Engineering 2.0: Rekindling American Ingenuity

Sridhar Kota
Herrick Professor of Engineering
The University of Michigan, Ann Arbor

Former Assistant Director for Advanced Manufacturing (2009-2012),
White House Office of Science and Technology Policy

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This is NOT Rocket Science

Creating Knowledge but Not Wealth

Scientific Discoveries → Engineering Inventions →Innovation → Manufacturing,..
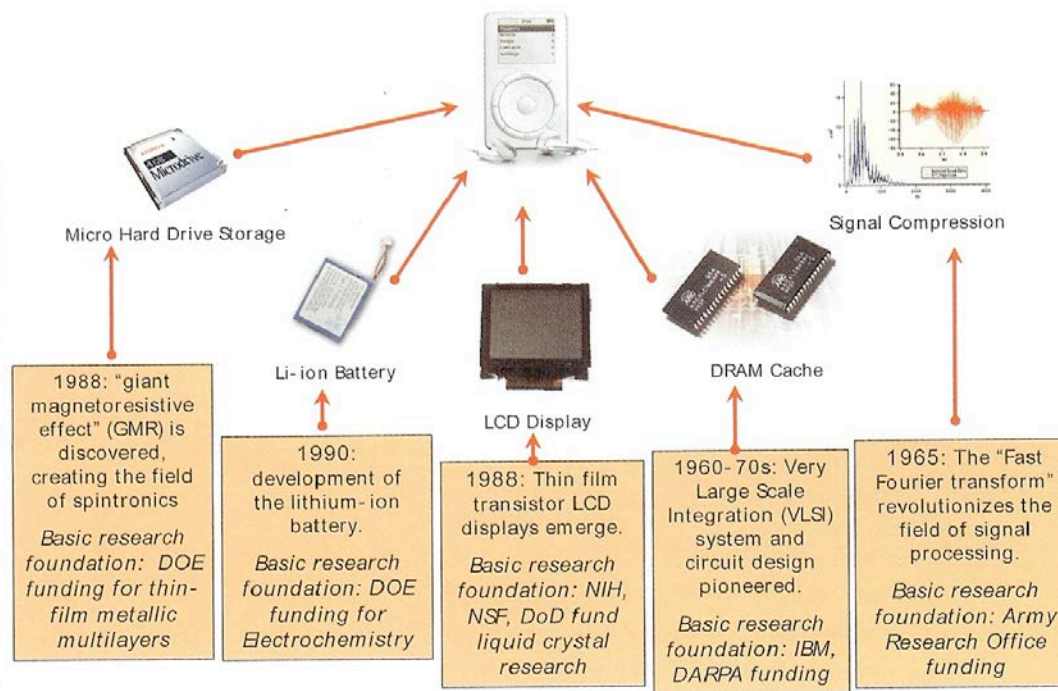
Federal R&D
$140 billion

Mfg. deficit ~ $700 billion
Adv. Tech. Products deficit ~ $100 billion

1800 suspected counterfeits in a more than 1 million parts in military equipment – Senate Armed Services Comm. Report 2012

IMPACT OF BASIC RESEARCH ON INNOVATION

OSTP 2006 report

Micro Hard Drive Storage

Signal Compression

1988: "giant magnetoresistive effect" (GMR) is discovered, creating the field of spintronics

Basic research foundation: DOE funding for thin-film metallic multilayers

Li-ion Battery

1990: development of the lithium-ion battery.

Basic research foundation: DOE funding for Electrochemistry

LCD Display

1988: Thin film transistor LCD displays emerge.

Basic research foundation: NIH, NSF, DoD fund liquid crystal research

1960-70s: Very Large Scale Integration (VLSI) system and circuit design pioneered.

Basic research foundation: IBM, DARPA funding

DRAM Cache

1965: The "Fast Fourier transform" revolutionizes the field of signal processing.

