

# *The Educational Imperatives of the Engineering Grand Challenges*

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*President*



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***KEYNOTE ADDRESS***

**KEEPING ENGINEERING EDUCATION RELEVANT IN THE NEW GLOBAL ECONOMY  
ASEE GLOBAL COLLOQUIUM ON ENGINEERING EDUCATION**

SINGAPORE

OCTOBER 19-21, 2010



# NAE Grand Challenges for the 21<sup>st</sup> Century

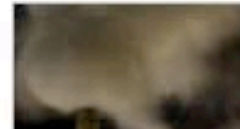
## Sustainability, Health, Security, Joy of Living



Make solar energy economical



Provide energy from fusion



Develop carbon sequestration methods



Manage nitrogen



Advance information



Prevent terror



Advance personalized learning



Engineer the tools of scientific discovery

Advancing the Grand Challenges of the National Academy of Engineering

Engineering Empowering Society

- HOME
- WEBCAST
- BLOG
- BACKGROUND
- OVERVIEW
- SCHEDULE
- SPEAKERS
- STUDENTS
- SPONSORS
- PRESS
- RELATED LINKS
- REGISTRATION
- LOCATION

The 2010 NAE Grand Challenges National Summit will bring together leading scientists and engineers, educators, policy leaders, innovators and corporate executives to address the **14 challenges** articulated by the **National Academy of Engineering**. The discussions will be organized around the four thematic threads of the challenges, namely sustainability, vulnerability, health and the joy of living, which represent key societal issues of the 21st Century.

**Los Angeles on October 6-8, 2010**

The Second National Academy of Engineering Grand Challenges Summit took place on the campus of the University of Southern California. Six sessions focusing on the Grand Challenges were presented from the following perspectives:

- TECHNOLOGY
- INNOVATION
- BUSINESS
- POLICY
- COMMUNICATION
- EDUCATION

...and a notable cast of panelists advanced the dialogue about addressing society's most critical needs.

Summit Moderator:  
Miles O'Brien

Broadcast Veteran and CNN's Former Science and Technology Correspondent

Enhance virtual reality

Conference Dates

October 6, 2010  
Student Day

October 7-8, 2010  
2010 NAE Grand Challenges National Summit

[Click here for schedule information](#)

Who Attended

- Policymakers
- Corporate leaders
- Engineers and Scientists
- Innovators and Entrepreneurs
- Students

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PRESENTING SPONSOR:

National Summit Organizers

Endorsed by

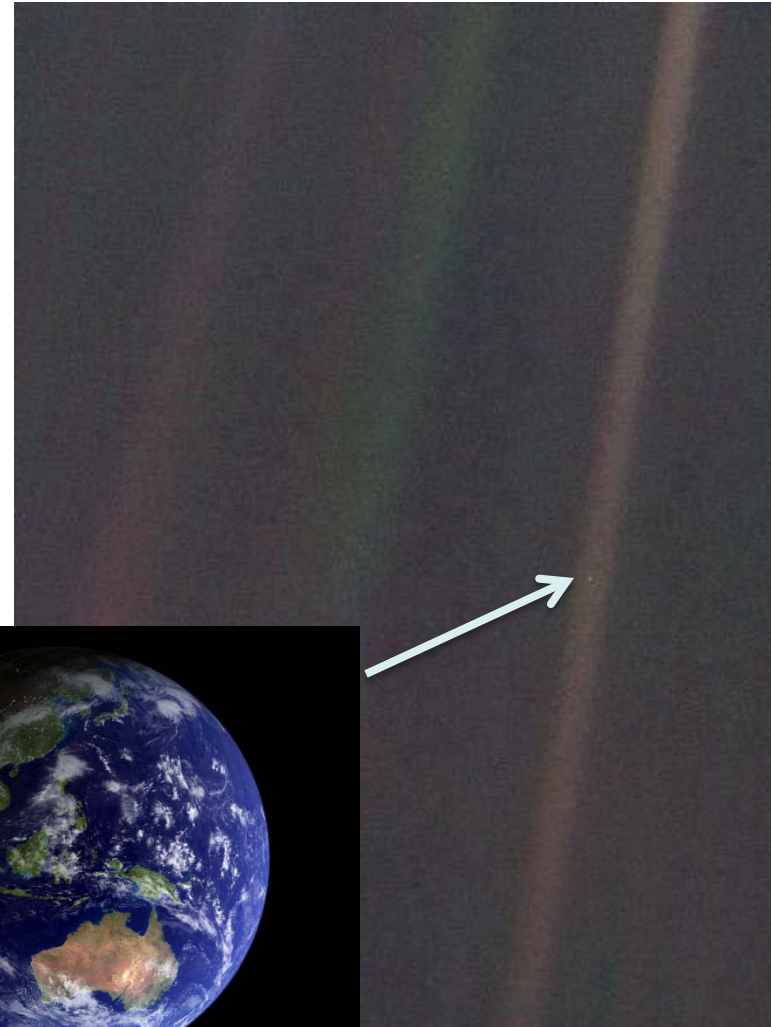
Restore and improve urban infrastructure

