The Engineer of 2020 Project

A high-risk, high-pay-off approach for the future of U.S. engineering education

-National Academy of Engineering-

Dr. Wayne Clough

President, Georgia Institute of Technology

The American Society for Engineering Education

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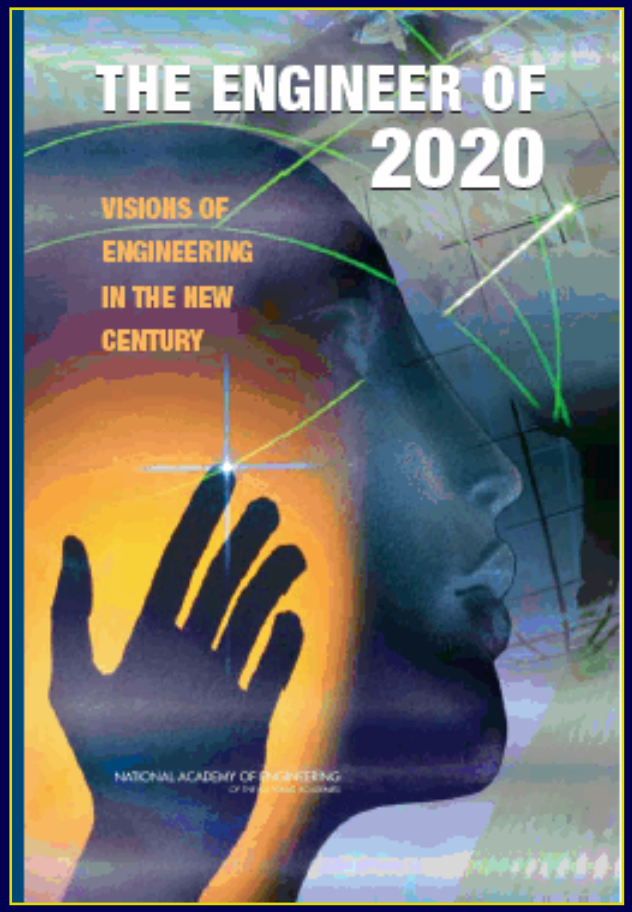
The premise

- Past: Engineering and engineering education were reactive, responding to change.
- Today: Rapid change signals that it is time to reverse the paradigm.
- Premise: If we anticipate the future and are proactive about changing engineering and engineering education, we can shape a significant, dynamic role for our profession.

The process

- Phase I: Imagining the future and the challenges it will present to engineering: Woods Hole Workshop.
- Phase II: Considering how engineering education should prepare for that future: Washington DC Summit.



National Academy of Engineering

Steering Committees

Phase I

- Wayne Clough, Chair, Ga Tech
- Alice Agogino, UC Berkeley
- George Campbell, Cooper Union
- James Chavez, Sandia Labs
- David Craig, Reliant Energy
- Jose Cruz, Ohio State
- Peggy Girshman, NPR
- Daniel Hastings, MIT
- Michael Heller, UC San Diego
- Deborah Johnson, U Virginia
- Alan Kay, H-P
- Tarek Khalil, U Miami
- Robert Lucky, Telcordia Technologies
- John Mulvey, Princeton
- Sharon Nunes, IBM
- Sue Rosser, Georgia Tech
- Ernest Smerdon, U Arizona

Phase II

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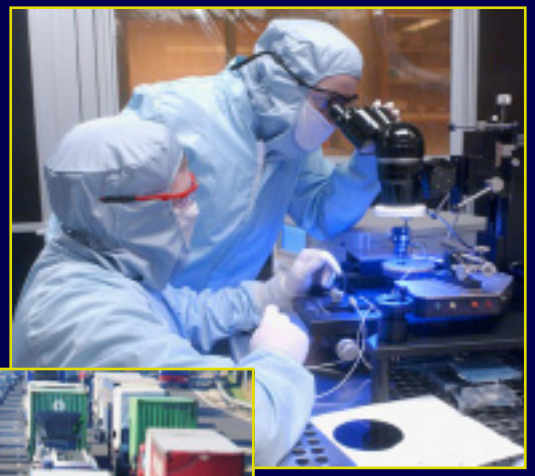
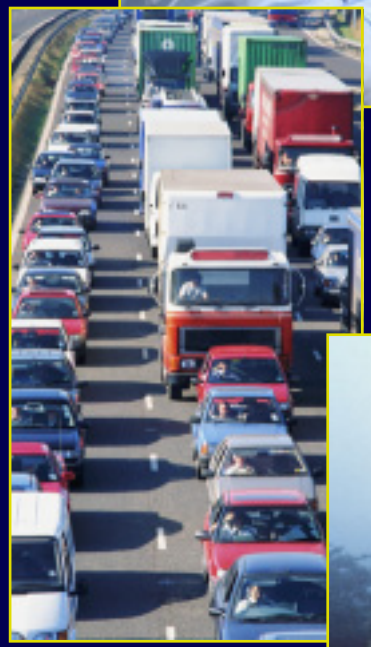
- Mark Dean, IBM
- Deborah Grubbe, DuPont
- Randy Hinrichs, Microsoft
- Sherra Kerns, Olin College
- Alfred Moye, H-P
- Diana Natalicio, UT at El Paso
- Siman Ostrach, Case West Res
- Ernest Smerdon, U Arizona
- Karan Watson, Texas A&M
- David Wisler, GE Aircraft Engines

