Achieving Gender Diversity in Engineering

AAC&U Pre-Conference Workshop

Dean Joseph J. Helble, PhD
Professor Vicki V. May, PhD, PE

November 2, 2017
Agenda

12-12:15pm: **Self-Introductions and Goals**

12:15-12:30pm: Overview of **engineering at Dartmouth/Thayer**

12:30-1:00pm: **Data** from Thayer faculty, alumni, students, and courses

1:00-1:15pm: Insights from **other engineering programs** that are close to achieving gender parity

1:15-1:30pm: **Research and literature** related to gender diversity

1:30-1:45pm: **Break**

1:45-2:30pm: **Develop and share plans** for increasing gender diversity on our campuses

2:30-2:45pm: Discuss **points of resistance** to change and approaches to overcoming these challenges

2:45-3:00pm: **Wrap up** and steps moving forward
Self-Introductions

What is your name and where are you from?
How diverse is your student body?
What is unique about your campus or student body?
What do you hope to gain from this workshop?
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Engineering at Dartmouth

• unique integration of ENGINEERING + LIBERAL ARTS:
  • “LIBERAL ENGINEERING” – only one to require AB before BE
  • how can you harness technology to address the world’s problems – if you don’t first understand the world?

• one of LARGEST MAJORS ON CAMPUS

• EXPERIENTIAL LEARNING: model of INTERDISCIPLINARY PROJECT BASED DESIGN – open to ALL (ie, not just engineers!)

• diverse students, national leader in reaching GENDER PARITY

• focus on ENTREPRENEURSHIP (1/3 faculty); recognized by NAE in 2014 with largest educational prize in the country for INNOVATION IN ENGINEERING EDUCATION
# Engineering Sciences Curriculum

<table>
<thead>
<tr>
<th>Bachelor of Arts (35 Courses)</th>
<th>Liberal Arts Courses: Writing, First-year Seminar, Foreign Language, Humanities, Social Science, World Culture</th>
<th>10-14 courses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Math and Science Pre-Requisites: MATH3, 8 and 13; PHSY13 and 14; CHEM5; ENGS20 (or COSC1 and 10)</td>
<td>7-8 courses</td>
</tr>
<tr>
<td></td>
<td>Common Core Courses: ENGS21, ENGS22, and ENGS23</td>
<td>3 courses</td>
</tr>
<tr>
<td></td>
<td>Distributive Core Courses: ENGS 24, 25, 26, or 27</td>
<td>2 courses</td>
</tr>
<tr>
<td></td>
<td>Gateway Courses: ENGS30, 31, 32, 33, 34, 35, 36, or 37</td>
<td>2 courses</td>
</tr>
<tr>
<td></td>
<td>STEM Electives: math, science, or engineering electives</td>
<td>2 courses</td>
</tr>
<tr>
<td></td>
<td>Culminating Experience (ENGS)</td>
<td>1 course</td>
</tr>
<tr>
<td></td>
<td>Free Electives</td>
<td>3-8 courses</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bachelor of Engineering</th>
<th>Capstone Course: ENGS89 and 90</th>
<th>2 courses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Engineering Concentration</td>
<td>3 courses</td>
</tr>
<tr>
<td></td>
<td>Engineering Electives</td>
<td>4 courses</td>
</tr>
</tbody>
</table>
## Faculty at Thayer

<table>
<thead>
<tr>
<th></th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tenure-Track Faculty</strong></td>
<td>5 (2 tenured) [13%]</td>
<td>33 (+1 Dean)</td>
</tr>
<tr>
<td><strong>Instructional Faculty</strong></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Research Faculty</strong></td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>10 [19%]</td>
<td>44</td>
</tr>
</tbody>
</table>
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Data from Thayer faculty, alumni, students and courses

- What courses are women taking?
- What attracts women to engineering and Thayer?
- How do alumni, students, and faculty characterize Thayer?
- Do faculty and staff have an impact on students?
- What do faculty, students and alumni see as the main factors affecting gender diversity at Thayer?
Students Graduating with an AB by Gender and Year

Female students as a % of total

Male students as a % of total

Overview Statistics

- The number of students who graduate as engineers is approximately the same as the number who expressed interest in engineering when initially enrolling.
- The number of students who take ENGS21 and ENGS22 is considerably larger than the number who expressed interesting in engineering before enrollment and the number who major (or minor) in engineering science.
- The number of students in ENGS23 correlates reasonably well with the number of students who graduate in engineering sciences.
- Once enrolled in the engineering program, our female and male students in general are equally comfortable. There are differences, however, in what subjects they emphasize. Some classical disciplines, such as electrical engineering, are considerably less attractive to women.
- On average, our female students have slightly higher grades than the male students.
- Once our students have declared engineering sciences as their major, only a very few drop out, whether male or female.