Reverse-engineer the brain

Enhance virtual reality

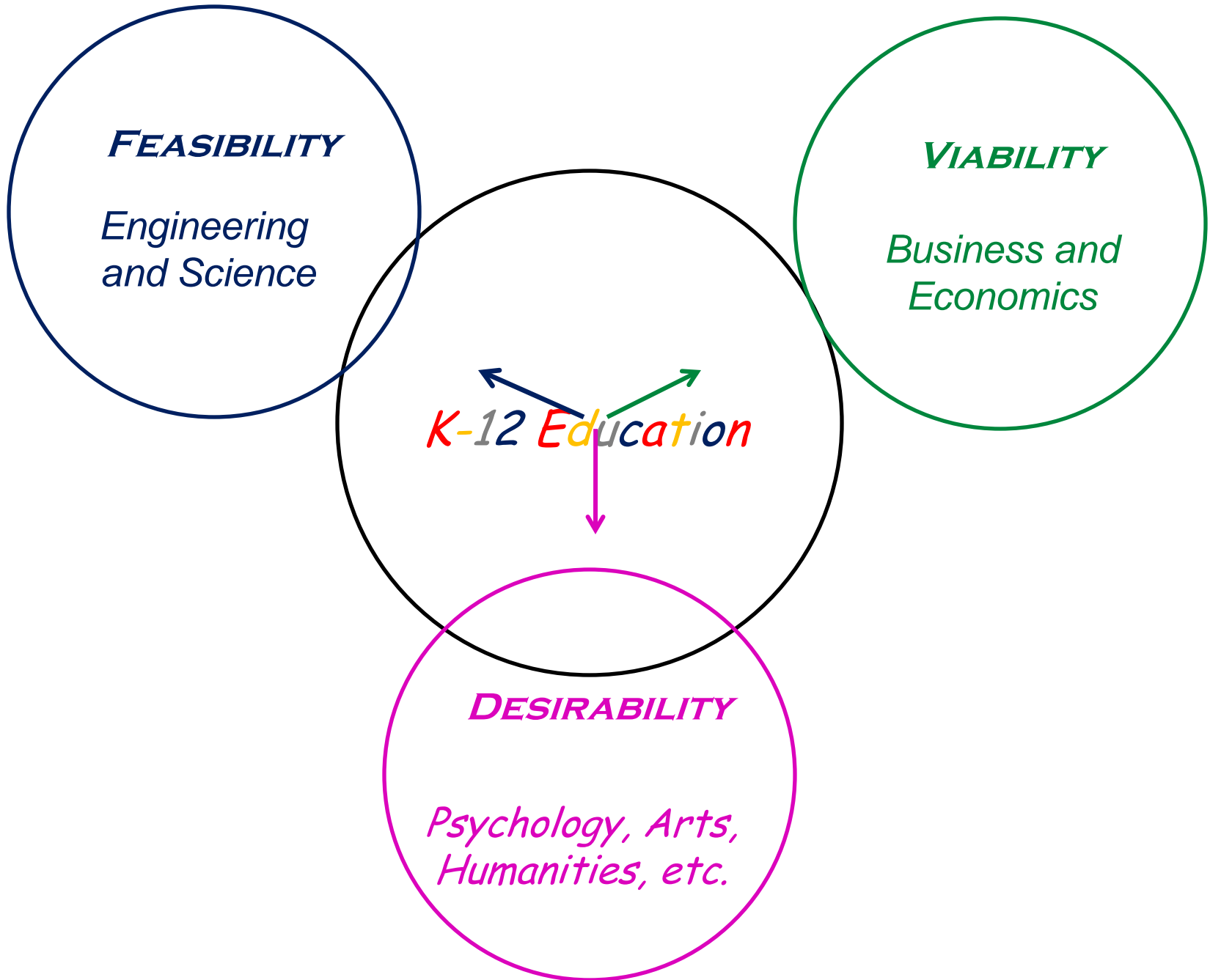
# *The Pale Blue Dot*

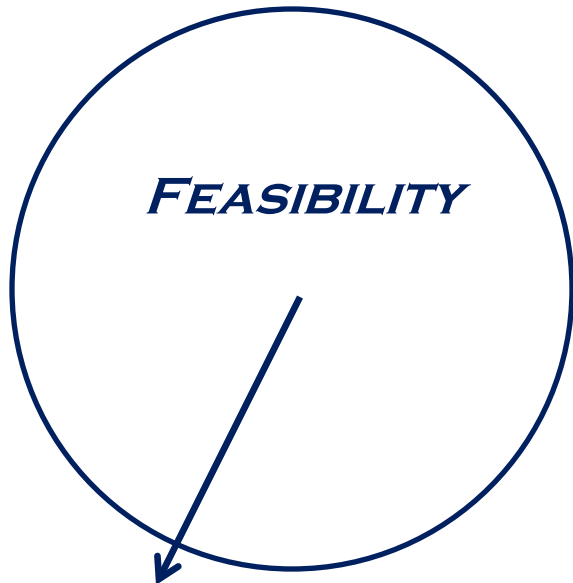
- *NASA, 1990 - Voyager 1*
- *3.8 billion miles (41 AU)*
- *Carl Sagan - address at  
Cornell University, Oct 13, 1994*



# *Educating Engineers Beyond Technology: The Need for Liberal Education for Engineers*

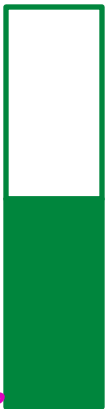