Context for engineering





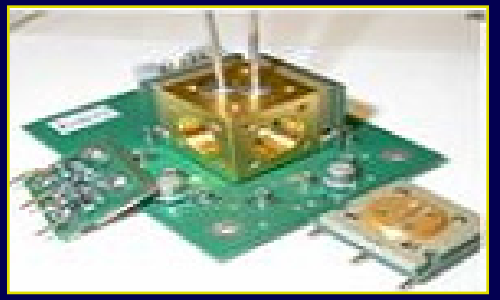
- Breakthroughs in technology
- Demographics
- Challenges
- Economic/societal forces

Breakthroughs

Sustainable Technology

Nanotechnology

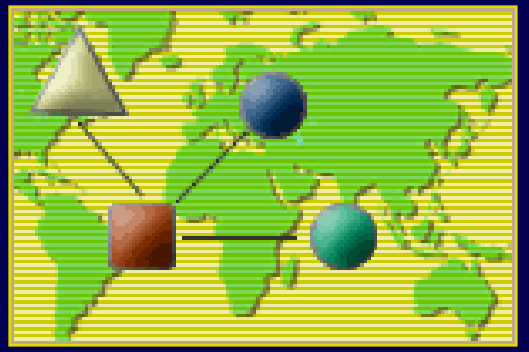
Biotechnology/
nanomedicine



Microelectronics/
telecommunications

Photonics/optics

Manufacturing



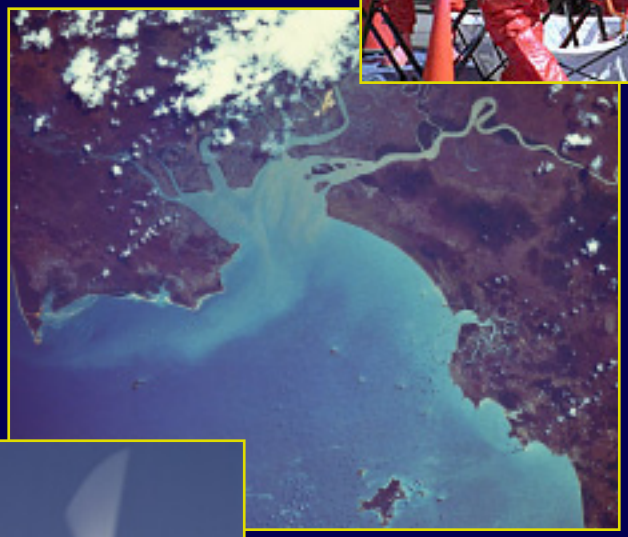
Logistics

Demographics

- 8 billion people; a 25% increase since 2000.
- Balance tipped toward urbanization.
- Youth “bulge” in underdeveloped nations while developed nations age.
- If the world condensed to 100 people:
  - 56 in Asia
  - 16 in Africa
  - 7 in Eastern Europe/Russia
  - 4 in the United States

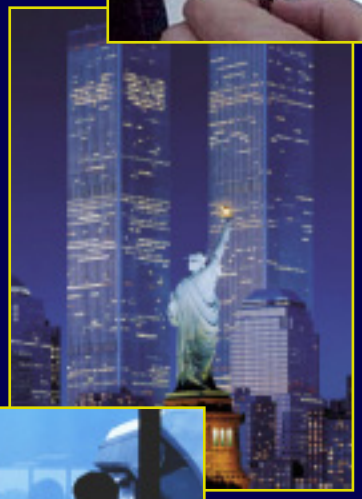
Challenges

- Fresh water shortages
- Aging infrastructure
- Energy demands
- Global warming
- New diseases
- Security