From: “Supporting Female Students in Thayer School of Engineering” by Elsa Garmire, Sydney E. Junkins Professor
Students in Non-Major Courses by Gender (2015-2016)
Students in Non-Major Courses by Gender (2010-2016)
Students in Gateway Courses (2015-2016)
Students in Gateway Courses (2010-2016)
National Data (ASEE Profiles)
Teaching Assistants by Term and Gender (Overall)
Teaching Assistants by Term and Gender (ENGS21)

- Fall 2017: Male 30%, Female 70%
- Spring 2017: Male 35%, Female 65%
- Winter 2017: Male 25%, Female 75%
- Fall 2016: Male 40%, Female 60%
- Spring 2016: Male 35%, Female 65%
- Winter 2016: Male 40%, Female 60%
Goal: determine what factors faculty, students and alumni think are most important in helping Thayer to diversify.

The surveys were adapted from one developed by the Assessing Women in Engineering (AWE) Program (https://www.engr.psu.edu/awe/).

Copies of the surveys are in your folders.

<table>
<thead>
<tr>
<th></th>
<th>Faculty</th>
<th>Alumni*</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Responses</td>
<td>29</td>
<td>95</td>
<td>60</td>
</tr>
<tr>
<td>Female Responses</td>
<td>7</td>
<td>51</td>
<td>30</td>
</tr>
<tr>
<td>Male Responses</td>
<td>22</td>
<td>44</td>
<td>30</td>
</tr>
</tbody>
</table>

*e-mailed to 908 alums from last 5 years
Faculty Wordle
https://worditout.com/word-cloud/create
creative  projects  design-focused  pragmatic  diverse  entrepreneurial  collaborative  late-nights
Student & Alumni

Wordle
https://worditout.com/word-cloud/create
List 3 Words to Characterize Thayer

<table>
<thead>
<tr>
<th>Word</th>
<th>Alumni frequency</th>
<th>Student frequency</th>
<th>Faculty frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>collaborative</td>
<td>16.3%</td>
<td>10.7%</td>
<td>14.1%</td>
</tr>
<tr>
<td>creative/innovative</td>
<td>9.1%</td>
<td>6.7%</td>
<td>10.9%</td>
</tr>
<tr>
<td>hands-on</td>
<td>9.1%</td>
<td>9.4%</td>
<td>4.7%</td>
</tr>
<tr>
<td>project-based</td>
<td>6.4%</td>
<td>4.0%</td>
<td>14.1%</td>
</tr>
<tr>
<td>challenging/rigorous</td>
<td>6.1%</td>
<td>15.4%</td>
<td>1.6%</td>
</tr>
<tr>
<td>fun</td>
<td>3.4%</td>
<td>6.0%</td>
<td>0%</td>
</tr>
<tr>
<td>design-focused</td>
<td>3.0%</td>
<td>1.3%</td>
<td>6.3%</td>
</tr>
<tr>
<td>interdisciplinary</td>
<td>3.0%</td>
<td>1.3%</td>
<td>18.8%</td>
</tr>
</tbody>
</table>
male boys dominated
high-potential arts mostly under white
New Challenging math
donated
Traditional structured Confusing appreciated
text small hard liberal growing
Faculty and Staff Impact

- Faculty: Female (6%)
- Faculty: Male (24%)
- Staff: Male (10%)
- Staff: Female (6%)
Factors that Influenced Engineering Interest at Thayer (rating of >3 out of 4 for female students)

- Atmosphere
- Caring Faculty and Staff
- Creativity
- Project-based
- Interdisciplinary
- Liberal Arts
- Teaching Quality
- Societal Problems
- Collaborate
- Role Models
- Peer Interactions

Legend:
- Green: Female Students
- Blue: Male Students
Participant Survey Results
Reasons cited by Female Students and Alums for Initial Interest in Engineering at Thayer

- Like to solve problems
- Good at math and science
- Like to design and be creative
- Want a well-paying job when I graduate
- Attracted by the challenge
- Want to address societal problems
- Took a Thayer course that I enjoyed

Female   Male
Comments from female students and alumni

I kept meeting really cool upperclassmen who were engineers.

ENGS 21 was a huge reason why I chose to major in engineering! I had had no other experience with engineering beforehand.

Thayer's flexible liberal arts degree was the #1 reason I became an engineering major.

As an undergrad, I majored in both Engineering and Math. In many ways, my experience studying in the two departments was very similar: both departments offered opportunities for research, in-class projects, creative and analytical thought, and real world problem solving. That said, I never felt nearly as comfortable in the Math department as I did at Thayer.

Don't discount the positive effect of the TA problem sessions (both attending and becoming a TA later in school).

Having everyone from the secretary to the janitor encouraging you makes more of a difference than you might think.

I can’t say enough good things about Thayer’s flexible, interdisciplinary focus and the unique worldview it provides students, and I would guess that this strength is a key reason the Thayer student body is so diverse.

