The Science And Engineering Workforce/Education Project

C. Bartz
E. Bloch
R. Fernandez
M. A. Fox
M. Gilliland
W. Massey
K. Nwabueze
R. Gomory
R. Herbold

The President's Council of Advisors on Science & Technology

I. Our Current Thinking

II. Future Work

Overview

- Our Current Thinking
  - Economic Conditions – Short and long term
  - Workforce production
- Our Future Work
  - Where should the panel focus its study?
  - Invite comments from full PCAST
  - Refine scope of work in Panel meeting today

Our Current Thinking

Point #1

Student performance in math and science is related to national economic growth!

“Performance on standardized tests of math and science is directly related to individual productivity and earnings and to national economic growth.”

The Long Run Importance of School Quality
by Eric Hanushek
Hoover Institute
October, 2002
Period Studied: 1960 - 1990

Our Current Thinking

Point #2

Our nation is competing in a globalized economy, BUT…

Many U.S. students may not be GLOBALLY COMPETITIVE in math and science!!

Student Achievement In Math And Science

U.S. Relative Rank (percentile) Versus Other Countries*

	Math	Science
4th grade	53	87
8th grade	33	64
12th grade	9	23
12th grade advanced Math & Physics	7	3

Source: The International Math & Science Study (TIMSS)

U.S. Students

National Assessment Of Educational Progress

Year 2000 Math & Science Proficiency

	4th Grade		8th Grade		12th Grade	
	Science	Math	Science	Math	Science	Math
Advanced	4%	3%	4%	5%	2%	2%
Proficient*	26%	23%	28%	22%	16%	14%
Partial Proficiency	37%	43%	29%	38%	34%	48%
Below Partial Proficiency	34%	31%	39%	34%	47%	35%

*Proficient = Solid academic performance for grade assessed

Global Math And Science Capabilities

Eighth Grade Students – TIMSS-R*, 1999

	Math		Science
Singapore	604	Taiwan	569
South Korea	587	Singapore	568
Taiwan	585	Japan	549
Hong Kong	582	South Korea	548
Japan	579	Australia	540
Australia	525	U.K.	538
United States	502	Hong Kong	529
U.K.	496	United States	515

