The Grand Challenges for Engineering & The Grand Challenges Scholars Program

- Preparing Students for the 21st Century

GCSP Workshop/Meeting
Bangalore, India
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National Academy of Engineering
Ensuring Engineering Talent

Programs

Honorific Membership

Members represent the highest level engineering achievement in the nation and the world.

Elected NAE members volunteer as advisors.
Grand Challenges for Engineering: A Growing Global Movement

Two primary activities:

A Partnership between China, UK and USA
The Globally Interconnected 21st Century

HIGH NOON
20 GLOBAL PROBLEMS 20 YEARS TO SOLVE THEM
J.F. Rischard
Basic Books
New York, 2002

The World Is Flat
A BRIEF HISTORY OF THE TWENTY-FIRST CENTURY
Thomas L. Friedman
NY Times columnist on Globalization, 2004
Attributes of the Engineer of 2020

- Strong analytical skills
- Practical ingenuity
- Creativity
- Communication competencies (oral, written, and cultural)
- Business, management, and leadership skills
- High ethical standards and professionalism
- Agility, resilience, flexibility
20th Century’s Greatest Engineering Achievements
20th Century’s Greatest Engineering Achievements

1. Electrification
2. Automobile
3. Airplane
4. Water supply and distribution
5. Electronics
6. Radio and television
7. Agricultural mechanization
8. Computers
9. Telephone
10. Air conditioning/refrigeration
11. Interstate highways
12. Space flight
13. Internet
14. Imaging
15. Household appliances
16. Health technologies
17. Petrochemical technology
18. Laser and fiber optics
19. Nuclear technologies
20. High-performance materials

http://www.greatachievements.org/
What will engineering achieve in the 21st century?

Almost impossible to predict, but perhaps we can try a different question...

What is a vision for what engineering needs to achieve in the 21st century?

A vision may have promise... but to do what?
Start with the **Why** and then only the **What** and the **How**
INSPIRE

CHALLENGE

EDUCATE

An Inspiring Definition of Engineering

Courtesy of NAE President C. Dan Mote

Engineers Create Solutions for the Welfare of Humanity and the Needs of Society
Vision: Continuation of **life** on the **planet**, making our world more **sustainable**, **safe**, **healthy**, and **joyful**

Goals: Grand Challenges for Engineering

Objectives: 1. R & D Effort - Advance the Frontiers  
2. Talent Building – Inspire the Next Generation
**Sustainability**
- Energy
- Environment
- Global Warming

**Security**
- Reducing Vulnerability to Human and Natural Threats

**Health**
- Improve Medicine and Healthcare Delivery

**Joy of Living**
- Expand and Enhance Human Capability
Goals: 14 Grand Challenges for Engineering

1. Make solar energy economical
2. Provide energy from fusion
3. Develop carbon sequestration methods
4. Manage the nitrogen cycle
5. Provide access to clean water
6. Restore and improve urban infrastructure
7. Advance health informatics
8. Engineer better medicines
9. Reverse-engineer the brain
10. Prevent nuclear terror
11. Secure cyberspace
12. Enhance virtual reality
13. Advance personalized learning
14. Engineer the tools of scientific discovery
Challenges and Opportunities

“In a crisis, be aware of the danger--but recognize the opportunity.

Rise up to challenges of the times and turn trials into accomplishments”
Vision: Continuation of life on the planet, making our world more sustainable, safe, healthy and joyful.

Goals: Grand Challenges for Engineering

Objective 2: Grand Challenges Scholars Program: Prepare students around the world to address problems like GC.
Impedance Mismatch

Engineering Schools

Inertia
Bureaucratic
Disconnected

Industry and Graduate Schools

Global/Multicultural
Entrepreneurial
Multidisciplinary
NAE Grand Challenges Scholars Program

5 Competencies

• **Research/Creativity**: Mentored research or project experience to enhance technical competence
• **Multidisciplinarity**: Understanding of the multidisciplinary character of implementable solutions
• **Business/Entrepreneurship**: Understanding that viable business models are necessary for successful implementation
• **Global/Multicultural**: Understanding that serious consideration of cultural issues is mandatory for all viable solutions
• **Social consciousness**: Motivation to address societal problems, often gained through service learning, because serving people and the planet is the vision served by the Grand Challenges
The 5 key “competencies” of GCSP program are:

- **Research/Creativity**: Depth
- **Multidisciplinarity**: Breadth
- **Business/Entrepreneurship**: Viability
- **Global/Multicultural**: Planetary Vision
- **Social consciousness**: Desirability

*Engineering*+
The GCSP is a combined curricular, co-curricular, and extracurricular program with five competencies especially designed to prepare the next generation of students to address major challenges facing society in this century.

Each participating institution creates its own specific realization of how the competencies are implemented. Outcomes-based and Flexible --- NOT Prescriptive!
21st Century engineers need to recognize that solutions must be Feasible, Viable, Desirable

- Feasible → Engineering fundamentals
- Viable → Economics and business knowledge
- Desirable → Context of culture and social policy
SHAPING HIGH SCHOOL STUDENTS

STATE STANDARDIZED TESTS

EVERYONE NEEDS TO FIT IN!!

WE WANT YOU TO BE WELL-ROUNDED

College Tests
Diversity of GCSP Institutions and Approaches

Olin College – small private college focusing on undergraduate education

Duke University – A Private Comprehensive Research University

Massachusetts Institute of Technology – Science and Engineering Research Intensive Private University

University of Southern California – A Private Comprehensive Research University

Georgia Tech – A Research Intensive Tech focused Public University

Arizona State University – Largest Public University and comprehensive Research University

Miami University – An undergraduate focused Liberal Arts Public University

Peking University – The “Harvard” of China – Research Intensive Liberal Arts Education
IMPRINT, conceived in 2014, is the first of its kind MHRD-supported initiative to address the major science and engineering challenges that India must address and champion to enable, empower and embolden the nation for inclusive growth and self-reliance.

IMPRINT has a twofold mandate that is focused on:

(a) Developing new engineering education policy
(b) Creating a road map to pursue engineering challenges
Ten Technology Domains/Themes of IMPRINT

- Healthcare
- Information and Communication Technology
- Energy
- Sustainable habitat
- Nano-Technology Hardware
- Water Resources and River Systems
- Advanced Materials
- Manufacturing
- Security and Defense
- Environment and Climate

IMPRINT is the Indian blueprint of the GRAND CHALLENGES of USA

IT Kings in the USA help them build "IT" and "US"
Synergy between UN Sustainable Development Goals, IMPRINT, India And Global Grand Challenges for Engineering

Creating the 21st Century Engineering Talent

GCSP model is Extremely Effective and Valuable as a mechanism for Creating the Workforce Addressing these needs
Vision Mandates Global Solutions

- Captures needs of People and the Planet
- Local flavors of Solutions depend on Societal considerations
- Students are inspired by the Grand Challenges
- Employers everywhere are looking for GCSP-type students

“We” are all in this together

Need for Global Partnership
The Role of the NAE

- Champion of the Vision
- Convener of the Stakeholders
- Community Influencer/Builder
- Change Agent

_to Catalyze a Global Movement_
Significance of a Community and a Consortium

GCSP Ecosystem Metaphor

A Distributed Network of Diverse, Flexible and Individualistic University Nodes, who will lead the charge in their own unique ways, but are in a Symbiotic Relationship that Adapt and Evolve Over time.
The Mantra....

The World at Home and At Home in the World
I Blink Therefore I am.
I Think Therefore I am.
I Link Therefore We are.

- Bindiganavale Ramakrishna
Thank You!!