

The National Academy of Engineering's

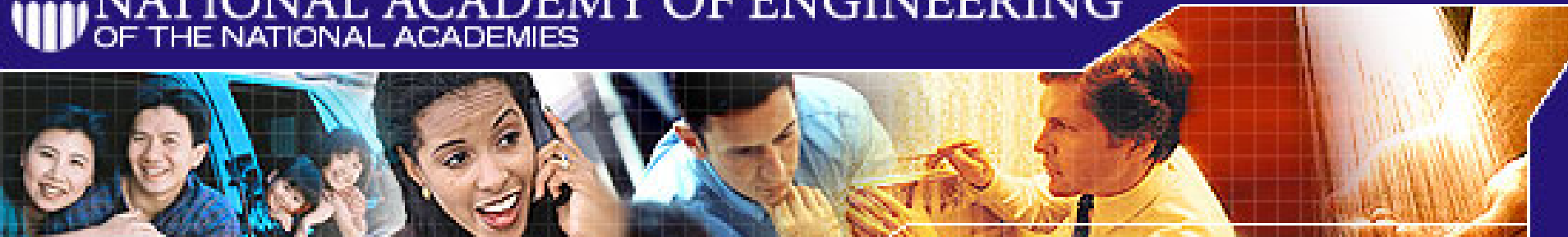
# Engineer of 2020

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

Dr. G. Wayne Clough

President, Georgia Institute of Technology

September 21, 2006

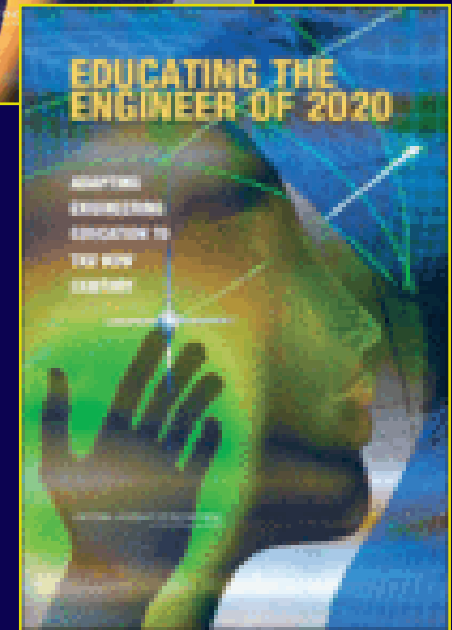
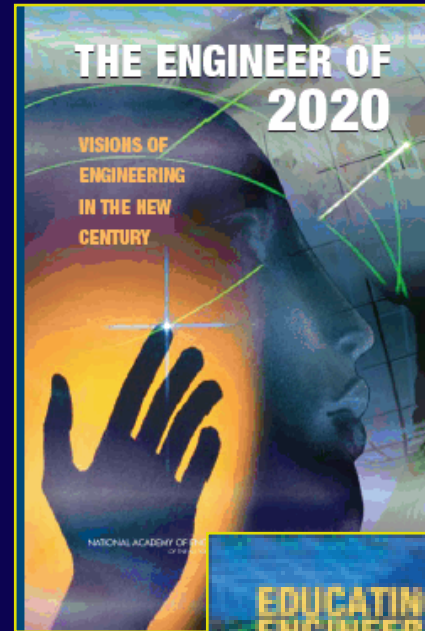


# Engineer of 2020: The premise

- Past: Engineering education changed only when driven to do so.
- Present: A reactive posture puts engineering education at risk in a time of rapid change.
- Premise: Anticipate the future and shape engineering education in advance to create a significant, dynamic role for our profession.

# The process

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



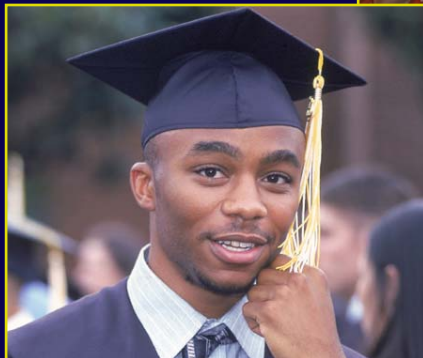
# Phase I: Scenario-based planning

- 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



# Phase II: Engineering education

- Attract best and brightest with a forward-looking education
- Educate them to be ready:
  - ▷ To implement new technology
  - ▷ To focus on innovation
  - ▷ To understand global trends



# 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

- Wayne Clough, Chair, Ga Tech
- Alice Agogino, UC Berkeley
- 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



