Enabling Greater Research Achievements by Transforming the Inception Phase

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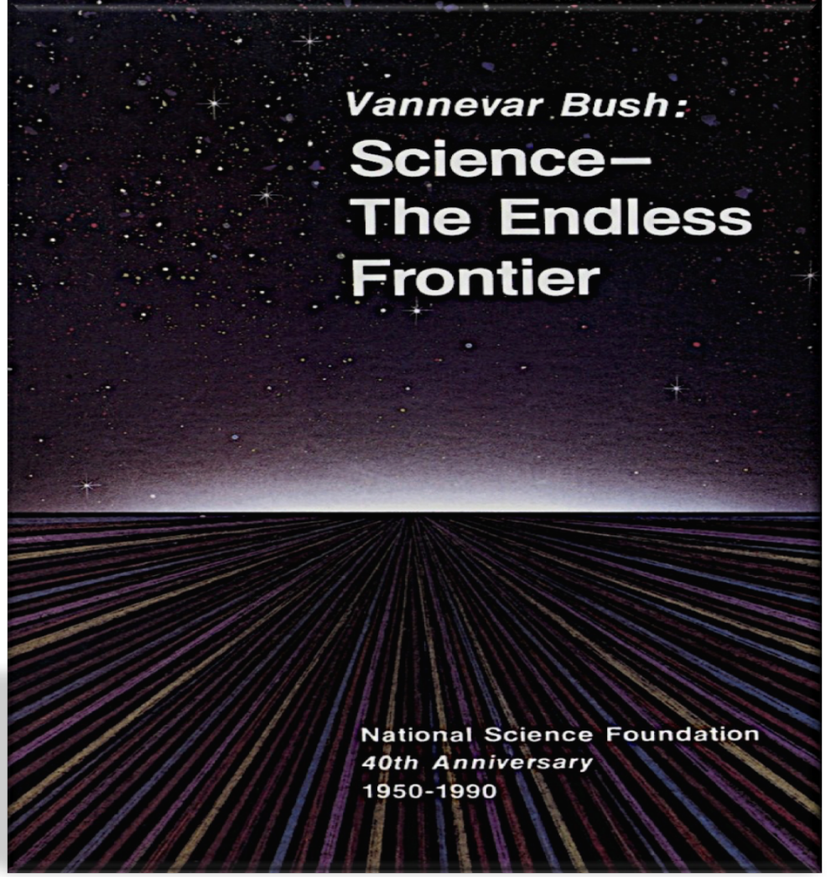
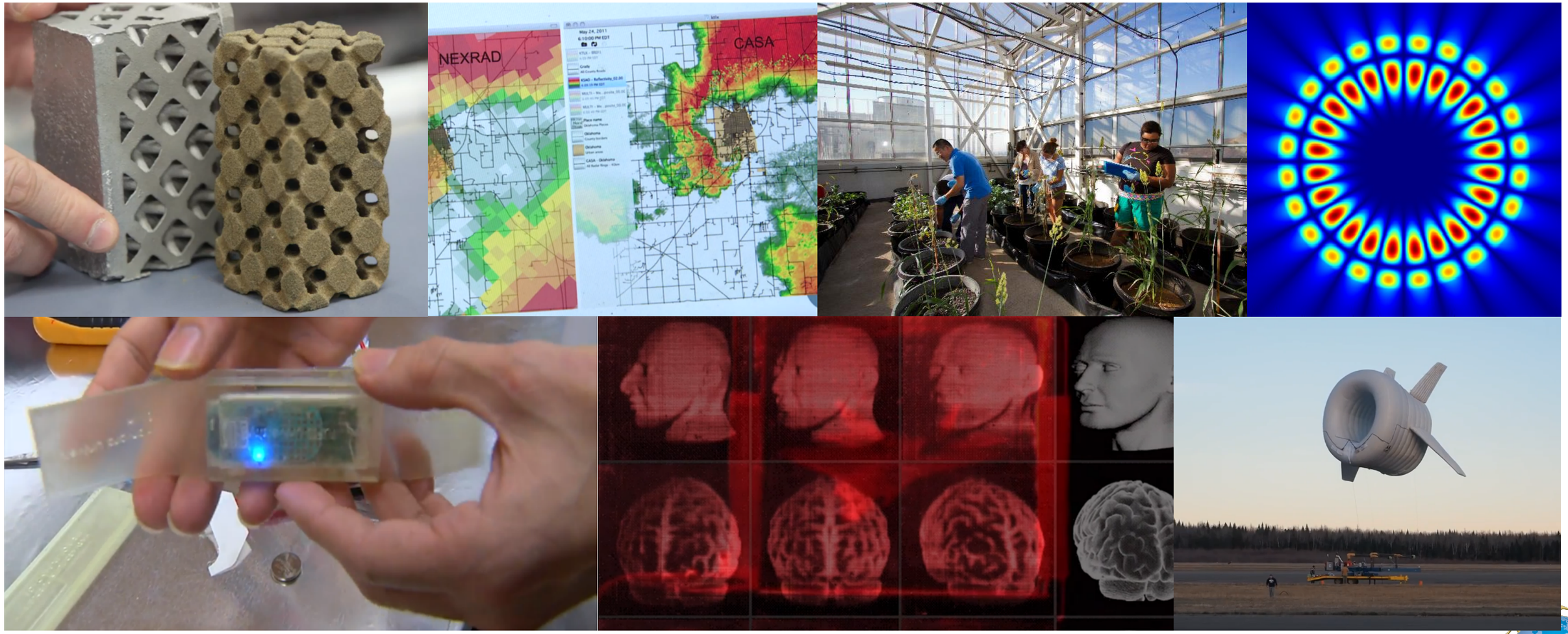


Science offers a largely unexplored hinterland for the pioneer who has the tools for his task. The rewards of such exploration both for the Nation and the individual are great. Scientific progress is one essential key to our security as a nation, to our better health, to more jobs, to a higher standard of living, and to our cultural progress.