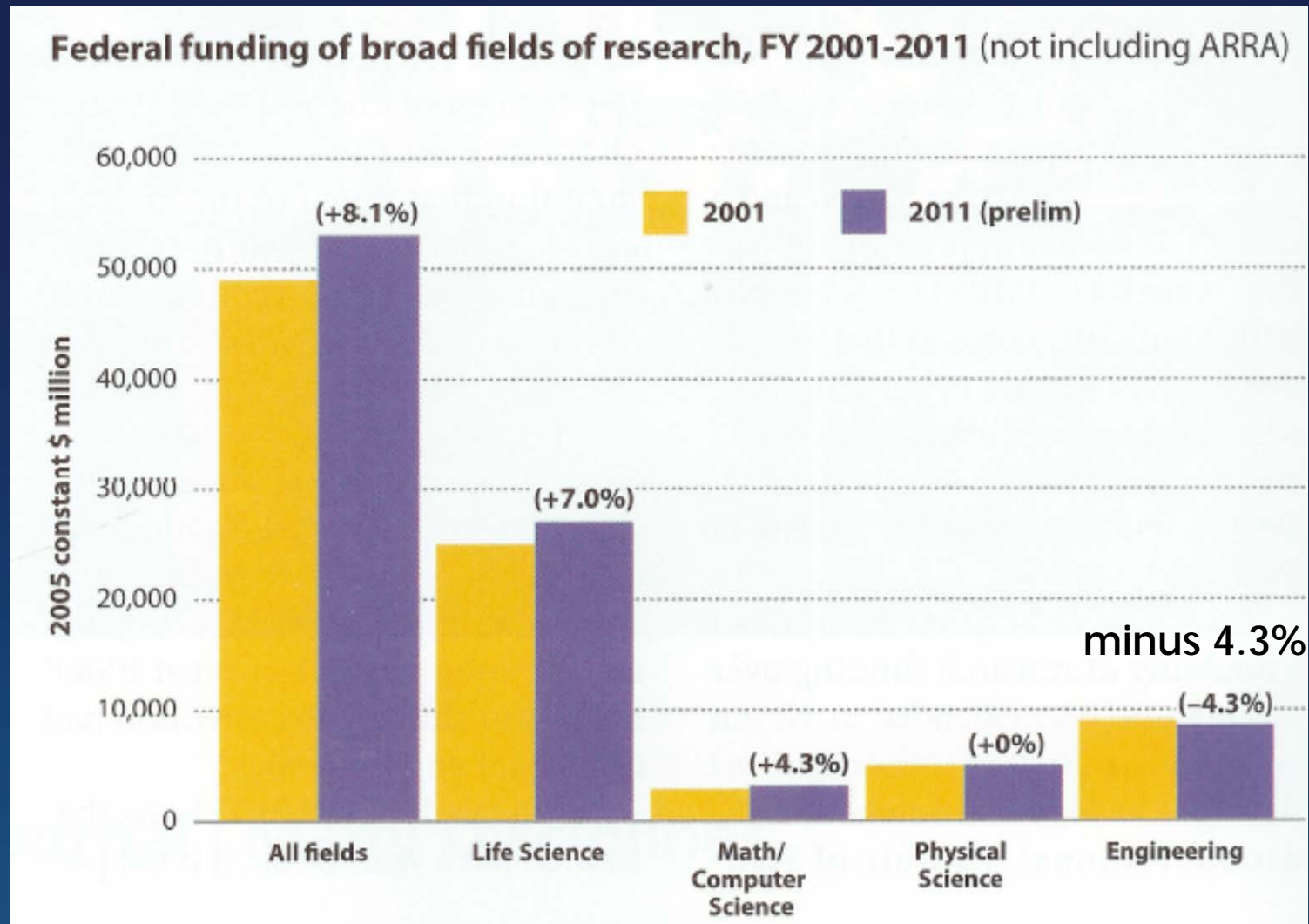*Basic research foundation: Army Research Office funding*

The Innovation Gap

The U.S is steadily falling behind in capitalizing on its own discoveries & inventions

Generalization of science to include engineering has had real consequences in investments and outcomes

Federal funding of broad fields of research, FY 2001-2011 (not including ARRA)

minus 4.3%

Investments in Engineering Education

STEM Field of Focus ($3,440 M)