* TIMSS = Third International Math & Science Study

Our Current Thinking

Point #3

Our Nation May Risk Losing Its Base of INNOVATION…

Challenges may exist through all portions of the S&E Workforce supply chain…

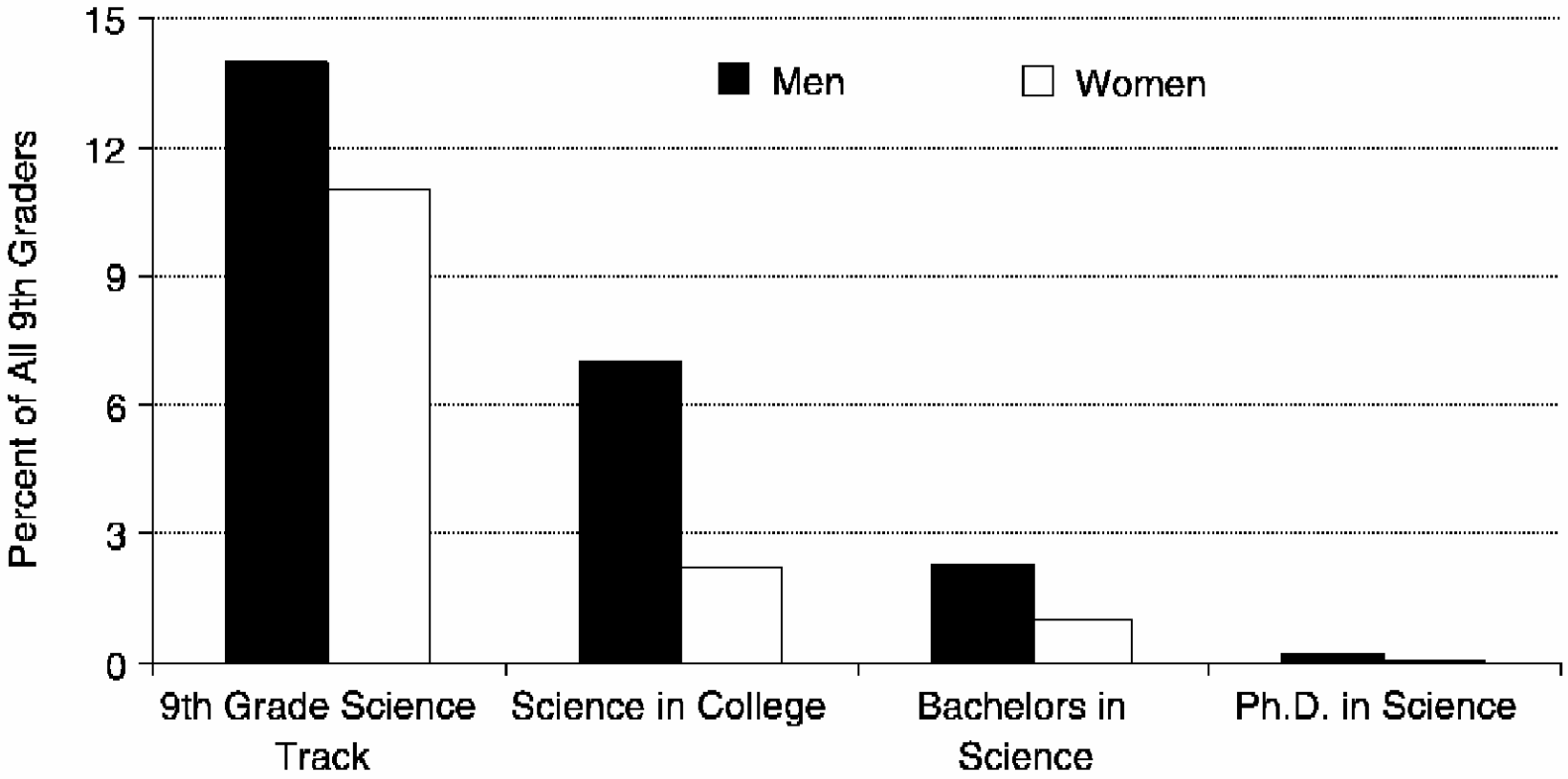


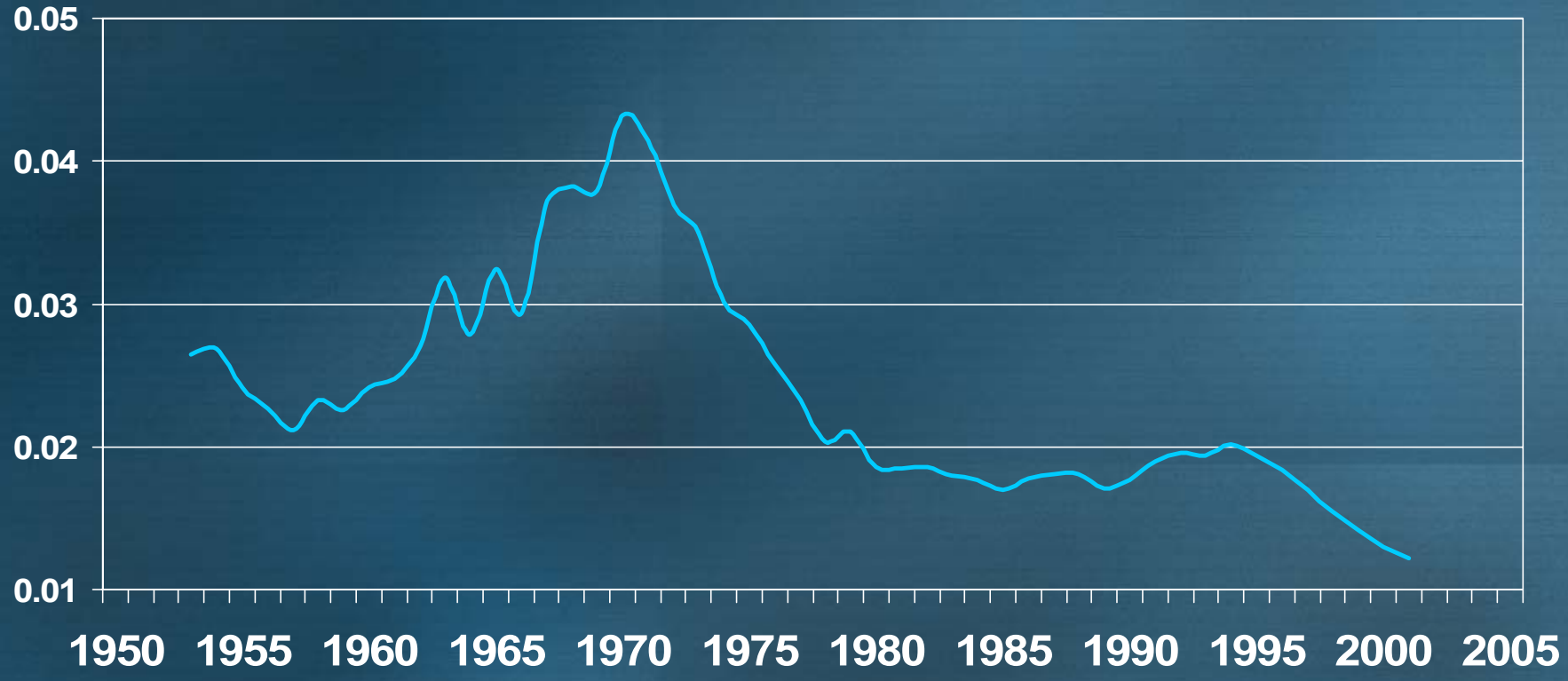
FIGURE 3-1 Summary of the pipeline to the Ph.D. SOURCE: Widnall (1988).

Fewer Ph.D.s – Reduced Innovation Base

- Our nation is producing fewer U.S. Ph.D.s
- The U.S. is retaining or attracting fewer international Ph.D.s
- Other countries are projected to surpass us

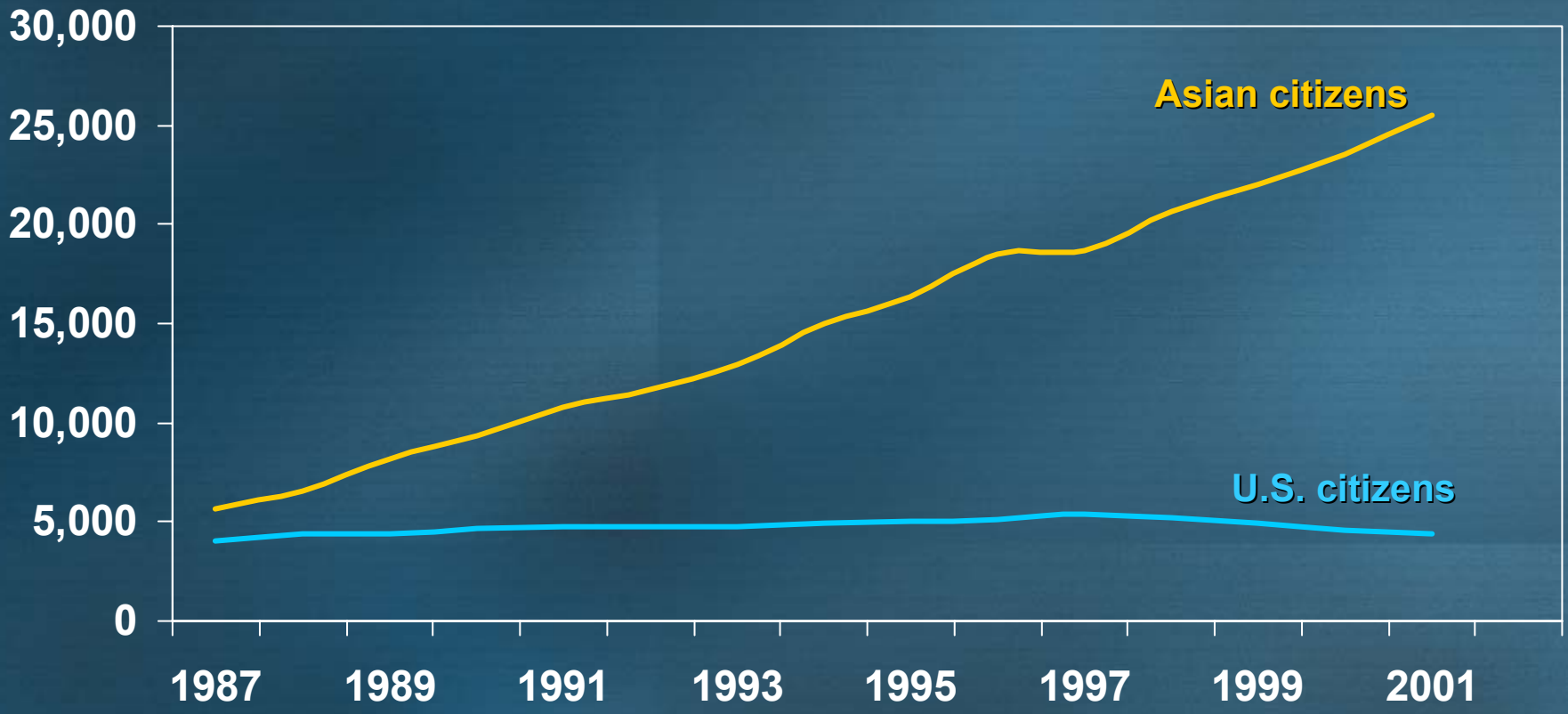
U.S. Physics Ph.D. Degrees As A Percentage of GDP

Physical Scientist Production in the US is not keeping up with GDP even though the physical sciences are the basis of most wealth creation



GDP is expressed in constant 1996 dollars (in million)
Source: American Institute of Physics & National Science Board, Science and Engineering Indicators, 2002.