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



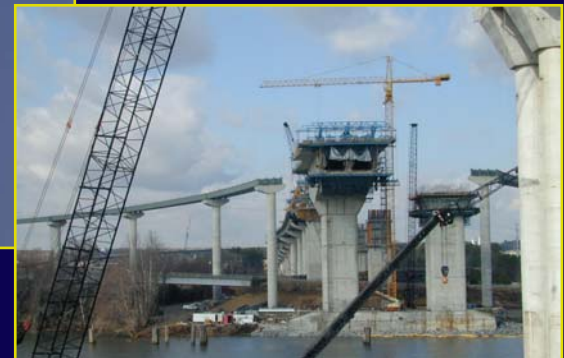
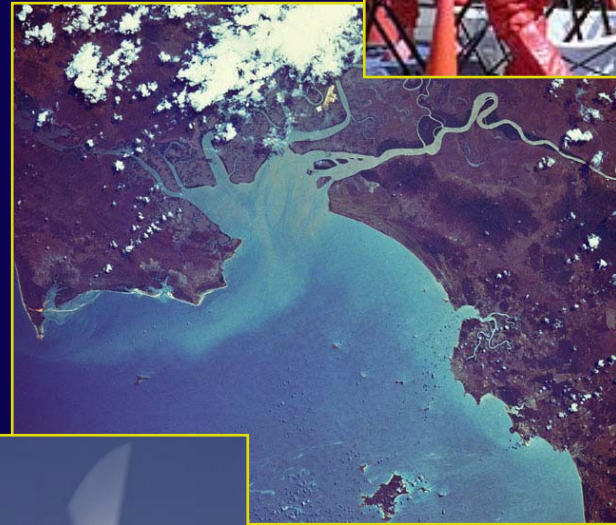


# Demographics for 2020

- 8 billion people; a 25% increase since 2000
- Balance tipped toward urbanization
- Youth “bulge” in underdeveloped nations while developed nations age
- If the world were condensed to 100 people:
  - ▷ 56 in Asia
  - ▷ 13 in the Western Hemisphere
  - ▷ 16 in Africa
  - ▷ 4 in the United States

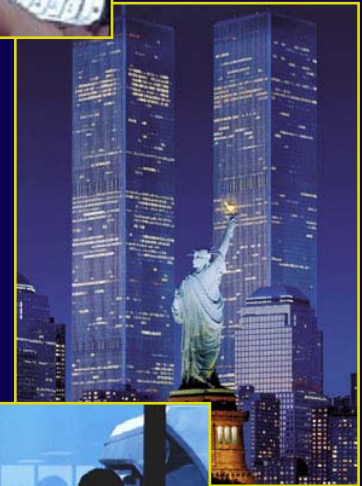
# Challenges

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



# Economic/societal forces

- Internet, high-speed communications
- Removal of trade barriers
- Terrorist attacks; wars in Iraq, Afghanistan, Lebanon
- Emergence of technology-based economies around the world
- Sustained investment in higher education in nations like China, India



## Sustainable Technology



Nanotechnology



Photonics/optics

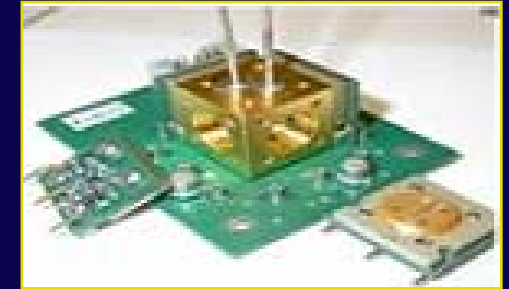


Manufacturing

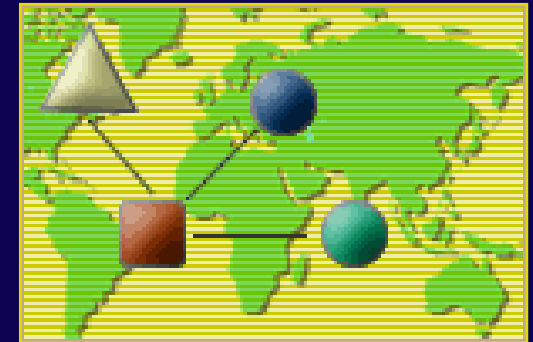
# Breakthroughs



Biotechnology/  
nanomedicine



Microelectronics/  
telecommunications



Logistics

# Social, global and professional context of engineering practice

- Population is more diverse.
- Technological change becomes even more rapid.
- 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 assessing and managing risk with view to security, privacy, and safety.

"When I hire someone today, I look for different skills than I did ten years ago. Today, it is not unusual for good candidates to have global references and experience on projects and assignments around the world. I think we must prepare our graduates for that type of career, because they aren't like to spend their careers working in one company, or even in one country. And they must become advisors, consultants, managers, and conceptual planners much more quickly than they did a few years back."