- Science, $1,393.83 41%
- Agency Specific, $883.29, 26%
- STEM, $1,023.34, 30%
- Math, $15.07 <1%
- Engineering, $14.13, <1%
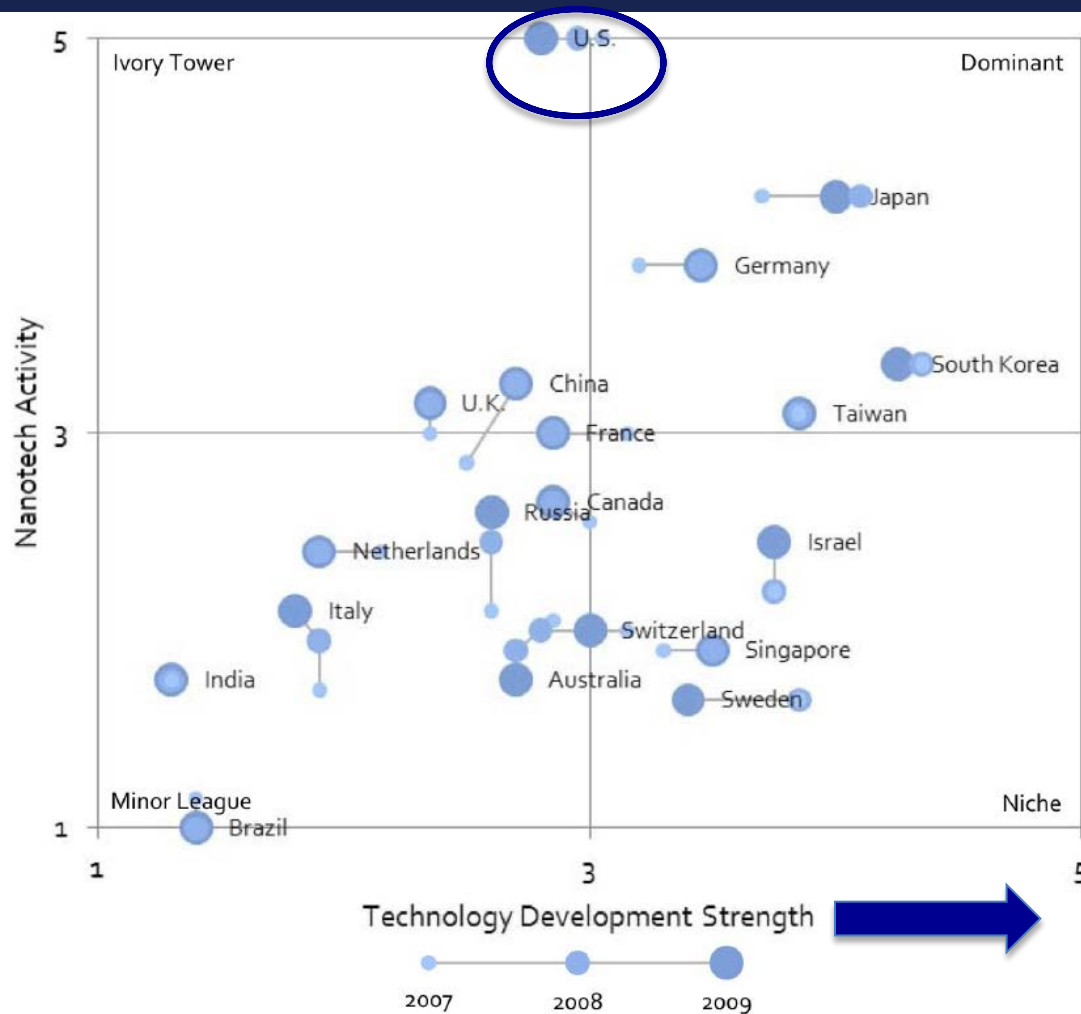- Science & Math, Engineering, or Technology $110.63, 3%