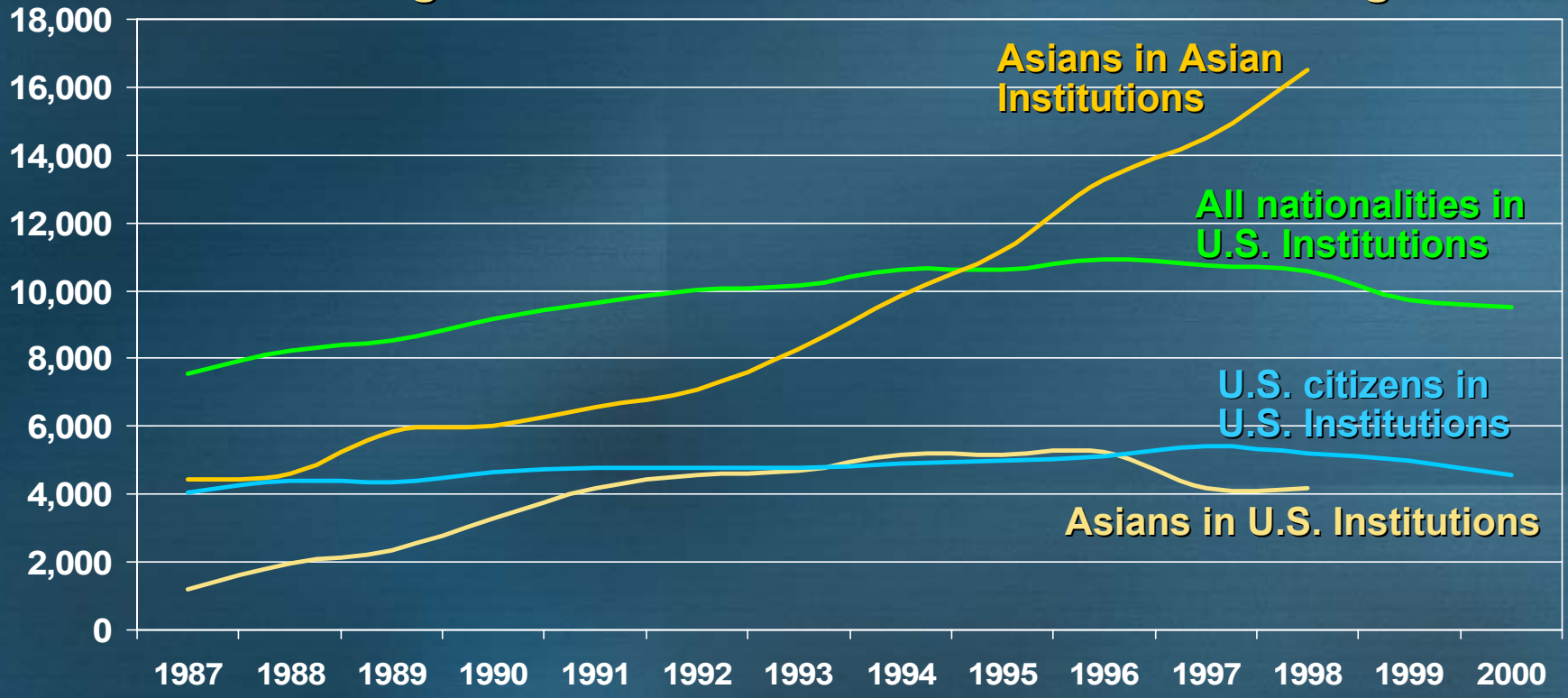
Physical Science And Engineering Ph.D. Degrees



Sources: Science and Engineering Doctorate Awards, NSF, 2001. Science and Engineering Indicators, NSB, 2002.
Sciences = Physics, chemistry, astronomy, earth, atmospheric, and ocean sciences
Engineering = Aeronautical, astronautical, chemical, civil, electrical, industrial, material, metallurgical, and mechanical.

Physical Science And Engineering Ph.D. Degrees

By 2010, if current trends continue, over 90% of all physical scientists and engineers in the world will be Asians working in Asia



Source: Science and Engineering Doctorate Awards, 1996 and 2000, NSF; Science and Engineering Indicators, NSB, 2002
Sciences = Physics, chemistry, astronomy, earth, atmospheric, and ocean sciences
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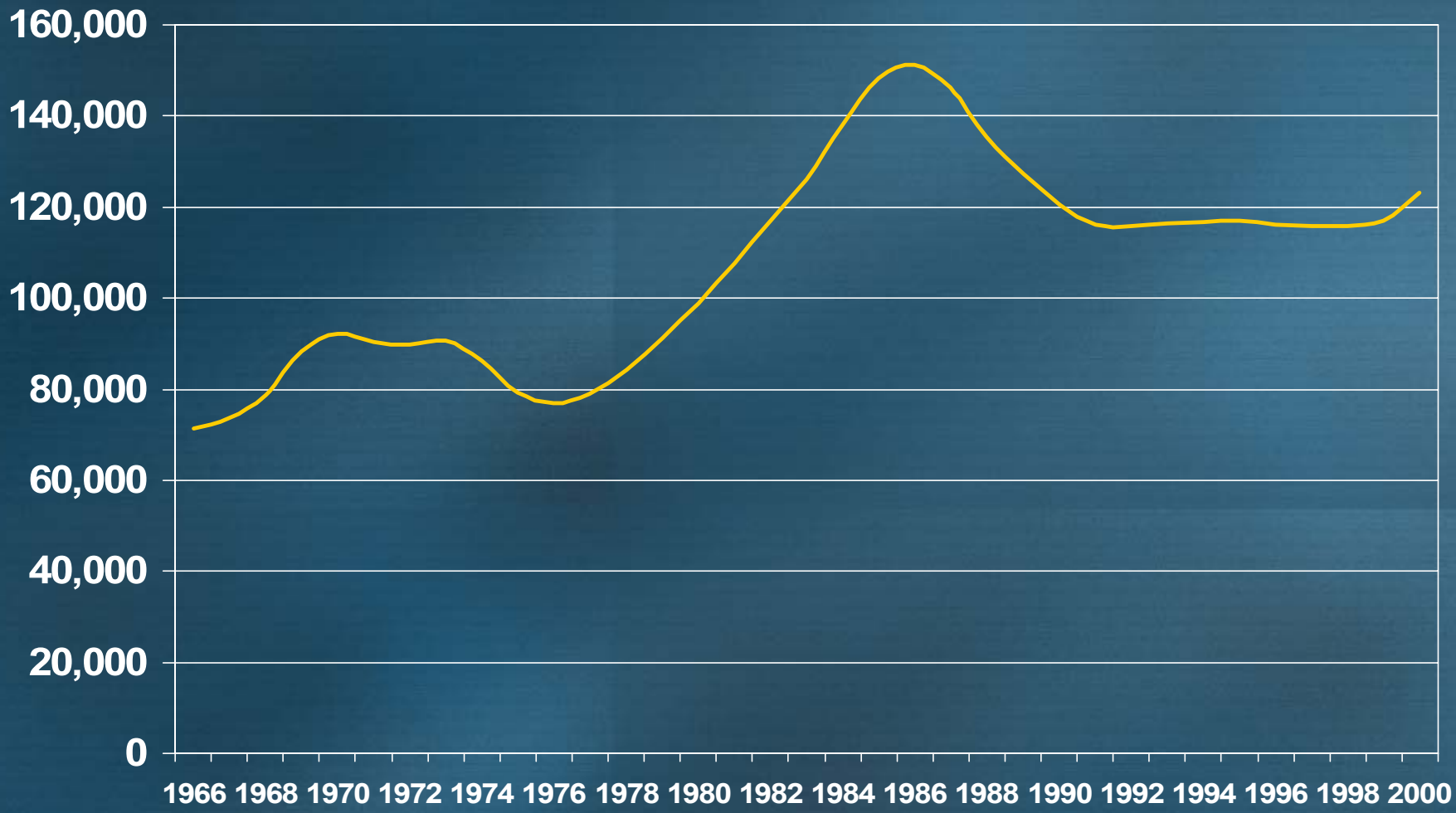
B.S. STEM Degrees