"to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…" NSF Act, 1950

Investing in Engineering Research and Education and Fostering Innovations for Benefit to Society



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ENG Directorate by Numbers

- Provides about 40% of federal funding for basic research in engineering at US academic institutions
- FY 2017 Budget Request has crossed $1 billion
- Receives about 12,000 proposals annually
- Funds about 2,500 awards annually

Top Engineering Achievements of the 20th Century

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 and Refrigeration
11. Highways
12. Spacecraft
13. Internet
14. Imaging
15. Household Appliances
16. Health Technologies
17. Petroleum and Petrochemical Technologies
18. Laser and Fiber Optics
19. Nuclear Technologies
20. High-performance Materials

Source: National Academy of Engineering

What will be on the 21st Century List?

NSF Laid the Foundations of 3D Printing in the 80's

'Revolutionary'

Machine makes 3-D objects from drawings

By Kathleen Sullivan
American-Statesman Staff

Wedged into the corner of an unused photo lab at the University of Texas is an ungainly machine that can transform a computer drawing into a three-dimensional model at the touch of a button.

Sometime next year, the machine, which was developed by a UT graduate student, will make its way out of the lab and into the commercial arena. It will leave with the blessing of the UT Board of Regents, which Thursday gave an Austin company exclusive licensing rights to the "revolutionary" new technology embodied in the machine.

The licensing pact paves the way for the first transfer of technology from the University of Texas at Austin to a commercial venture.

The company that won the right to market the invention is Nova Automation Corp., whose principal shareholders are an Austin consulting engineer and Nova Graphics International Corp., an Austin-based computer graphics software firm.

The agreement represents a "hard fought" victory for UT's fledgling Center for Technology Development and Transfer, said Meg Wilson, coordinator of the center, which was given life during the last Texas Legislature and got

See Inventor, A11

Staff photo by Ralph Barrera

Associate Professor Joe Beaman shows some three-dimensional plastic models made by the 'selective laser centering' device developed by Carl Deckard, left.

How can NSF ENG Enable Fundamental Research with High Potential?

Salient Challenges in Enabling Fundamental Engineering Research

- Challenges in impacting engineered systems
  - Easier to advance a device or component innovation
  - Difficult to rethink the entire system

- Increasing pace of research and technological advances

- Pull toward safe and incremental research

Convergence Paradigm

- An emerging research paradigm: the convergence of life sciences, engineering, physical sciences, computing and data, and social-behavioral sciences
- Core idea: deep integration of knowledge, ideas, tools, techniques, and modes of thinking for greater understanding and innovations
- Potential impacts:
  - Creation of new knowledge and research fields
  - Medicine
  - Energy and Environment
  - Manufacturing
  - Agriculture
  - Education

Role of Creativity

"Given the importance of creative thinking in science, is it possible to create optimal conditions in a research organization with the aim of enhancing the creativity of its scientific staff? This article describes a study that addressed this question in a large research institute—the European Molecular Biology Laboratory (EMBL; Heidelberg, Germany). The results show that conditions that enhance scientific creativity can be clearly defined, and thus applied to any organization striving for innovation."

C. J. Neumann, EMBO Rep. 2007 Mar; 8(3): 202–206

What can we Learn from Bell Labs and other Models that have been Successful in Spawning High Impact Research?

Importance of the Inception Phase

- Low funding rates lead to conservatism and less transformative projects
- Path of least resistance is to go to the next logical and feasible step, i.e., incremental progress
- Research problem formulation has tremendous implications for the ultimate potential
- Inception phase is the right focal point for NSF

"If I had 60 minutes to solve a problem and my life depended on it, I'd spend 55 minutes determining the right question to ask. Once I got the right question, I could easily answer it in 5 minutes."

A. Einstein

NSF Engineering: Rising to the Challenge

- Ultimate impact of fundamental research advances is not easy to predict
- Impact can be in generating surprising discoveries and/or breakthrough solutions to pressing societal problems
- Is it possible to design environments and/or experiences that can help researchers in formulating “high impact research questions”?

NSF 16-028 Dear Colleague Letter: Germination of Research Ideas for Large Opportunities and Critical Societal Needs (GERMINATION)

Motivating Question:

Can effective learning frameworks, platforms and/or nurturing experiential environments be designed to germinate transformative research ideas and questions to advance discoveries and open large opportunities that address important societal needs?

Key Question for the Workshop

What is the Potential of this Idea?

QUESTIONS?

IDEAS, SUGGESTIONS!

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