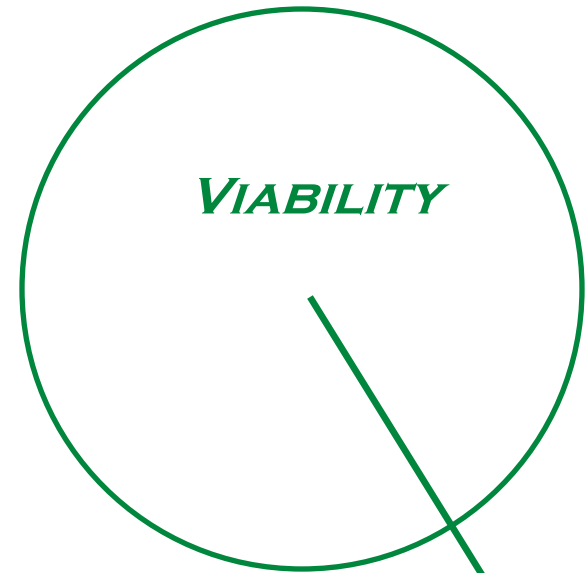
- *Minimizing Unintended Consequences*
- *Systems Architects of Complex Systems with  
Technical, Economic, Political, Social, even Religious  
Dimensions*
- *Conceiving, Creating, and Managing the Technologies of the  
Grand Challenges*
- *Engineering Innovators Who Make a Positive Difference  
in the World*