# of Investments = 252
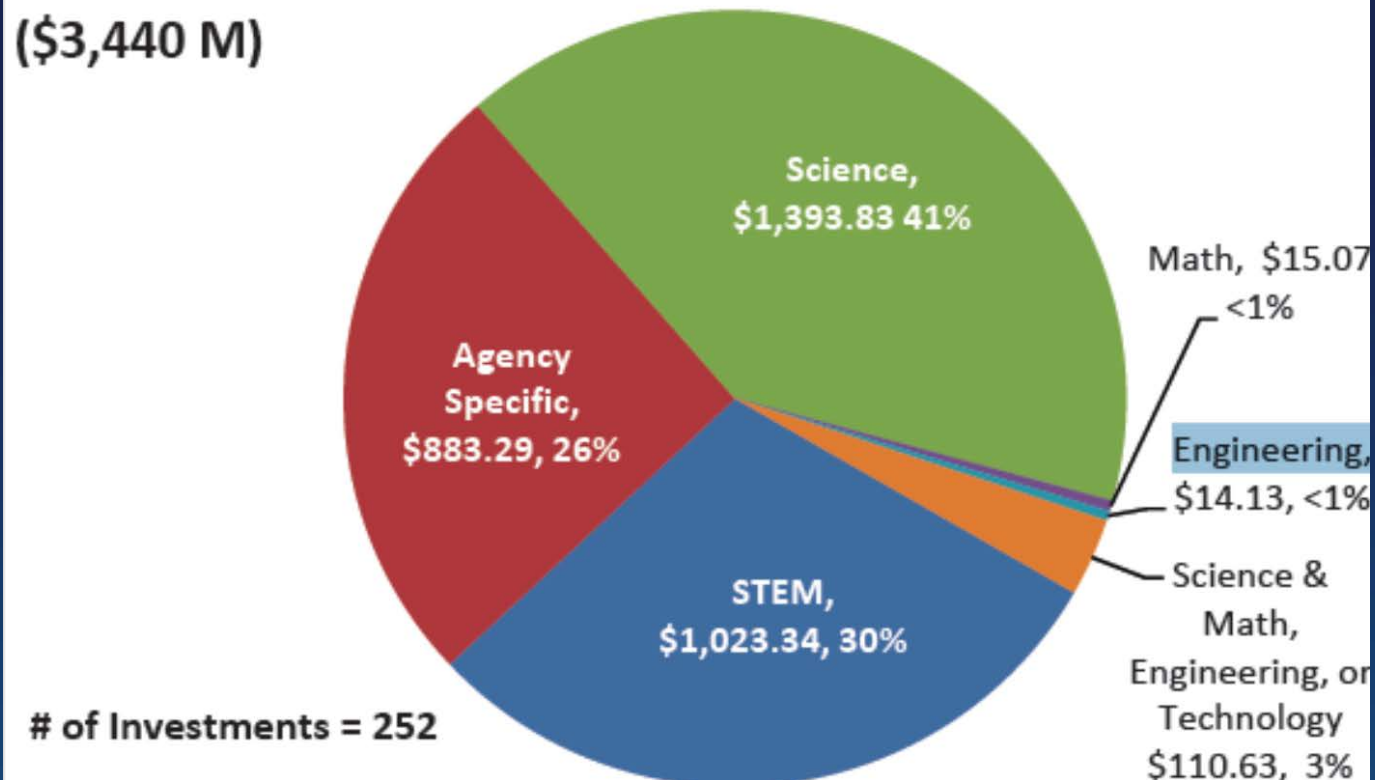
Source; NSF Science and Engineering Indices 2011

While most high schools require students to dissect a frog to learn biological anatomy, few require students to dissect a power tool to study machine anatomy.

Outcomes

Source: *"Ranking the Nations on Nanotech"- Lux Research Report, Aug 2010*

Different View points

Congressional Testimony by a senior government official (2010)
"… recent analyses of the number of nanotechnology citations, patents, and publications show that we are very quickly being surpassed by other nations in an area where, until recently, we had a strong lead. This has the potential of putting our national security at risk, since technological superiority has been a foundation of our national security strategy since World War II."

Engineering is NOT Science

NSF Science and Engineering Index 2011

RESEARCH OUTPUTS: PUBLICATIONS AND PATENTS

WHY IS THIS IMPORTANT?

Research produces new knowledge, products, or processes. Research publications reflect contributions to knowledge, patents indicate useful inventions, and citations on patents to the scientific and technical literature indicate the linkage between research and practical application.

Science: "Publish or Perish"