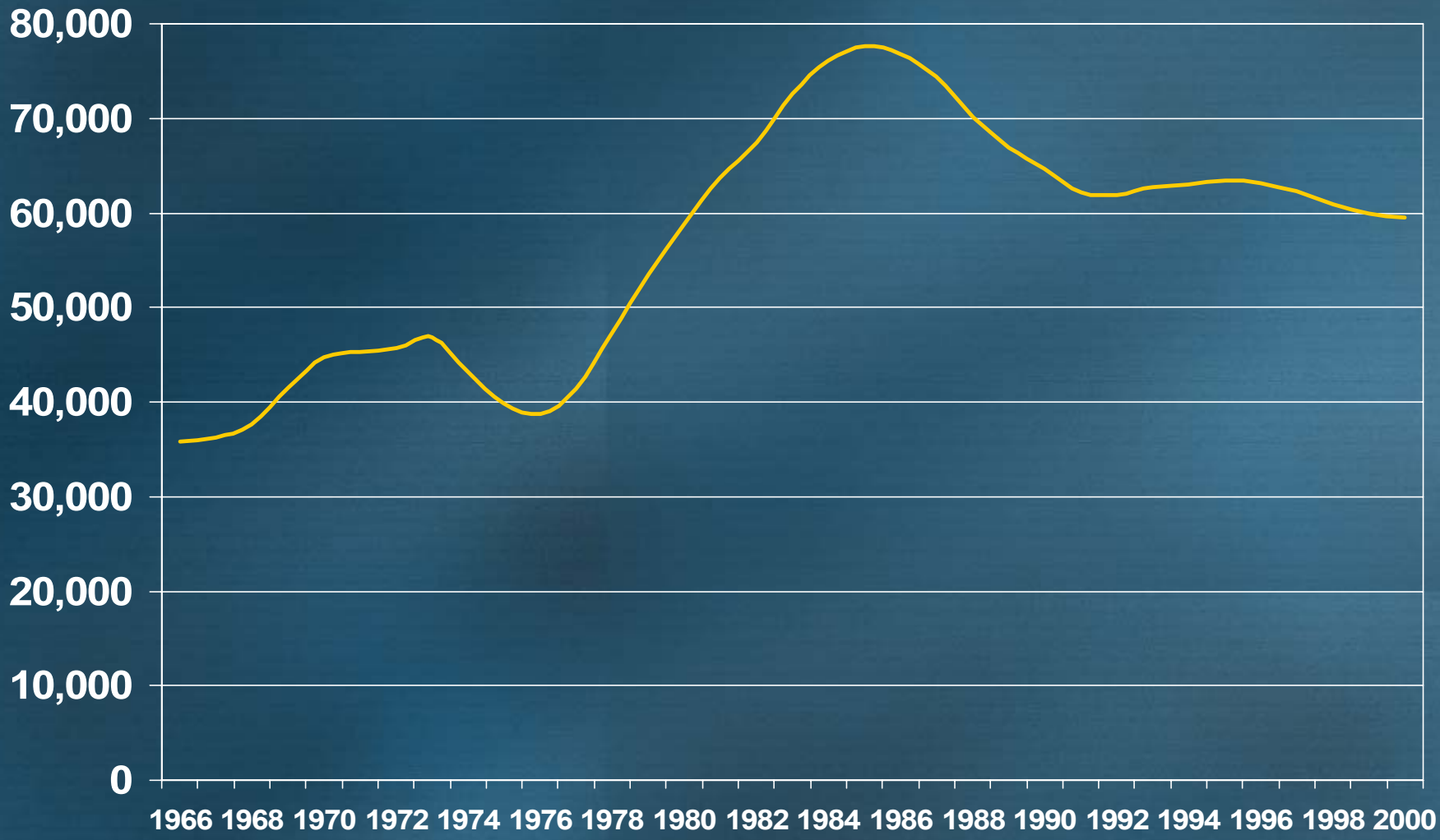
(Science/Technology/Engineering/Mathematics)

Production of B.S. STEM degrees has remained flat over the past 10 years, and down versus the mid 1980's

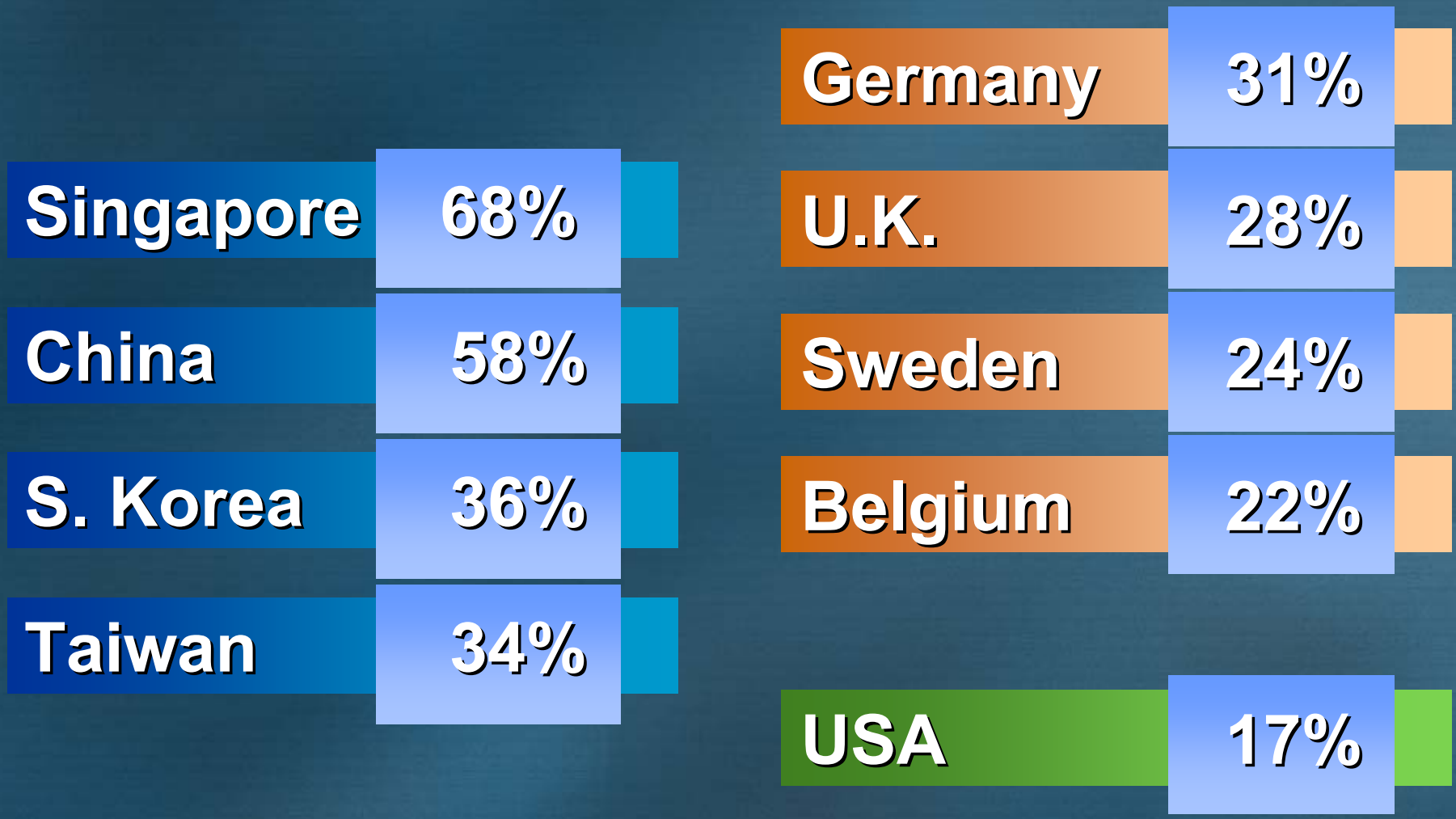
Total B.S. Degrees In Engineering, Physical Sciences, Computer Science And Mathematics Flat



Engineering B.S. Degrees



Engineering & Science Degrees As A % Of All Bachelor Degrees



2002: B.S. In Software and Computer Science Engineering

- India: 220,000
- India starting salaries: 1/5th of US

Source: Business Week 11/25/02

2002: B.S. In Electrical Engineering

- China: 200,000

Source: Fortune 11/11/02

Does the United States Actually Need More STEM Workers?