Hands-on projects, machine shop, and team experiences were key for me. Its scary when the all the guys in your class already know what a rear differential is from working on cars/models, etc... but the early and often project approach got me caught up fast.

Advising is HUGELY important and influential in studying engineering... but I got very little of it.
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Percentage of Bachelor Degrees Awarded to Women (published by ASEE in June of 2016)

<table>
<thead>
<tr>
<th>Institution</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Franklin W. Olin College of Engineering</td>
<td>46.2%</td>
</tr>
<tr>
<td>Massachusetts Institute of Technology</td>
<td>44.8%</td>
</tr>
<tr>
<td>Dartmouth College</td>
<td>44.0%</td>
</tr>
<tr>
<td>Harvey Mudd College</td>
<td>41.7%</td>
</tr>
<tr>
<td>George Washington University</td>
<td>40.1%</td>
</tr>
<tr>
<td>Cornell University</td>
<td>39.9%</td>
</tr>
<tr>
<td>Southern Methodist University</td>
<td>39.3%</td>
</tr>
<tr>
<td>Tulane University</td>
<td>38.9%</td>
</tr>
<tr>
<td>Howard University</td>
<td>37.7%</td>
</tr>
<tr>
<td>Columbia University</td>
<td>37.3%</td>
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Observations from “Top 20” (%F) Deans*

- Collegial collaborative culture
- Particular choice of majors on their campuses (emphasis ChemE, BME, ENVE)
- Women in “leadership roles” (primarily citing faculty)
- Publicly recognizing and celebrating success
- Focus on the individual (Howard: “wholistic advising”)
- SWE frequently cited (note: not clear that this is cause, v. outcome)
- Many admit to engineering (selection advantage?); others stress flexibility

* Brown  Bucknell  CMU  Columbia  Harvard  Howard  Princeton  Tulane  Vanderbilt  Yale
What is working at Thayer (and beyond)?
What may be adapted at other campuses?

- Project-based
- Resources
- Attracting
- Community
- Mentoring
- Multiple entry points
- Curriculum
- Environment
What is working at Thayer? What we think...

- **Community/Atmosphere**: project and work spaces
- **Supportive Faculty, Staff, and Peers**: undergraduate teaching assistants, evening problem sessions, small campus
- **Liberal Engineering**: Interdisciplinary, project-based curriculum that goes beyond the technical details
- **Multiple Entry Points**: Courses for non-majors, human-centered design minor, time to explore majors
- **ENGS21**: An NSF Study (Craemer, 2007) named ENGS21 as a pivotal course
Community/Atmosphere: Couch Project Lab, Great Hall, Atrium, Machine Shop
Supportive Faculty, Staff, and Peers: Undergraduate TAs and Problem Sessions
Liberal Engineering: Interdisciplinary, project-based curriculum that goes beyond technical details
Multiple Entry Points: Courses for non-majors, human-centered design minor, time to explore majors
77.4% of the teams (since 1987) who have won the Jackson Prize were mixed gender teams.
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Key Studies


Dartmouth Studies


Related Studies


Recent Articles


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## Gender Diversity Action Plan

<table>
<thead>
<tr>
<th>Action Steps</th>
<th>Responsibilities</th>
<th>Resources</th>
<th>Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What needs to be done?</strong></td>
<td>Who will be responsible for each step?</td>
<td>What resources are available and what resources are needed?</td>
<td>By When?</td>
</tr>
</tbody>
</table>

**Evaluation:** How will progress be monitored?
- ENTRY POINTS
- EXPLORATORY COURSES (*staffing & silos could be difficult)
- HOLISTIC APPROACH
- MENTORING - working w/ students
- ADVISING THE WHOLE STUDENT (disconnect b/w advisors & advisory groups)
- FEEDBACK FROM STUDENTS
- PLACE UNDECIDED STUDENTS IN ENG. (*have it count)
- CHANGING THE CONVERSATION - sell the discipline
  - discussion group
  - human-focused
  - entry ps.
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Points of Resistance

Where do you expect points of resistance or challenges?

• **List** points of resistance to your action plan (lack of resources, lack of support, etc.)
• **Share** points of resistance
• **Discuss** ways to address the points of resistance
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Steps Moving Forward

Voluntary check-in via email?

Resource and Idea Sharing?

NAE Grand Challenges Scholars Program

Preparing a Generation to Tackle the Grand Challenges

http://www.engineeringchallenges.org/GrandChallengeScholarsProgram.aspx
"To prepare the most capable and faithful for the most responsible positions and the most difficult service."

— Sylvanus Thayer, Founder
<table>
<thead>
<tr>
<th>Year</th>
<th>Started in Math 1 or 3</th>
<th>Female</th>
<th>Male</th>
<th>ENGS1-19 as first engineering course</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td>16%</td>
<td>27%</td>
<td>9%</td>
</tr>
<tr>
<td>2017</td>
<td></td>
<td>16%</td>
<td>15%</td>
<td>9%</td>
</tr>
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</table>