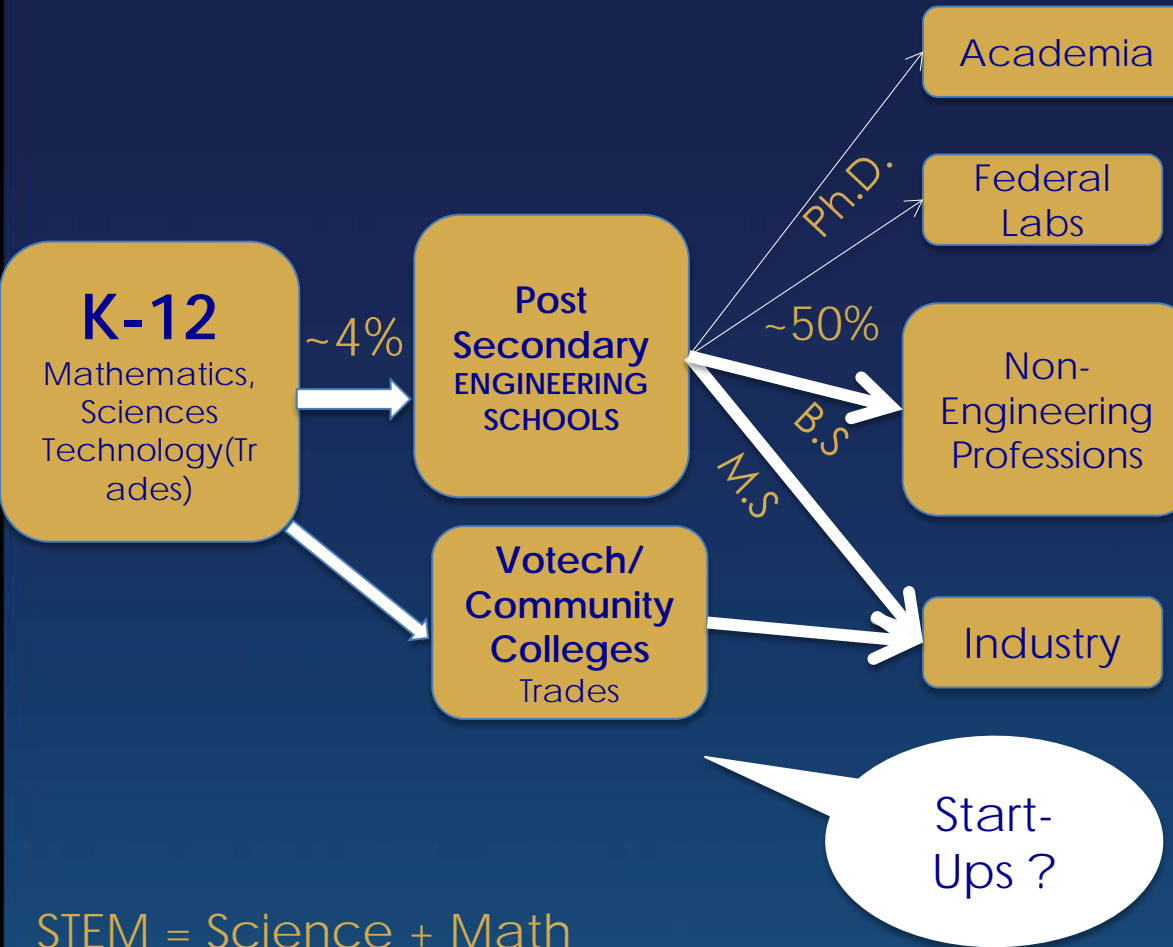Engineering: Can no longer afford to simply "publish and perish"

There are no equivalent journals to "Science" and "Nature"

"Engineering Science", publications and patents are only intermediate steps in engineering

National universities and colleges are ranked based on inputs not outcomes

The Missing E in STEM

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K-12                    Post                    Academia
Mathematics,    ~4%→    Secondary
Sciences                ENGINEERING    Ph.D.    Federal
Technology(Tr           SCHOOLS                 Labs
ades)                          ~50%
                         B.S.            Non-
                                         Engineering
                    Votech/     M.S      Professions
                    Community/
                    Colleges
                    Trades                Industry

                                  Start-
                                  Ups ?
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STEM = Science + Math
T = Information Technology
E is Silent
Innovation = scientific discovery

Perception: For nerds

High (math)barriers to entry

Greater emphasis on analytics
rather than creative aspects

Gender gap is not the issue

Women in Engineering
(% degrees awarded- overall)

B.S. 19%;   Ph.D. 22%

Environ. Eng. :   45%, 40%
Biomed. Eng. :   40%, 36%

Perceived as careers that
can make a difference in
the world

Scaling Best Practices

STIHL Summer Engineering Camps

"My son enjoyed everything and is now convinced he will become an engineer in the future."

Apprenticeships

FIRST Robotics Competition

Project Lead The Way

It's Collaborative, It's Creative, It's Critical Thinking

Maker Faire

a family-friendly showcase of invention & creativity across the country

NAE

ENGINEERS HOW ARE YOU CHANGING THE CONVERSATION?

Engineering for High School Girls

Why Engineering?
Ten great reasons why you'll love it
ASK an Engineer! >

1. Love your work, AND live your life too!
2. Be creative.
3. Work with great people.
4. Solve problems, design things that matter.
5. Never be bored.
6. Make a big salary.
7. Enjoy job flexibility.
8. Travel.
9. Make a difference.
10. Change the world.

Olin College of Engineering 's mission is to produce engineering innovators

50% of Olin's graduates are women!!

Rebuilding an Engineering Economy

Early Education : Bring engineering into the mainstream K-12 curriculum

High Schools: Redouble industry internships and summer camps

University Education: Rebrand Engineering as a creative discipline for inventors, innovators and entrepreneurs.

R & D: Establish appropriate metrics to evaluate research outcomes at federal agencies – put "&" back in "R&D"

        NSF-iCorp is an important first step

Public Policy: Establish a single and a unified voice for engineering in Washington. Example: AAAS for Science

National Campaign to inspire young minds about "rocket engineering"