Economic/societal forces

- High speed communications / Internet
- Removal of trade barriers
- Terrorist attacks; wars in Iraq, Afghanistan
- Emergence of technology-based economies in other nations
- Sustained investment in higher education in countries like China, India

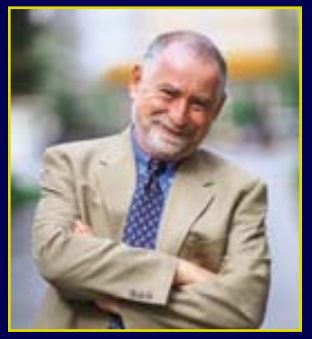


Social, global and professional context of engineering practice

- Population is more diverse.
- Social, cultural, political forces will shape and affect the success of technological innovation.
- Consumers will demand higher quality, customization.
- Growing imperative for environmental sustainability.
- Increasing focus on managing risk and assessment with view to security, privacy, and safety.

Scenario-based planning

- Facilitated by Peter Schwartz, author of “The Art of the Long View”
- Scenarios considered:
  - The Next Scientific Revolution
  - The Biotechnology Revolution in a Societal Context
  - The Natural World Interrupts the Technology
  - Global Conflict/Globalization



Aspirations for the Engineer of 2020

Engineering's image

- Public that understands and appreciates the impact of engineering on socio-cultural systems.
- Public that recognizes engineering's ability to address the world's complex and changing challenges.
- Engineers will be well grounded in the humanities, social sciences, and economics as well as science and mathematics.

Aspirations for the Engineer of 2020

Engineering without boundaries

- Embrace potentialities offered by creativity, innovation, and cross-disciplinary fertilization.
- Broaden influence on public policy and the administration of government, nonprofits, and industry.
- Recruit, nurture and welcome underrepresented groups to engineering.

Aspirations for the Engineer of 2020

Engineering a sustainable society

- Lead the way toward wise, informed, economical, and sustainable development.
- Assist in the creating of an ethical balance in standard of living for developing and developed countries alike.

Educating the engineer of 2020

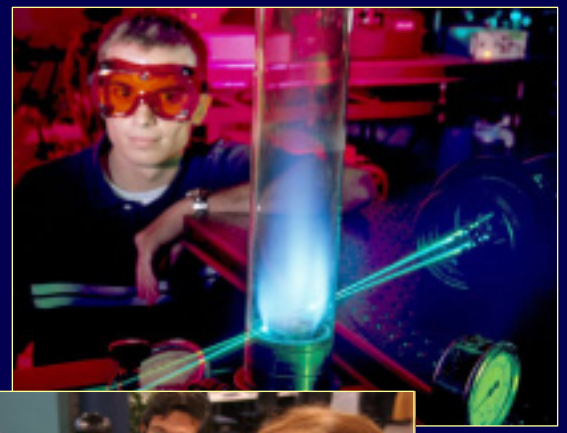
- Reconstitute engineering curricula and related educational programs to prepare today's engineering students for the careers of the future.
- Create a well-rounded education that prepares students for positions of leadership and a creative and productive life.

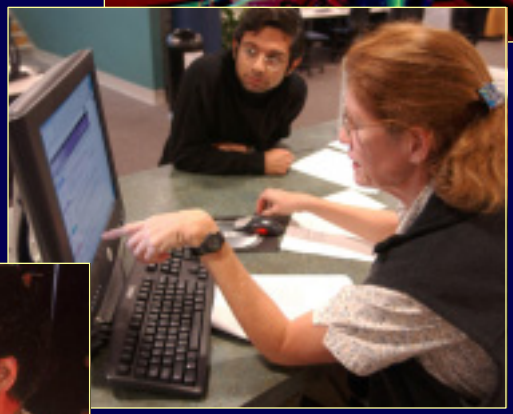
Attributes of the engineer of 2020

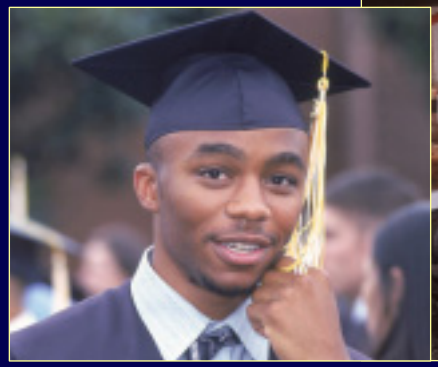
- Strong analytical skills
- Practical ingenuity, creativity; innovator
- Good communication skills
- Business, management skills
- High ethical standards, professionalism
- Dynamic/agile/resilient/flexible
- Lifelong learner
- Able to put problems in their socio-technical and operational context
- Adaptive leader

