2.009 Product engineering processes

powered garden cart automatically follows user
Hello!

and welcome to 2.009!

powered garden cart automatically follows user
2.009 Product engineering processes

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
Which object is different from all the others?

Congratulations!
The only one with all straight lines
Which object is different from all the others?

Congratulations!
The only one that is asymmetric
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

+ 30 mentors!

- course instructor
- teaching assistants
- lab instructors
- communication instructors
- technical instructors
- administrative assistant
- media coordinators
- meta yoda
- librarian
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
ty ing 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

C reativity to see many unique viewpoints/framing
C apability to understand/analyze/model/test viewpoints
C reativity *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>
<th>2 instructors</th>
<th>2 instructors</th>
<th>2 instructors</th>
<th>2 instructors</th>
<th>2 instructors</th>
<th>2 instructors</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 students</td>
<td>20 students</td>
<td>20 students</td>
<td>20 students</td>
<td>20 students</td>
<td>20 students</td>
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<tr>
<td>mentors: ~4 design 1 comm.</td>
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</tbody>
</table>

#### discipline-specific mentors

- 2 course librarians
- 4 lab staff

#### class (development process and design methods)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 course instructor</td>
<td>CEO</td>
</tr>
<tr>
<td>course TAs</td>
<td>aides</td>
</tr>
</tbody>
</table>
Product engineering processes
how is the class organized?
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

product definition

physical modeling

design techniques
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**

---

### First order energy feasibility

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>To meet activity constraint of 60 mph</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Activity weight must be less than 10 lbs</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>To meet cost constraint</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>batteries must be lead-acid</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Assume 12.5 mph</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>with user weight of 165 lbs</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>and a counterweight of 2 lbs</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>with energy</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Rolling resistance of 1.5% (including wheels and bearings)</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Wind resistance of 7.5 square feet (frontal area)</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Total</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Minimum drivetrain efficiency allowable: 147%
What will I experience?

concept development

Modeling activities

mockups

market analysis

feasibility analysis
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
What are the milestones?

3-ideas presentation (September 23)

4 minutes for 6 opportunities

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

**sketch model presentation (October 4)**

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

efficient exploration of concepts
What are the milestones?

mockup presentation (October 17)

4 product concepts per team
technical feasibility/operational principles

identify and resolve critical issues
Process check!

Oct. 17! 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 14)**

demonstrate functional alpha prototype
discuss remaining areas for improvement

detailed engineering assessment
What are the milestones?

final public presentation (December 9)

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

a complete package: presentation quality, product design, business case
When 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 7</td>
<td>5 PM</td>
</tr>
<tr>
<td>Project idea fair</td>
<td>Monday, September 9</td>
<td>7-8 PM</td>
</tr>
<tr>
<td>3 ideas presentation</td>
<td>Monday, September 23</td>
<td>during class</td>
</tr>
<tr>
<td>Sketch model review</td>
<td>Thursday, October 3</td>
<td>7-10 PM</td>
</tr>
<tr>
<td>Mockup review</td>
<td>Thursday, October 17</td>
<td>7-10 PM</td>
</tr>
<tr>
<td>Selection of final product idea</td>
<td>Week of October 21</td>
<td>during team lab</td>
</tr>
<tr>
<td>Assembly review</td>
<td>Wed. Oct. 30 and, Fri. Nov. 1</td>
<td>during class</td>
</tr>
<tr>
<td>Technical review</td>
<td>Thursday, November 14</td>
<td>7-10 PM</td>
</tr>
<tr>
<td>Final design review</td>
<td>Monday, November 18</td>
<td>1-5 PM</td>
</tr>
<tr>
<td>Thanksgiving</td>
<td>Thursday, November 28</td>
<td>all day long!</td>
</tr>
<tr>
<td>Final presentation practice session</td>
<td>Friday, December 6</td>
<td>5-9 PM</td>
</tr>
<tr>
<td>Final presentation</td>
<td>Monday, December 9</td>
<td>7:00-10:30 PM</td>
</tr>
<tr>
<td>Instructor grades meeting</td>
<td>Tuesday, December 17</td>
<td>noon</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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</thead>
<tbody>
<tr>
<td>Brainstorming</td>
<td>5</td>
<td>Individual</td>
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<tr>
<td>Design notebook</td>
<td>10</td>
<td>Individual</td>
</tr>
<tr>
<td>Peer review</td>
<td>10</td>
<td>Individual</td>
</tr>
<tr>
<td>Instructor leverage</td>
<td>5</td>
<td>Individual</td>
</tr>
<tr>
<td>3-Ideas review</td>
<td>5</td>
<td>Section</td>
</tr>
<tr>
<td>Sketch model review</td>
<td>15</td>
<td>Section</td>
</tr>
<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?
googleg MIT 2.009 not on stellar!

Hello! Fall 2019
What’s happening this week?
Key milestone dates for the term

We don’t use stellar. This home page is where you can quickly see what needs to happen at any time, on any day, throughout the term. It updates daily. The site content is updated for 2019, but the masthead for this year’s theme won’t post until after the theme reveal.

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, room 3-333
- secret of success: grit
- creativity crisis

Lab information
Labs start during the second week of class! There are no labs in the first week.

Don’t worry about your lab section assignment with the registrar—we assign lab sections (based on your preferences) at the end of the first week of class. You will need to complete the lab signup by Saturday, September 7.

due 5 PM Saturday (the 7th)! Signup with your lab time preferences—absolutely, most positively, definitely required by all students in the class. Lab assignments will be posted on the website no later than 8 PM Sunday. You will need to know your team for lecture on Monday.
# Where do I find course information? schedule and details

<table>
<thead>
<tr>
<th>CLASS/EVENT</th>
<th>ASSIGNED</th>
<th>DUE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SEP 4 Wed</strong></td>
<td>2.009 Introduction&lt;br&gt;Slides&lt;br&gt;Failed prototype test</td>
<td>Lab section signup&lt;br&gt;(absolutely, most definitely required! We do not use registrar section assignments)</td>
</tr>
<tr>
<td><strong>SEP 6 Fri</strong></td>
<td>Creativity and product theme&lt;br&gt;Slides&lt;br&gt;Creativity strategies cheat-sheet&lt;br&gt;Group brainstorming tutorial&lt;br&gt;Theme reveal video</td>
<td>Brainstorming</td>
</tr>
<tr>
<td></td>
<td>Tutorial: Idea Sketching&lt;br&gt;5-6 PM in room 3-333&lt;br&gt;Idea sketching by product designer Roger Zhu. All students welcome. This tutorial will be quite useful for the brainstorming assignment and sketching materials will be provided for participants.</td>
<td>Idea Fair&lt;br&gt;(Monday September 9, 7 PM)</td>
</tr>
<tr>
<td><strong>SEP 7 Sat</strong></td>
<td></td>
<td>Lab section signup&lt;br&gt;due at 5 PM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CLASS/EVENT</th>
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<th>DUE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LAB 1</strong></td>
<td>Electing officers and opportunity ideation&lt;br&gt;Week 1 lab instructions</td>
<td>Brainstorming</td>
</tr>
<tr>
<td><strong>SEP 9 Mon</strong></td>
<td>Teams&lt;br&gt;Slides&lt;br&gt;Team-building challenge roles</td>
<td>3-Ideas presentation&lt;br&gt;Project timesheet</td>
</tr>
</tbody>
</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