Point #4

There appears to be conflicting viewpoints regarding the need to increase the future STEM Workforce!

Do We Need More STEM Workers?

Conflicting Viewpoints!

Viewpoint 1:

- We are meeting our S&E Workforce needs
  - Future job opportunities limited
  - Flat salary growth

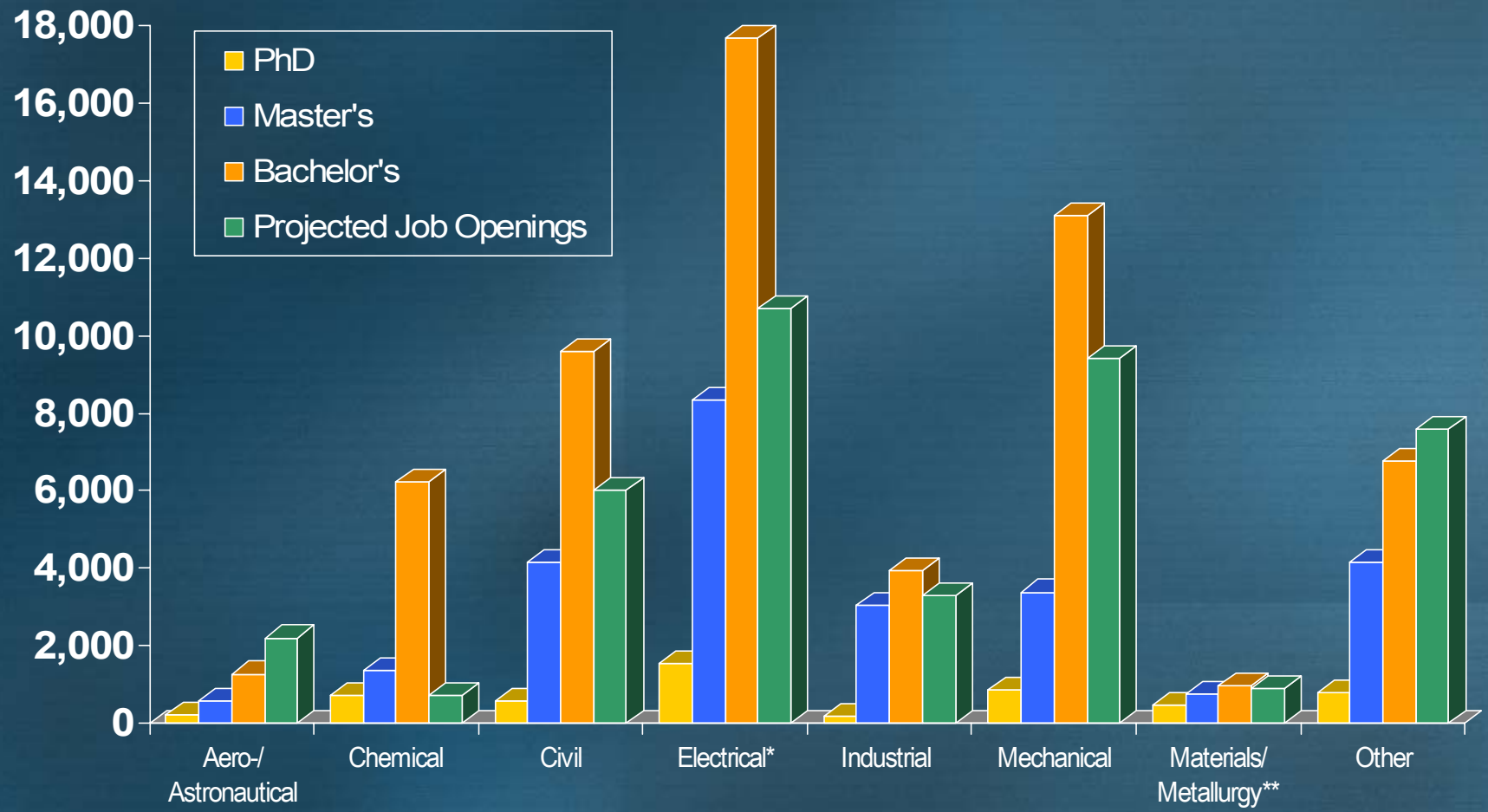
“All available evidence suggests that overall labor markets for scientists and engineers are relatively slack.”

“Labor market projections that go very far into the future are notoriously problematic.”

Michael Teitelbaum
Sloan Foundation
November 12, 2002

Engineering

Degrees and Projected Job Openings



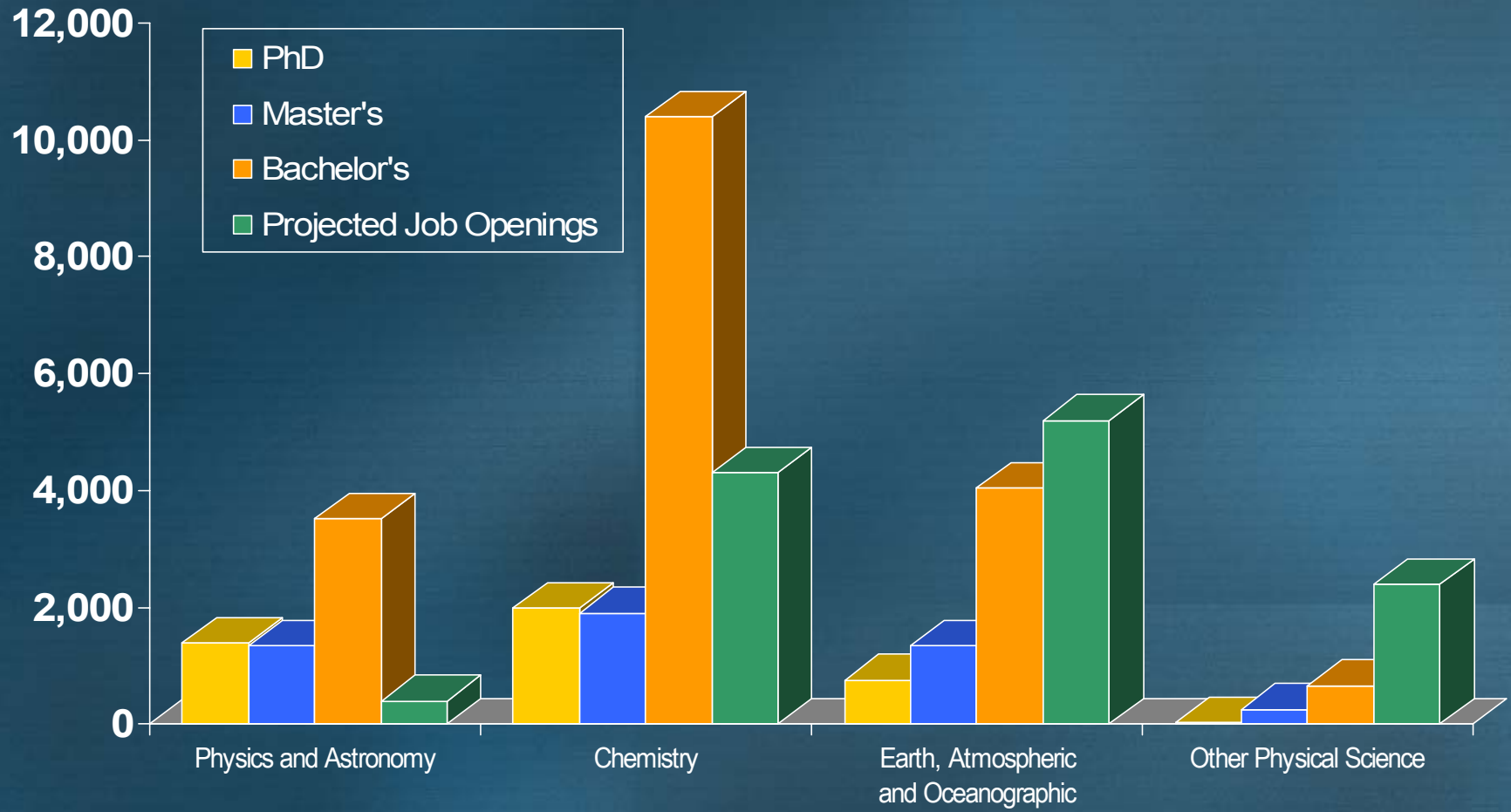
* Occupations include Electrical, Electronics, Computer Hardware Engineers