To succeed

- Attract best and brightest with a forward-looking educational experience – Phase II
- Educate them to be ready:
  - To implement new technology
  - To focus on innovation
  - To understand global trends







Thoughts from the Phase II summit

- Some needs have not changed:
  - A sound grounding in science
  - The learning experience of great lectures
  - Studio experiences with open-ended problem solving
- Other things have really changed:
  - Access to IT creates challenge of coupling deep learning with instant gratification
  - Means and ends of using computers to bring the world to campus and enrich learning
  - Design tools and sophisticated instruments that enable students to experience the excitement of engineering

Charles Vest

Thoughts from the Phase II summit

- Begin the curriculum with “grand challenges”
- Integrate more directly with the sciences
- Provide multiple entry points to the curriculum
- Build working interdisciplinary partnerships
- Give students self-confidence early on
- Stop tinkering around the edges and shake things up

Gretchen Kalonji

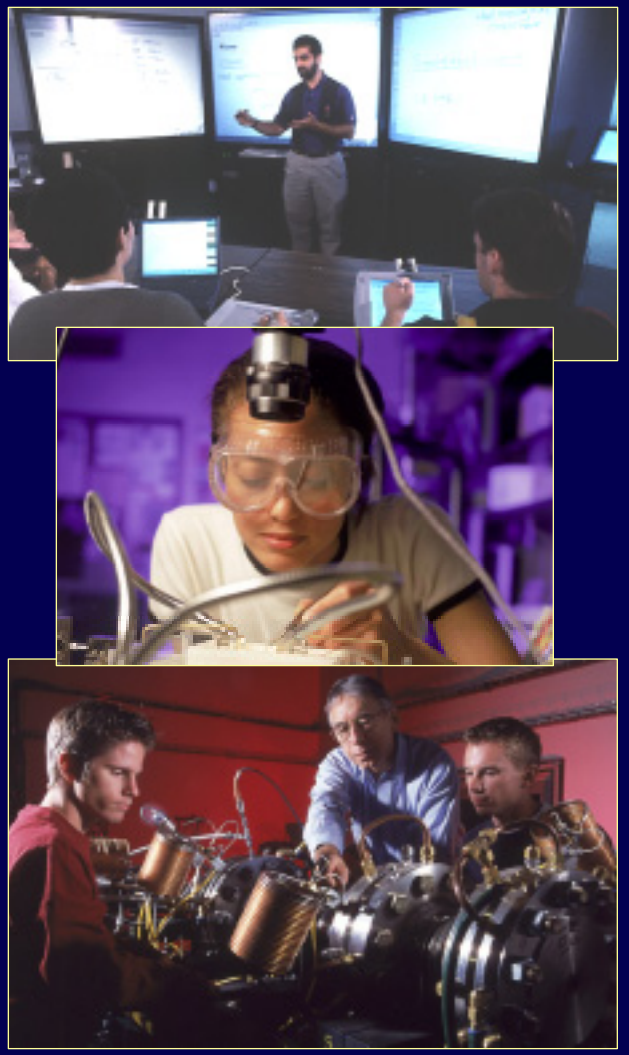
Thoughts from the Phase II summit

- Research/co-op experience with real problems
- Experience with real-world tools and teams
- Encourage and recognize diversity
- Social, ethical aspects of engineering
- What students learn instead of what we want to teach
- Creative and practical thinking