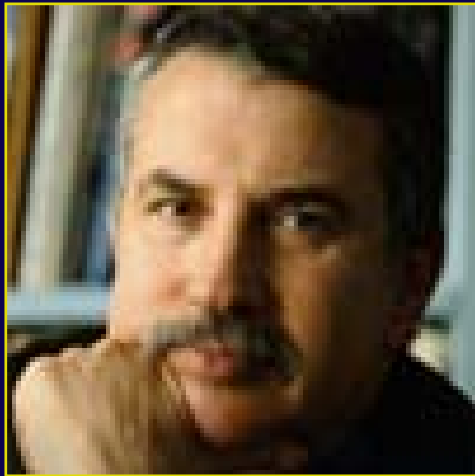
Theodore Kennedy, founder of BE&K Inc.,  
speaking to the 2005 NAE annual meeting

# Educating a new breed of engineer

- Strong analytical skills
- Practical ingenuity, creativity; an innovator
- Understanding of the larger social context of technology
- Global perspective
- High ethical standards, professionalism
- Dynamic, agile, resilient, flexible
- Lifelong learner
- Adaptive leader

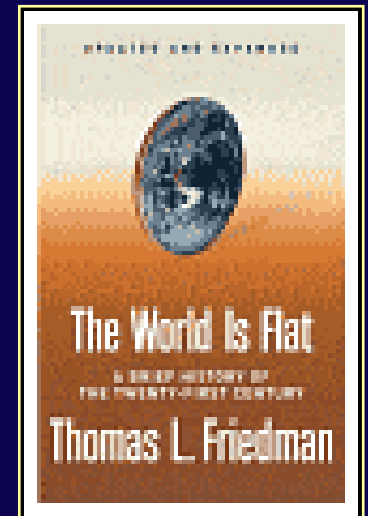


# Operating in the flat world



"It is now possible for more people than ever to collaborate and compete in real time with more other people on more different kinds of work from more

different corners of the planet and on a more equal footing than at any previous time in the history of the world."





## The competition grows fiercer

- By 2010, 90 percent of the world's scientists and engineers will live in Asia.
- The US has increased nanotechnology research funding to \$1 billion a year, but Western Europe and Japan have kept pace, and other nations are also making significant investments.
- 6 of the world's 25 most competitive IT companies are headquartered in the US; 14 are headquartered in Asia.



"The big winners in the increasingly fierce global competition for supremacy will not be those who simply make commodities faster and cheaper than the competition. They will be those who develop talent, techniques, and tools so advanced that there is no competition."

*Ensuring Manufacturing Strength through Bold Vision*  
National Science Foundation report

"Innovation fosters new ideas, technologies, and processes that lead to better jobs, higher wages, and a higher standard of living. For advanced industrial nations no longer able to compete on cost, the capacity to innovate is the most critical element in sustaining competitiveness."

*InnovateAmerica*

National Innovation Initiative report

# Innovation is critical to meeting important goals:

- Security
- Economic prosperity
- Environmental sustainability
- Treating and preventing illness and disease

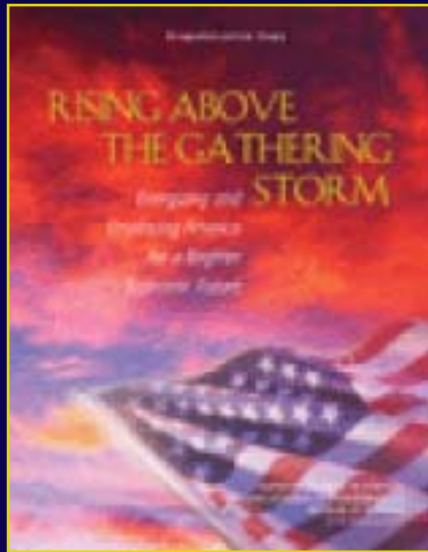


# Characteristics of an innovation leader

- **Large corps of scientists and engineers**
- Flexible and skilled workforce
- Strong investment in R&D
- Reliable utilities and infrastructure
- Policies that support and value innovation
- Competitive tax and investment climate
- Trade agreements and IP protection that provide a level international playing field

# Among the NII recommendations

- Build the base of scientists and engineers
  - ▷ Financial incentives for undergraduates
  - ▷ Graduate fellowships
- Revitalize and balance research investment
  - ▷ Greater focus on engineering, physical sciences
  - ▷ Emphasis on frontier and multidisciplinary research
- Catalyze the next generation of innovators
- Energize the entrepreneurial economy



# Among National Academies' recommendations

- Vastly improve K-12 science and math
  - Double the U.S. students going into science and engineering fields by providing undergraduate scholarships, graduate fellowships
  - Tax credit for companies to improve knowledge and skills of the science and engineering workforce
  - Increase investment in long-term fundamental research

# American Competitiveness Initiative recommendations

- Double federal research funds for engineering and physical sciences over next 10 years
- Permanent R&D tax credit for private-sector technology initiatives
- Strengthen high school math and science education



# Conclusions

- 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.
- Before we increase numbers of engineers, we must educate them differently.
- Success is tied to innovation and marketing.
- Each country will have to develop a strategy for the future to drive innovation; engineering needs to piggyback on this strategy and create goals that complement it.
- The future of engineering lies in the balance; engineering education needs to lead the charge to a time of new energy and opportunity.