



Grand Challenges and the Grand Challenges Scholars Program A Global Vision for 21st Century Engineering:

Engineering a Better World for All Humanity

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A CENTURY OF INNOVATION

- 1. Electrification
- 2. Automobile
- 3. Airplane
- 4. Clean water
- 5. Electronics
- 6. Radio and television
- 7. Mechanized Agriculture
- 8. Computers
- 9. Telephone
- 10. Refrigeration and A/C
- 11. Highways
- 12. Spacecraft
- 13. Internet
- 14. Imaging
- 15. Household Appliances

- 16. Health technologies
- 17. Petroleum & technologies
- 18. Laser and fiber optics
- 19. Nuclear technologies
- 20. High performance materials





21st Century Engineering Challenges



Make Solar Energy Economical



Provide Energy From Fusion



Develop Carbon Sequestration Methods



Manage the Nitrogen Cycle



Provide Access to Clean Water



Restore and Improve Urban Infrastructure



Advance Healthcare Informatics



Engineer Better Medicines



Reverse Engineer the Brain



Prevent Nuclear Terror



Secure Cyberspace



Enhance Virtual Reality



Advance Personalized Learning



Engineer the Tools of Scientific Discovery



21st Century Engineering Challenges

Sustainability

Provide access to clean water; Make solar energy economical; Provide energy from fusion; Develop carbon sequestration methods; Manage the nitrogen cycle

Security

Secure cyberspace; Prevent nuclear terror; Restore and improve urban infrastructure

Health

Engineer better medicines; Advance health informatics; Reverse engineer the brain

Enhancing Life

Advance personalized learning; Enhance virtual reality; Engineer the tools of scientific discovery

CONTEXT:

Rethinking Engineering Education for the 21st Century

What does it mean to be educated?

What does it mean to be an engineer?

Olin College of Engineering - \$460 million – 1997 starting over – from the ground up "Olin College is intended to be different, not for the mere sake of being different, but in order to become an important and constant contributor to the advancement of engineering education in America and throughout the world,..." FOUNDING PRECEPTS, OLIN COLLEGE

→ Olin College is intended to become an education laboratory.

"An engineer is a person who envisions what has never been and does whatever it takes to make it happen—to make a better world"

Olin College produces "Engineering Stem Cells!"



The Role of Olin College



No Tenure, No Academic Departments, \$100k Merit Scholarships for all, Everything has an Expiration Date



Since 2010, visited by more than 2,500 visitors from 800+ universities and 50+ countries





What you Know

What you can Do

What you Conceive

Why education must change

World Population Growth Through History





Global, Complex, Multidisciplinary Challenges

- Security, Sustainability, Health, Enhancing Life
- Unintended Consequences, systems thinking
- Coupled Scientific-Social-Economic-Political-Religious
- Need New Kind of Education for Innovators

Our traditional approach to higher education may be actually preventing us from producing innovators!



21st century Innovators require more than specialized knowledge!

Attitude:

More often than not, your attitude^{*} determines your altitude in life

*not your aptitude



Importance of Mindset! Attitudes, Behaviors, and Motivations:

- Entrepreneurial Mindset
- Ethical Behavior
- Teamwork, Leadership
- Global perspective
- Interdisciplinary thinking
- Creativity and design
- Empathy, social responsibility
- Employability skills



Educate to Innovate

Compete.

Competitiveness



Capacity, Capability, Competitiveness



Importance of Mindset! Attitudes, Behaviors, and Motivations:

- Collaborative Mindset
- Entrepreneurial Mindset
- Interdisciplinary Mindset
- Global Mindset
- Ethical Mindset



Educate to Innovate





Capacity, Capability, Competitiveness



It's NOT just about content knowledge anymore!

Mindset – can be defined, measured, and taught!





Angela Duckworth, U. Penn 2013 MacArthur Prize





NAE Grand Challenge Scholars Program



- Conceived in 2009 Duke U, Olin College, USC
- Adopted by more than 75 universities globally
- Now a signature program of the NAE

Cultivates

Consistent with WEF report on added skills for the 21st century: Creativity, Leadership, Perseverance Research Provide the Engineer of 2020

- Interdisciplinary/ Collaborative
- Entrepreneurial
- Ethical/Compassionate
- Global/Cultural



NAE Grand Challenge Scholars Program

- Prepares talent to solve the Grand Challenges
- Each university determines how, and whether its students achieve these competencies
- The NAE Network Office as a Convening Power









Mindsets of Growth To here From here Knowledge **Skills**

From Ortiz et al





Evolution of GCSP Graduates







NAE Convening Role for the GCSP

Strategy Group: creates organizational solutions (such as the Global Grand Challenges Summits)

Talent Group: creates and grows the workforce

Prepares the talent to solve the problems



Global Grand Challenge Summits



2013 – London, UK

2015 – Beijing, China



2017 – Washington, DC

2019 – London, UK



Sponsors

The Boeing Company Charitable Trust

BOEING



Summits Support the Initiative Approach to Meeting the Grand Challenges Objectives







NAE Grand Challenge Scholars Program

In 2015, 120+ US Deans of Engineering (~ 1/3 U.S. deans) committed to graduating more than 20,000 Grand Challenge Scholars over the next decade.

Today: 75 GCSP Programs active (63 US, 12 int'l) 12 GCSP Programs under review (10 US, 2 int'l) 97 Programs exploring (58 US, 39 int'l)





Points to Remember:

Grand Challenges Define Engineering Today

- The Grand Challenges are Mega-engineering Problems
- They contribute to the public understanding of engineering because they answer:
 - What is engineering?
 - How does engineering serve people and society?
- They are changing the conversation about engineering





Points to Remember: Creating a Global Movement Grand Challenges

- Provide Local Solutions to Global Problems
- Engage national academies and organizations
- Led to Grand Challenges Scholars Program
- Students inspired by the Grand Challenges
- Attract Under-represented Groups (0ver 50% GCSP students (US) are female or minority)

They are changing the conversation about engineering





Harnessing the Power of Emerging Technology to Secure the Future of Humanity

Achieving Humanity's Goals through the Solution of Grand Challenges and the Cultivation of Engineering Talent with New Aptitudes GCSP *"Making universities and engineering schools exciting, creative, adventurous, rigorous, demanding, and empowering milieus is more important than specifying curricular details,"*

DR. CHARLES VEST, FORMER PRESIDENT OF MIT AND OF THE US NATIONAL ACADEMY OF ENGINEERING.