Arden Bement

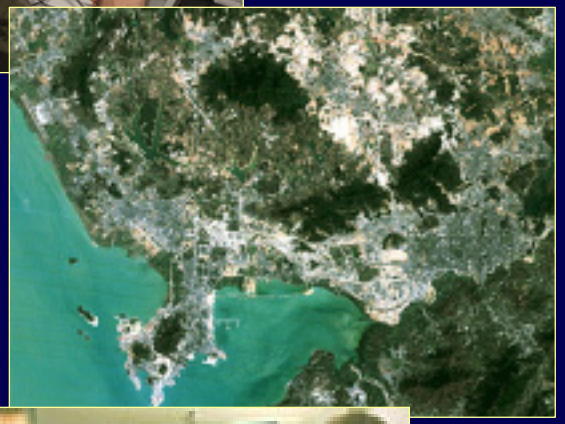
Highlights from Phase II summit

- Break out of the present mold
- Education, not just curriculum
- Career, not just jobs
- Multiple models, not just one
- Leadership, not just teamwork
- More coordination with industry
- Cross-disciplinary emphasis



More highlights from Phase II summit

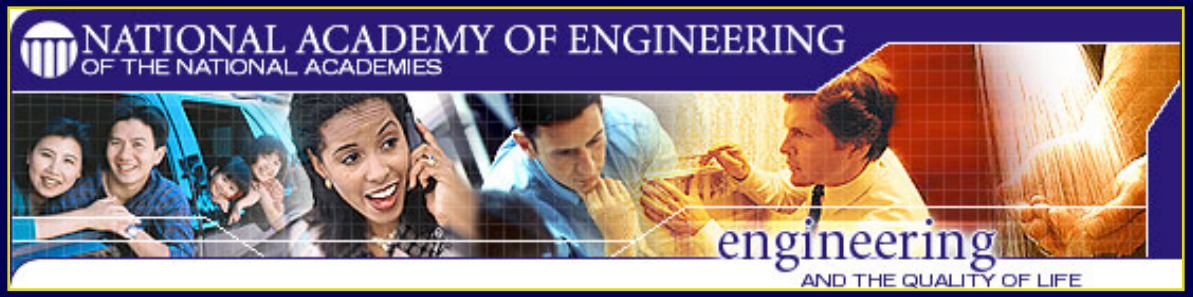
- Emphasis on innovation
- Systems approach
- Larger context for engineering and technology
- Non-engineering career tracks
- Global perspective
- Market forces, macroeconomics
- Sense of urgency



Related Initiatives

Council on Competitiveness

National Innovation Initiative



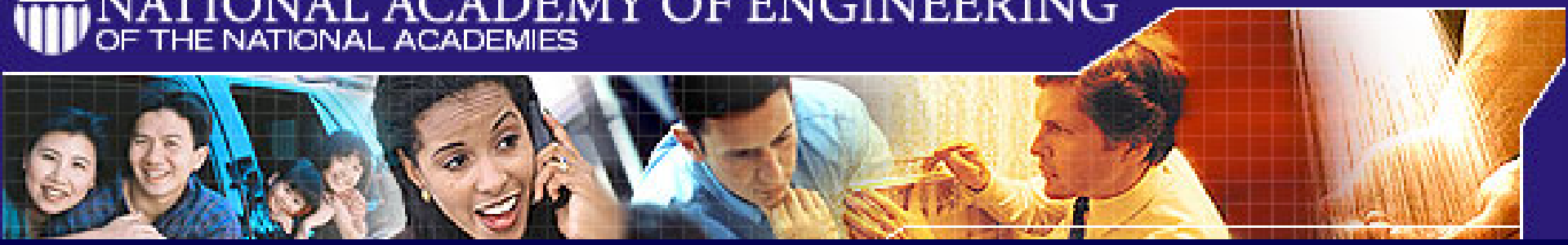
Frontiers of Engineering Survey

Council on Competitiveness

National Innovation Initiative

- Brought together 400 of the nation's best minds to develop a national innovation agenda.
- National summit, December 2004.
- 30 recommendations in 3 broad areas:
  - Talent, the human dimension of innovation.
  - Investment, the financial dimension of innovation.
  - Infrastructure, the enabling framework of innovation.
- Now proceeding with implementation phase.
- Excellent context for new economic and global realities (www.compete.org).