*All other subjects*

*Feasibility*

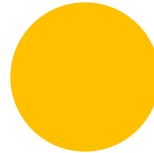


*All other subjects*

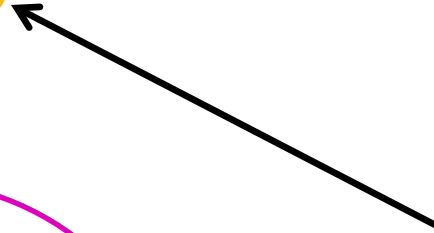
*Viability*



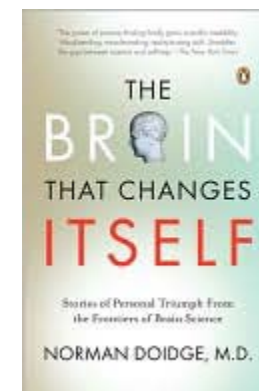
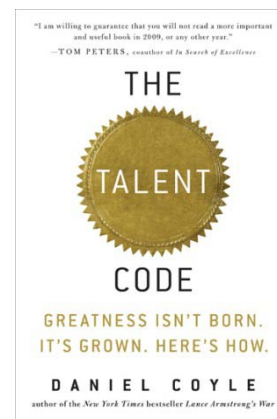
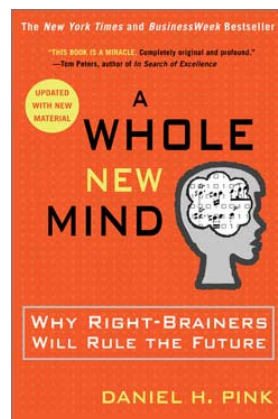
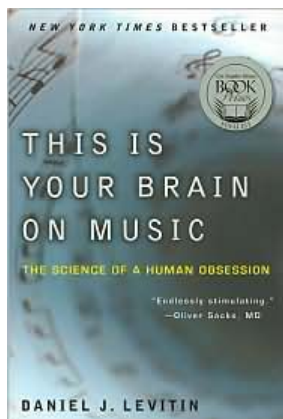
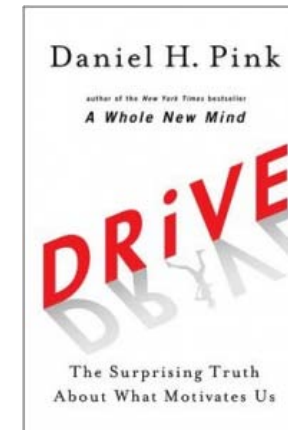
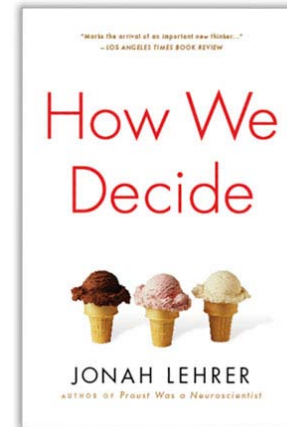
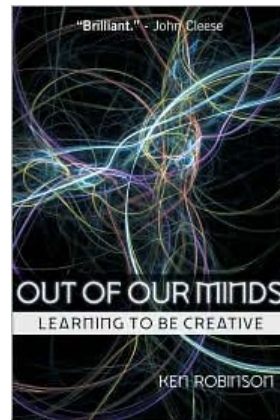
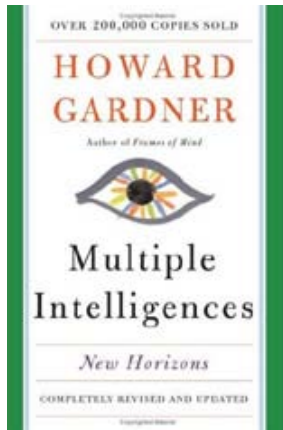
*Negligible  
Feasibility  
Or Viability  
Required*



*INNOVATION*



# Creativity & Cognition



**YOUTUBE:  
Sir Ken Robinson  
(TED 2006)**

# Multiple Intelligences: Howard Gardner, Frames of Mind (1983)

- All people have at least 7 "intelligences"