** There are an additional 400 jobs per year for Material Scientists (not shown here; included in the "Other Physical Sciences" category)

Sources: Tabulated by National Science Foundation/Division of Science Resources Statistics; degree data from Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey; and NSF/SRS: Survey of Earned Doctorates; Projected Annual Average Job Openings derived from Department of Commerce (Office of Technology Policy) analysis of Bureau of Labor Statistics 2000-2010 projections

Physical Science

Degrees and Projected Job Openings



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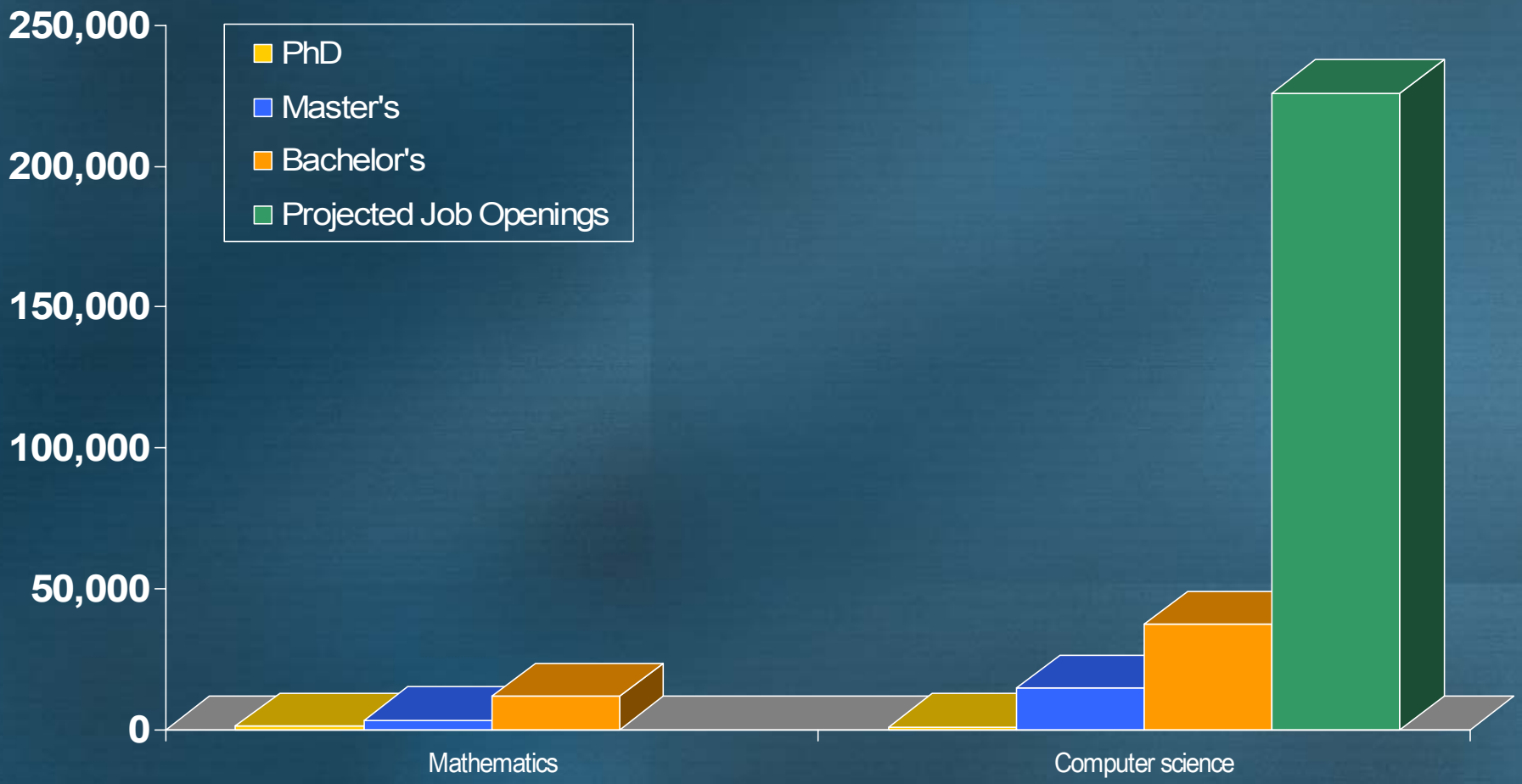
Math And Computer Science
Degrees and Projected Job Openings



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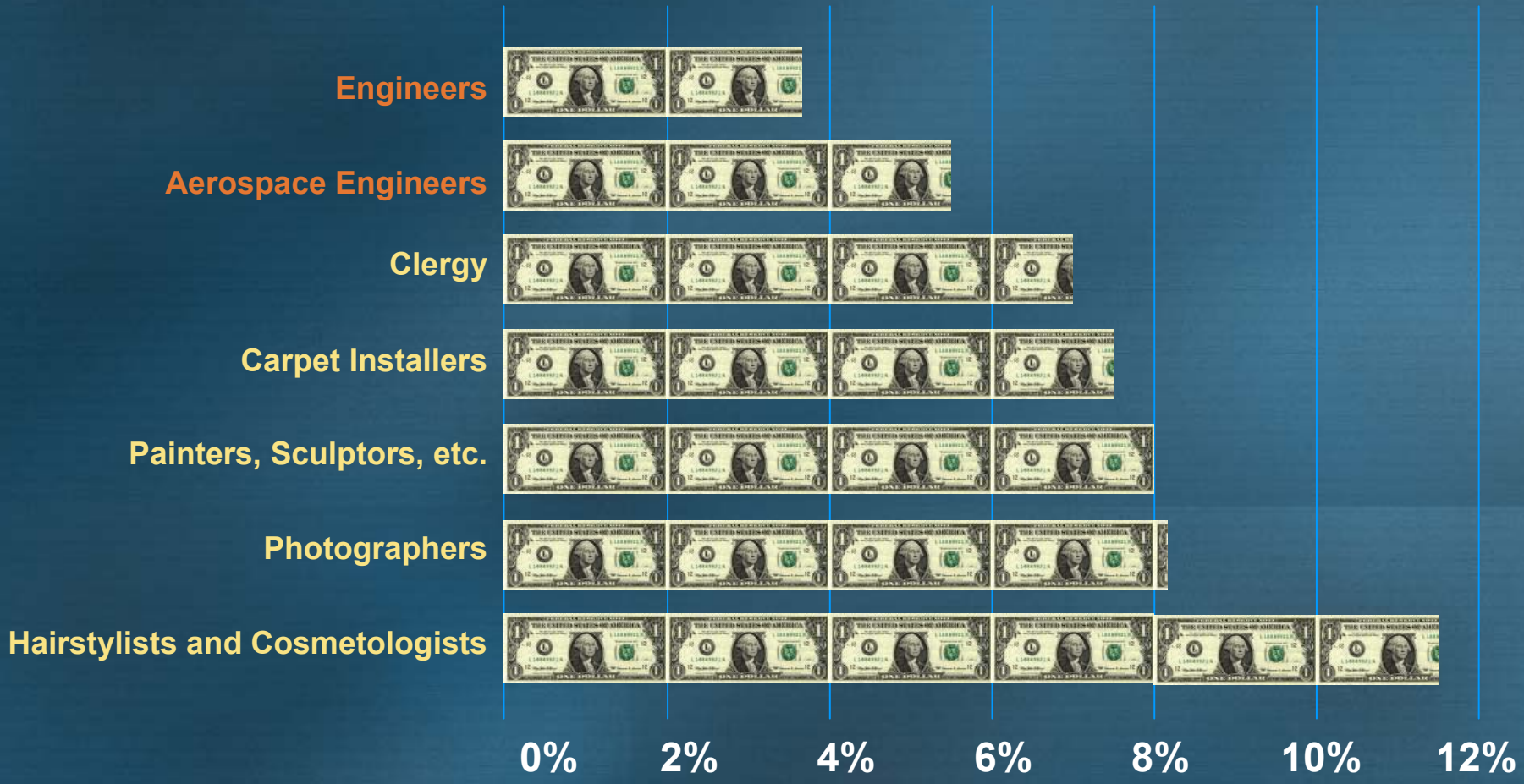
Some suggest that STEM graduates could be in oversupply because STEM wages are not growing at an aggressive rate

