Educating Leaders for the 21st Century – Role of Engineering

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National Science Foundation
“to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense...” NSF Act, 1950

Science offers a largely unexplored hinterland for the pioneer who has the tools for his task. The rewards of such exploration both for the Nation and the individual are great. Scientific progress is one essential key to our security as a nation, to our better health, to more jobs, to a higher standard of living, and to our cultural progress.
NSF ENG: Investing in engineering research and education to foster innovations for benefit to society
Larger Context

• Employment, economic growth and competitiveness, and sustainability
• Mega problems: food, health, energy, water, security, education, infrastructure, …
• Globalization: flows of components, products, services, knowledge, and people
• Stubborn long-standing issues in STEM talent, diversity, and education
• Public perception and support of science and engineering
Major Trends and Forces

• **Ubiquitous computing and communications**
  – Computational modeling, data, simulation, optimization pervasive in all fields of engineering
  – Networks and computation deeply integrated into engineered systems
  – Machine intelligence

• **Systems science and engineering**
  – Multi-scale analysis, design, and optimization
  – Integration of physical and cyber components
  – Range: nano- to micro- to macro-scale
  – Scale and complexity: large numbers of components
  – Safety, robustness, resilience, …
Major Trends and Forces

• Nanoscale science and technologies
  – Improving understanding and new tools at the atomic and molecular scales
  – Progressing from passive components to active systems, design, and manufacturing

• Biological/Bio-medical Frontiers
  – Interaction of engineered systems and biology at all scales – DNA to cells to organs to organisms to eco-systems
  – Engineering for neuroscience and brain
  – Synthetic biology
  – Plants, food, and agriculture
  – Advanced biomanufacturing
  – Biologically inspired engineering
Major Trends and Forces

• Behavioral/economic/cognitive sciences
  – Human behavior and game theory in engineered systems and technology design
  – Prominent role in infrastructure systems such as electric grid, transportation, water, gas
  – Economic, regulatory, policy issues

• Design, creativity, aesthetics, …
Translational

• Academic Partnerships
• Small Business Partnerships

IIP

Fundamental

CBET
• Chemical, Biochemical, and Biotechnology Systems
• Biomedical Engineering and Engineering Healthcare
• Environmental Engineering and Sustainability
• Transport and Thermal Fluids Phenomena

CMMI
• Advanced Manufacturing
• Mechanics and Engineering Materials
• Resilient and Sustainable Infrastructure
• Systems Engineering and Design

ECCS
• Electronics, Photonics, and Magnetic Devices
• Communications, Circuits, and Sensing Systems
• Energy, Power, and Adaptive Systems

EEC
• Engineering Research Centers
• Engineering Education
• Engineering Workforce

Directorate for Engineering

EFRI
Role of ERCs

• Highly prestigious signature program from Engineering Directorate
• Illustrious history of successes and positive impacts
• NSF and ENG fully committed to supporting and enhancing the ERC program
New ERC Competition Underway

- 188 pre-proposals received
- 18 invited for full proposals
- 8 selected for site visits
- Awards in FY15
Emerging Outlines of the 21st Century
World Population

9 Billion by 2050
420 Million in the US

Aging populations in the advanced nations
Population Growth in Asia and Africa
World GDP per capita (1 – 2003)

“Hockey-stick” growth starting with the industrial revolution
Rising inequality in recent decades
“So this is a book about the second machine age unfolding right now—an inflection point in the history of our economies and societies because of digitization. It’s an inflection point in the right direction—bounty instead of scarcity, freedom instead of constraint—but one that will bring with it some difficult challenges and choices.”
THE FUTURE OF EMPLOYMENT: HOW SUSCEPTIBLE ARE JOBS TO COMPUTERISATION?, Osborne and Frey, 2013, Oxford University

In this paper, we address the question: how susceptible are jobs to computerisation? ... First, drawing upon recent advances in Machine Learning (ML) and Mobile Robotics (MR), we develop a novel methodology to categorise occupations according to their susceptibility to computerisation. Second, we ... estimate the probability of computerisation for 702 detailed occupations, ... impacts ... on US labour market outcomes.
Smalley’s List of Top 10 Problems

- Energy
- Water
- Food
- Environment
- Poverty
- Terrorism and War
- Disease
- Education
- Democracy
- Population

Image courtesy Oak Ridge National Laboratory
“The best way to predict your future is to create it”
- Abraham Lincoln
“...the future announces itself from afar. But most people are not listening. The noisy clatter of the present drowns out the tentative sound of things to come. The sound of the new does not fit old perceptual patterns and goes unnoticed by most people. And of the few who do perceive something coming, most lack the energy, initiative, courage or will to do anything about it. Leaders who have the wit to perceive and the courage to act will be credited with a gift of prophecy that they do not necessarily have.” John Gardner
Opportunity for ERCs

• Unique environment to educate the leaders of tomorrow
• Combine technical excellence with broader educational experiences to create a strong foundation for a lifetime of leadership
• Let’s learn from each other and adopt best practices
QUESTIONS?

IDEAS, THOUGHTS!

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