- Linguistic
- Logical/mathematical

*Academic Intelligence (IQ, SAT, etc.)*

- Spatial
- Bodily-kinesthetic
- Musical

*Artistic Intelligence*

- Interpersonal
- Intrapersonal

*Persuasion, Management*



## *What We Teach vs. What They Need to Know*

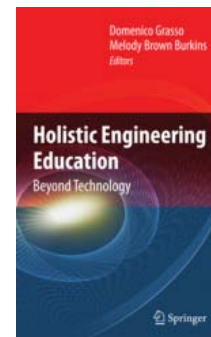
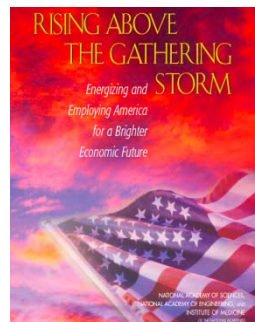
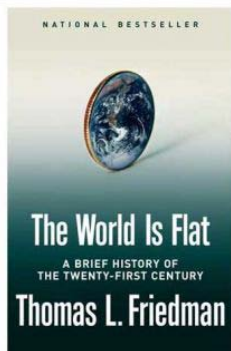
- *Engineering alumni report that engineering science is not as useful in their careers as design, communication, teamwork, and entrepreneurial thinking* (Kristen Wolfe, “Understanding the Careers of the Alumni of the MIT Mechanical Engineering Department,” SB Thesis, June, 2004, MIT (supervised by Prof. Warren Seering)).
- *Prof. Woodie Flowers, “Man Who Waits for Roast Duck to Fly Into Mouth Must Wait a Very Long Time,” Engineer of the Future 2.0, Olin College, April 1, 2009.*

*YouTube: Prof. Woodie Flowers on Education Reform*

# The Need for Change in Engineering Education

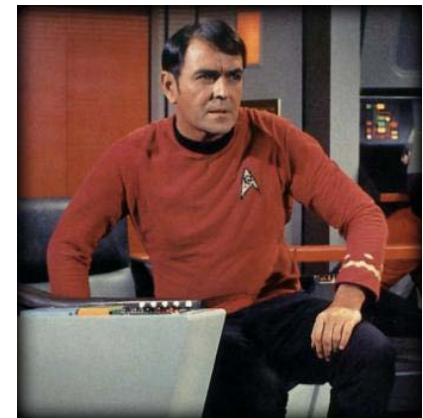
- Thomas L. Friedman, *The World is Flat: A Brief History of the Twenty-first Century*
- Council on Competitiveness, *National Innovation Initiative*
- National Academy of Engineering, *Rising Above the Gathering Storm*
- National Academy of Engineering, *Educating the Engineer of 2020*
- D. Grasso, M. Brown-Burkins, *Holistic Engineering Education: Beyond Technology* (Springer, 2010)

→ • *Teamwork, communication, creativity, leadership, entrepreneurial thinking, ethical reasoning, global contextual analysis*



# What Is An Engineer?

- *Applied Scientist*
- *noun: “a person who carries through an enterprise by skillful or artful contrivance,” (Merriam-Webster Dictionary)*
- *Designer/Architect of a System, Process, or Device*
- *Project/Team Leader*
- *“To Engineer is to Make” (D. Chapman-Walsh)*
- *“An Engineer is a person who envisions what has never been, and does whatever it takes to make it happen”*



*“Scotty”*

# Olin College Overview

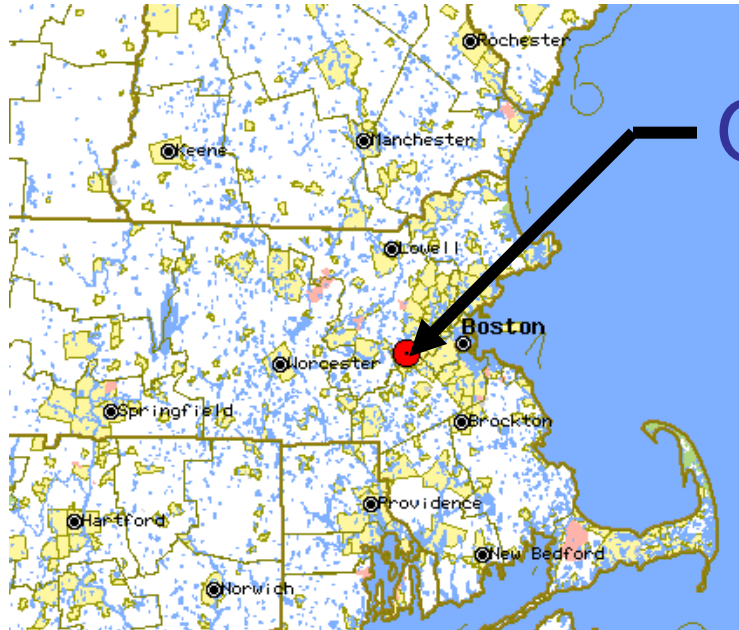
- Undergraduate residential engineering education
- Total enrollment of about 350
- Nearly 50% women
- BS degrees in ECE, ME, Engr only
- 9-to-1 student/faculty ratio
- Founded in 1997, first graduates in 2006
- 75 acres and 400,000+ sq. ft. new buildings
- Endowment > \$1 million/student
- Research expenditures ~ \$1 million/yr
- Adjacent to Babson College, Wellesley College
- **No academic departments**
- **No tenure**
- **Low tuition**
- **Continuous improvement**



