From Design to Reality: Guiding First-Year Students from Design to Makerspace Reality

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NYU Tandon School of Engineering
Weekly Course Structure

- 1 Hour Lectures on Disciplines
- 3 Hours Lab Experiments
- 1.5 Hours Recitations
- Semester-Long Design Project
Course Learning Objectives

- Programming
- CAD and 3D printing
- Data analysis
- Testing
- Physical prototype
- Customer interviews
Embedding the MakerSpace in the Design Process

Labs, videos, project
3D Printing & MakerSpace

Lab Activities
• 3D printing & CAD
• Sensors testing
• MakerSpace tour

Project Applications
• Team logos
• Robot/terrain parts
• Prototype component
Flipped Teaching Videos

Training the Engineering Design Process

• CAD for projects
• Intro to 3D printing
• Circuitry & wiring
**MakerSpace Training Timeline**

**Week 1**
- CAD lab
- Project proposal

**Week 2**
- CAD video
- Team assigned

**Week 3**
- 3D printing video
- Sensors lab

**Week 4**
- Makerspace tour
- Prototyping lab orientation

**Week 5**
- Breadboarding video
- Project milestone 1

**Week 7**
- Initial 3D print due
- Project milestone 2

**Week 11**
- Final 3D print due
- Project milestone 3

**Week 14**
- Project submission
- Final presentation
Inspiring Making in the First Year

Global issues, tech trends, and large projects
Maker Movement and IoT
### Great Problems in Engineering

<table>
<thead>
<tr>
<th>National Academy of Engineering</th>
<th>National Science Foundation</th>
<th>United Nations</th>
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</thead>
<tbody>
<tr>
<td>14 Grand Challenges</td>
<td>10 Big Ideas</td>
<td>17 Sustainability Goals</td>
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<tr>
<td>Cyber Security</td>
<td>Harness Data</td>
<td>Clean Energy</td>
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<tr>
<td>Virtual Reality</td>
<td>Quantum Computing</td>
<td>Sustainable Communities</td>
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<td>Urban Infrastructure</td>
<td>Human Computer Interaction</td>
<td>Inclusive Education</td>
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<tr>
<td>Solar Energy</td>
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<td>Water &amp; Food</td>
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- Great Problems in Engineering:
  - Cyber Security
  - Virtual Reality
  - Urban Infrastructure
  - Solar Energy
Integrating Project-Based Curriculum

First Year

EG ENGINEERING

Second & Third Year

VIP Vertically Integrated Projects

Fourth Year

Capstone Design
Open-Ended Problem Solving through Making

Project description, prototyping kit, examples
Rapid Assembly & Design (RAD) Challenge

Task: Prototype technology for real-world problem.

- Application due 1\textsuperscript{st} week
- Feasibility report 3\textsuperscript{rd} week
- 3 milestones on pivots
- Physical prototype

manual.eg.poly.edu/index.php/Rapid_Assembly_and_Design_Challenge_(RAD)
Project Kits
RAD Examples
New Initiatives to Support Making Projects

First-Year lab, workshops, mentors
Workshops

MakerSpace, First-year program, and clubs

1. Soldering
2. Circuitry
3. Arduino
4. PCB milling
5. Woodworking
6. Carbon fiber
Mentors

• 1 mentor per team
• TA in field or interest
• Paired in the 2nd week
• Assist and train
• Track progress
Survey of Student Making Experience
Self-efficacy, product development, comments
Engineering Self-Efficacy

- Better equipped to solve problems when I'm stuck: 16% Strongly Disagree, 37% Disagree, 42% Neutral, 5% Agree, 0% Strongly Agree
- Decreased my motivation to study math, physics and chemistry: 5% Strongly Disagree, 20% Disagree, 15% Neutral, 30% Agree, 0% Strongly Agree
- Increased my motivation for school work: 20% Strongly Disagree, 40% Disagree, 45% Neutral, 0% Agree, 0% Strongly Agree
- Improved my confidence in my ability to succeed in engineering: 20% Strongly Disagree, 40% Disagree, 40% Neutral, 0% Agree, 0% Strongly Agree
- Increased my interest in engineering: 15% Strongly Disagree, 35% Disagree, 50% Neutral, 0% Agree, 0% Strongly Agree
- Intend to practice, conduct research in, or teach engineering: 30% Strongly Disagree, 20% Disagree, 50% Neutral, 0% Agree, 0% Strongly Agree
- Enhanced ability to design a system, component, or process: 0% Strongly Disagree, 35% Disagree, 65% Neutral, 0% Agree, 0% Strongly Agree
- Understanding of contemporary engineering practice: 10% Strongly Disagree, 35% Disagree, 50% Neutral, 0% Agree, 0% Strongly Agree
- Understanding of the design process: 10% Strongly Disagree, 40% Disagree, 45% Neutral, 0% Agree, 0% Strongly Agree
<table>
<thead>
<tr>
<th>Survey Question</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
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</thead>
<tbody>
<tr>
<td>Interested in working on a team to change a product</td>
<td>30%</td>
<td>20%</td>
<td>45%</td>
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<tr>
<td>Interested in creating another product</td>
<td>5%</td>
<td>35%</td>
<td>50%</td>
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<td>Proud of the product I created</td>
<td>25%</td>
<td>25%</td>
<td>40%</td>
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<td>Plan to continue working on the product</td>
<td>25%</td>
<td>5%</td>
<td>30%</td>
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<tr>
<td>Dissatisfied with my project selection</td>
<td>25%</td>
<td>10%</td>
<td>10%</td>
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<tr>
<td>Happy with my team this semester</td>
<td>10%</td>
<td>30%</td>
<td>35%</td>
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<tr>
<td>Struggle</td>
<td>Enjoyed</td>
<td>Improve</td>
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<td>choosing an idea</td>
<td>freedom to create</td>
<td>more mentors</td>
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<td>feasible timeline</td>
<td>understand which field</td>
<td>labs that are more related</td>
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<td>learning the coding</td>
<td>creating a physical prototype</td>
<td>programming tutorial</td>
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<td>learning CAD</td>
<td>safety net of a mentor</td>
<td>more support on CAD</td>
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<td>unreliable teammate</td>
<td>solidified my interest</td>
<td>an application process</td>
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If you are interested in creating an open-ended Making project...

Conclusions, recommendations, warnings
Recommendations

• Start small (5% of your class size)
• Application review
• No digital prototype
• Strict requirements and deadlines
• Contest requested budget
• Multifaceted training
• Grow slowly
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