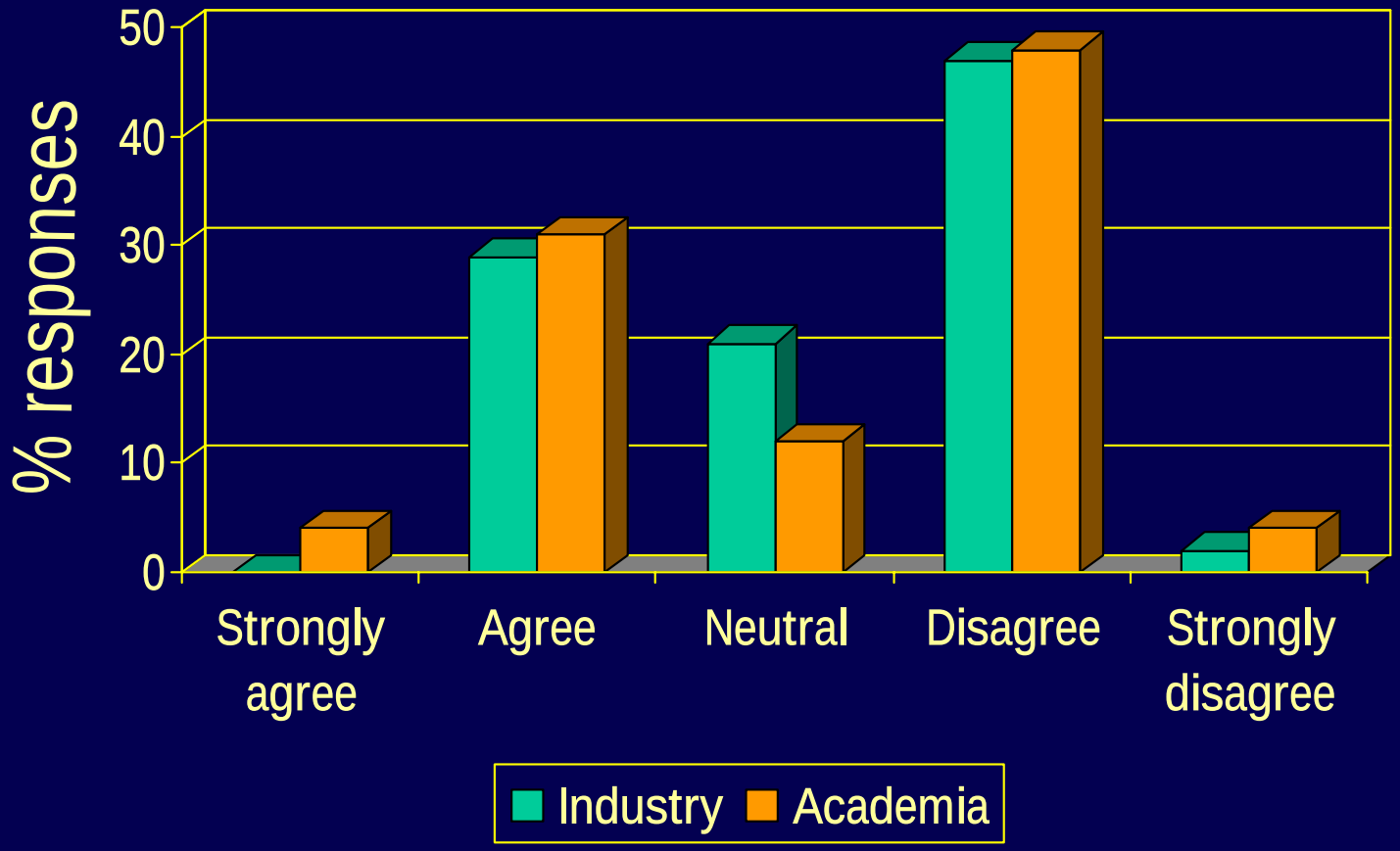
NATIONAL ACADEMY OF ENGINEERING
OF THE NATIONAL ACADEMIES



Frontiers of Engineering survey

- Frontiers of Engineering participants:
  - Selected as future leaders in engineering.
  - Ages 30-45 (will still be active in 2020).
  - 61 respondents from academia, 44 from industry.
  - Have worked in field for over 10 years.
  - Involved in cutting-edge engineering topics.
- Intent: assess how well their education prepared them for issues they will face in practice in 2020.

Current undergraduate engineering education is sufficiently flexible to adequately meet the needs of 21st century engineers.



Concluding remarks

- We may have only one chance to achieve our aspirations; that time may be now.
- The momentum generated by the Engineer of 2020 Project should be used to advantage.
- Strategically engage those outside of engineering who are needed to help in our cause.
- Success is tied to innovation and marketing.
- Think as engineer/scientist, not “specialty name here” engineer.
- The future of engineering in the U.S. lies in the balance; engineering education needs to lead the charge to a time of new energy and opportunity.