies cheat-sheet (.pdf)</td>
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<td>Idea fair</td>
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<tr>
<td></td>
<td>Group brainstorming tutorial (.pdf)</td>
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<td>For sketching help see the condensed online sketching tutorial, or the broader set of 2.009 online sketching tutorials.</td>
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<td></td>
<td>Theme reveal video</td>
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</tr>
<tr>
<td>Sat, Sept. 8</td>
<td>Lab section signup (due at 5 PM)</td>
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</table>
2.009 Product engineering processes
preparation for this Friday

lab section registration:
You MUST register online for a lab section before Saturday at 5 PM—see the 2.009 home page
Please help each other not miss this deadline

review: course goals and syllabus
read chapters 1 and 2 in text
buy a design notebook
Friday
the project theme