# *Olin College Campus Needham, MA*

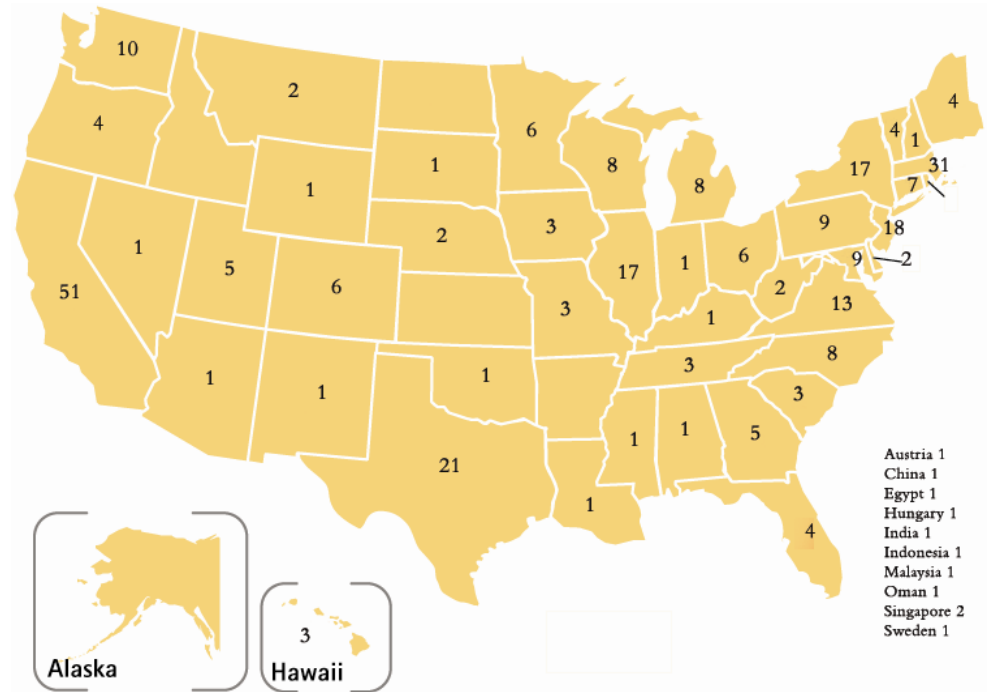


# Olin College Overview



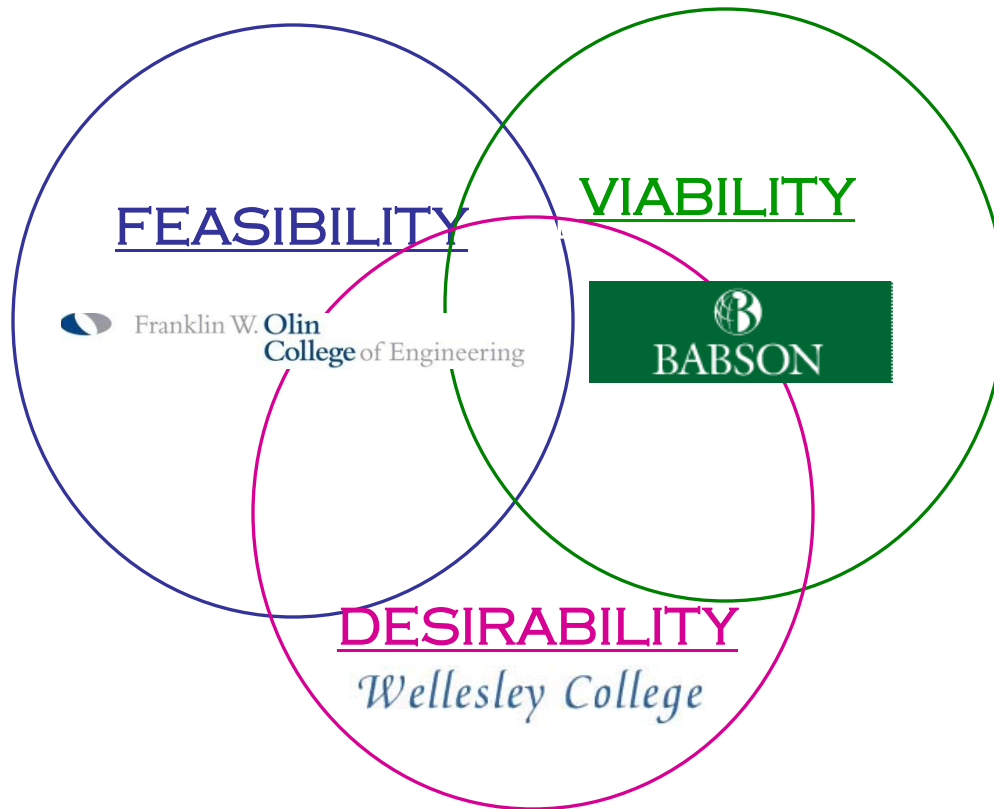
Olin College

## Where Do Olin Students Come From?



- Austria 1
- China 1
- Egypt 1
- Hungary 1
- India 1
- Indonesia 1
- Malaysia 1
- Oman 1
- Singapore 2
- Sweden 1

# Blurring Boundaries



# Some Features of the Olin Curriculum

- **Candidates' Weekend:** interviews required for admission
- **Extensive DESIGN** core required
- Multiple Team design projects required in 6+ semesters
- **SCOPE** senior project: corporate sponsored, year-long (\$50k/project)
- **EXPO** at end of each semester: "stand and deliver"
- **Olin Self Study** self-directed independent research required for graduation
- **AHS/E! Capstone** project required for graduation
- Study Away in Junior year
- Summer internships: REU and corporate experience
- Business and entrepreneurship:
  - all students must start and run a business** for a semester
- **Nine competencies** across all four years: *quantitative analysis, qualitative analysis, teamwork, communication, life-long learning, context, design, diagnosis, opportunity assessment*
- Continuous improvement: **expiration date on curriculum every 7 years**
- **BUT, the learning culture is far more important than the curriculum!**

# Reflections

*Overall, Greatly Exceeded Our Expectations*

## Positives

- *very successful alumni*