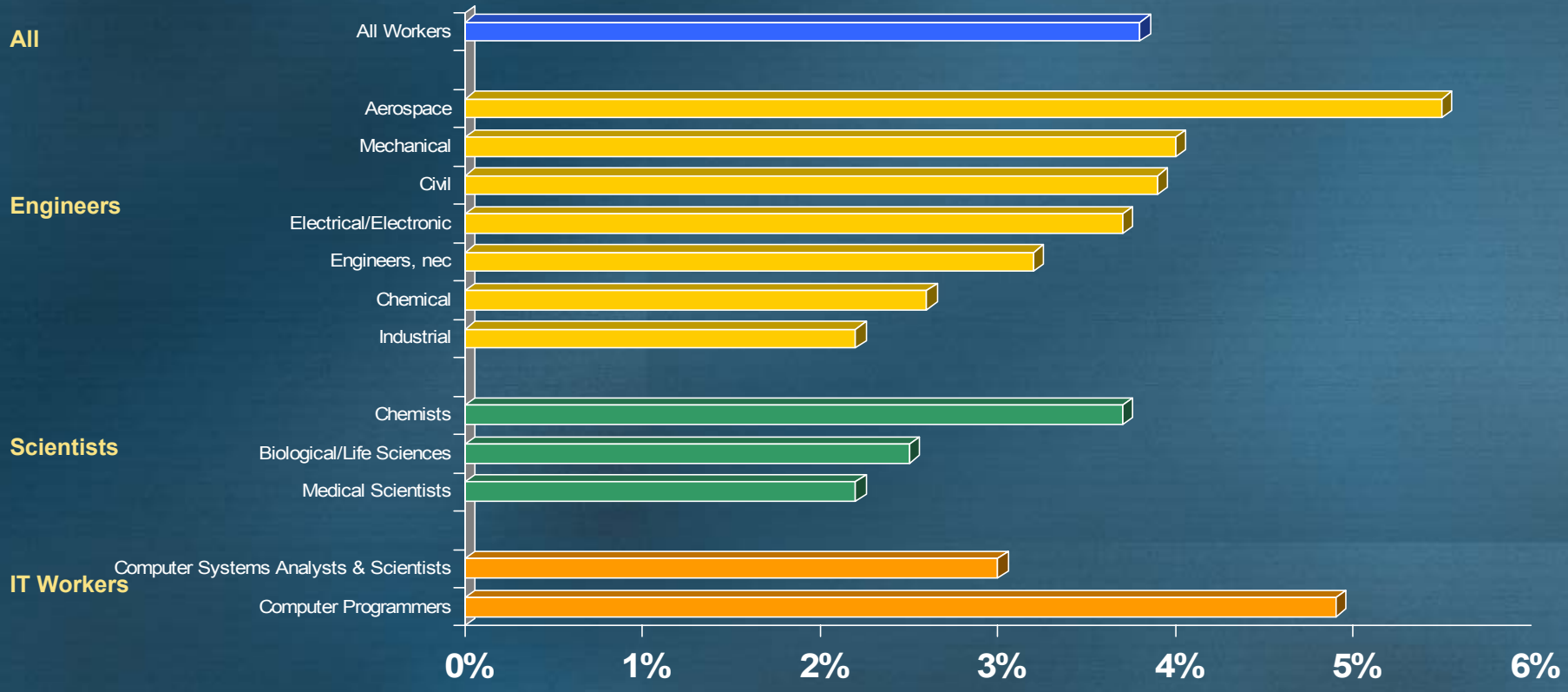
Source: “Is there a shortage of scientists and engineers?” - Rand Issue Paper, 11/02/02

Other Low-Tech Occupations

Have Enjoyed Faster Salary Growth



No Rapid Wage Growth For Scientists And Engineers



Sources: Department of Commerce analysis of U.S. Department of Labor, Current Population Survey (Annual Averages) data

Do We Need More STEM Workers?

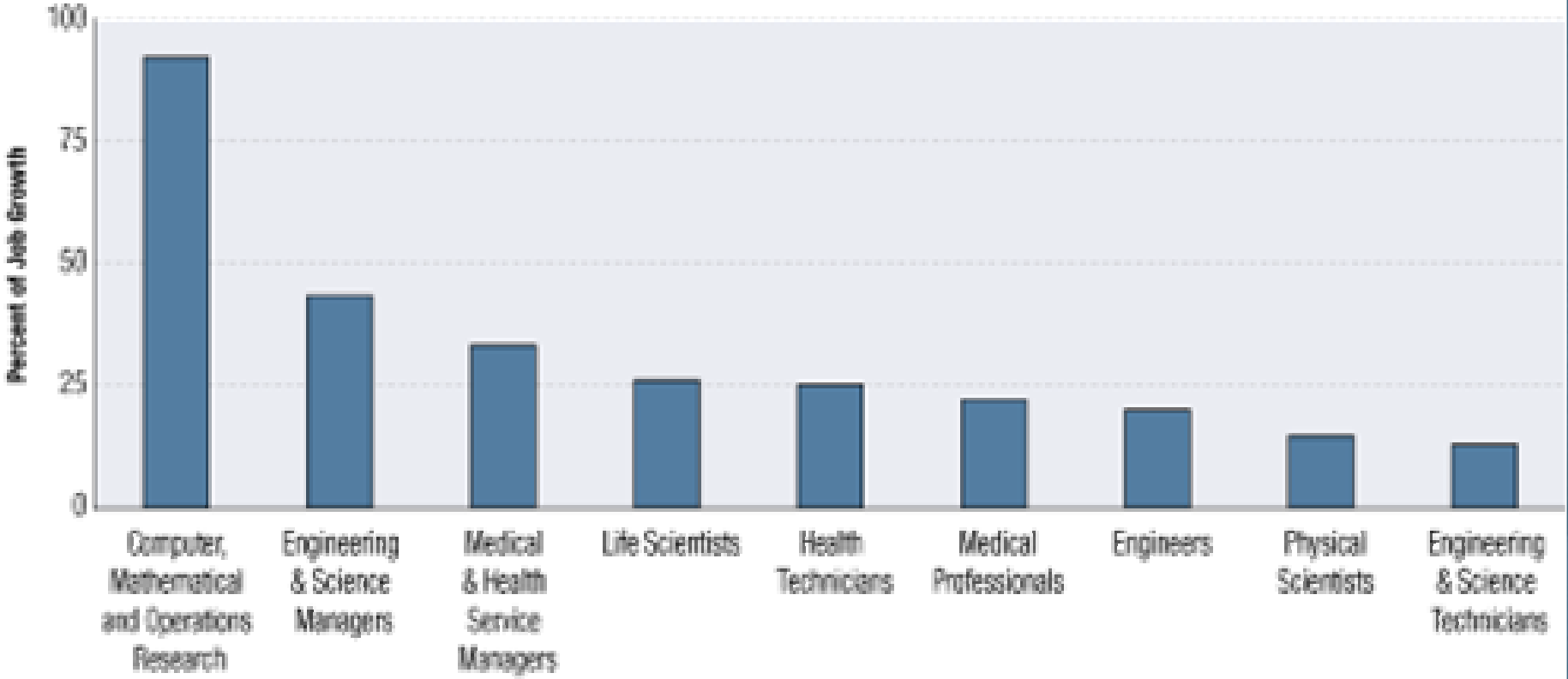
Conflicting Viewpoints!

Viewpoint 2:

- Continued growth of the U.S. S&E workforce needed to produce long term economic growth
  - Should ignore short-term economic slumps
  - Future employment opportunities promising

Jobs Requiring Technical Skills Are Projected to Grow by 51%

Projected New Job Growth by Technical Field, 1998-2008



Source: Council on Competitiveness, *U.S. Competitiveness 2001*

Labor market rates for recent doctorate recipients one to three years after Ph.D.: 1997 and 1999 (Percentages)

Ph.D. field	Unemployment rate		Involuntary out-of-field rate	
	1997	1999	1997	1999
All S&E	1.5	1.2	4.5	4.2
Engineering	1.0	0.9	3.6	2.7
Chemical	1.7	1.7	5.8	1.8
Civil	0.0	1.5	5.5	0.0
Electrical	0.6	0.7	3.2	2.5
Mechanical	0.5	0.3	2.7	3.2
Other	1.6	0.9	3.0	3.6
Life sciences	1.7	1.1	2.6	2.5
Agriculture	2.2	0.0	7.3	3.1
Biological sciences	1.5	1.3	2.2	2.5
Computer sciences and mathematics	0.6	0.8	6.5	4.1
Computer sciences	0.7	0.9	2.1	1.8
Mathematics	0.6	0.7	11.0	6.2
Physical sciences	2.1	0.4	6.9	6.6
Chemistry	3.5	0.5	3.3	2.4
Geosciences	1.0	1.2	6.3	9.4
Physics and astronomy	0.7	0.0	12.2	11.1
Social sciences	1.6	2.1	5.4	5.7
Economics	0.9	0.5	5.2	4.2
Political science	2.6	3.4	7.9	11.6
Psychology	1.2	1.0	3.8	3.5
Sociology and anthropology	2.5	1.6	7.7	11.9
Other	2.5	1.9	7.1	4.4

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Survey of Doctorate Recipients, 1997 and 1999.

Science & Engineering Indicators – 2002

Observations, So Far…

1. **Student performance in math and science is *related* to national economic growth!**

2. **Our nation is competing in a globalized economy and many U.S. students may not be *globally competitive* in math and science!**

3. ***Challenges* at all phases of the S&E Workforce supply chain!**
   - Dwindling numbers of STEM Ph.D's and B.S. degrees in U.S. may handicap our innovation base
   - Other countries are projected to surpass the United States in some STEM Ph.D's and B.S. degrees

4. ***Conflicting* viewpoints regarding the need to increase the future STEM Workforce!**

Observations

Recognize "Chicken and Egg" Phenomenon

- **Despite short term economic downturns (i.e., collapse of Tech bubble) and possible near term job losses…**

…"long-term" economic growth depends upon strong S&E Workforce that stimulates INNOVATION!

Observations

Short term, we may continue to lose our technology related industrial base to China, India, South Korea, Taiwan, Singapore, Ireland, etc.

Observations

Long term, many should realize that we are in a global competition for the technology related industrial base and we could significantly improve the science and math skills of our K-12 students

Why are our math and science scores so low in the U.S.?

Some experts say it is a teacher problem

National Commission On Math And Science Teaching For The 21st Century

John Glenn – Commission Chairman

September, 2000

- 56% of high school students taking physical science are taught by “out of field” teachers
- 27% for mathematics

Why Are Math And Science Scores So Low In The U.S.?

Committee for Economic Development
January, 2003 Report: Learning for the Future

- Low expectations
  - Less than half of 4th grade teachers teach 4th grade level content
- Low teacher quality
  - 93% of middle school science students are taught by “out of field” teacher
  - 70% for mathematics

Why Are Math And Science So Low In The U.S.?

Committee for Economic Development January, 2003 Report: Learning for the Future

- Problems with the curriculum
  - American Association for the Advancement of Science rated less than 10% of middle school math books as acceptable and no science books
- Retention of qualified teachers
  - Attrition for beginning teachers is 33% during the first three years and 46% during the first five years

Observations

- We have had 20 years of attempts to improve K-12 results and we still have much work ahead
- We may learn from other countries how to dramatically improve our K-12 results
- We may need to quickly launch experiments and change

Administration Initiatives to Improve Math & Science Education

"No Child Left Behind"

- Requires states to fill classrooms with teachers who are knowledgeable and experienced in math and science by 2005
  - all new teachers will have to be certified by the State, hold at least a bachelor's degree, and pass a rigorous State test on subject knowledge and teaching skills.
- Requires states to measure student's progress in math annually in grades 3 to 8 beginning in 2005, and student's progress in science at least once in three grade spans (3-5, 6-9, 10-12) each year beginning in 2007; and,
- Provides funding only to research-based programs that are backed by good evidence.

Administration Initiatives
"No Child Left Behind"

- **Math and Science Partnership (MSP) program**
  - brings together scientists and mathematicians from institutions of higher education with teachers and administrators from primary and secondary schools
  - increase and sustain the number, quality, and diversity of preK-12 teachers of mathematics and science, and enhance the capacity of schools to provide a challenging curriculum
    - pre-service education
    - alternative routes into the profession
    - induction
    - continued professional development
  - $260 M in 2003, $300 M in 2004 request (NSF & ED)

Administration Initiatives
National Science and Technology Council (NSTC)

- A Cabinet-level council of advisers to the President on Science and Technology
- Principal means to coordinate science and technology matters within the Federal research and development enterprise
- An NSTC Subcommittee is *currently examining K-12 math & science education*

Administration Initiatives

NSTC Subcommittee on Education and Workforce Development

- Chairs: Bill Berry-DOD & Judith Ramaley- NSF
- Facilitates strong coordinated effort & identifies priority needs
- Coordinates education efforts with policies to promote growth U.S. STEM Workforce
- Heavily weighted on “Measurements” of Success
- Two Future Activities
  - International Education Forum
  - Higher Education Reauthorization Act

Observations

- This Administration has several initiatives now underway to tackle K-12 math & science education…just a few are:
  - "No Child Left Behind"
  - NSTC Subcommittee on Education and Workforce Development
- Where can the PCAST best contribute?

PCAST S&E Workforce and Education Panel

- **Our Future Work**
  - Where should the panel focus its study?
  - Invite comments from full PCAST
  - Refine scope of work in Panel meeting today

Questions & Comments

The President's Council of Advisors on Science & Technology