- *intense student engagement*
- *increased motivation and autonomy*
- *strong leadership potential*
- *entrepreneurial "disease"*
- *very high levels of teamwork*
- *faculty commitment to lead change in education*
- *students ability to "stand and deliver," manage projects, and work with ill-structured problems*
- *strong engagement with Wellesley and Babson Colleges*

## Negatives

- *possible diminished student interest in purely theoretical subjects*
- *alumni preference for small start-up companies*
- *growing resistance to change(!)*
- *concerns about balance: design vs. advanced theory, qualitative vs. quantitative design, etc.*
- *assessment challenges: metrics?*
- *scalability?*

# Student Engagement and Learning Outcomes

- *Educational research shows that the more students are enthusiastic and personally engaged in their studies, the more they learn, and the more they want to continue learning. (G. Kuh, E. Pascarella, A. Astin, etc.)*
- *National Survey of Student Engagement (Indiana University)*
  - *About 700 universities and 500,000 students in the US*
  - *Five major areas:*
    - 1. Level of Academic Challenge*
    - 2. Active and Collaborative Learning*
    - 3. Student-Faculty Interaction*
    - 4. Enriching Educational Experiences*
    - 5. Supportive Campus Environment*

**→ *Results for Olin College exceed 90%-ile level in 9 of 10 metrics***

# First year Student Engagement (NSSE 2009)

