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**The Role of Science in Our Society**  
Economics, Education, Impact on Thought

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### The Impact of Science

- **Basic research in science tends to focus on the fundamental properties of the natural world**
  - As opposed to applied research, product development
- **Basic research has many spinoff advantages**
  - Basic research develops *knowledge* base
  - Research funding builds bridges to *applications*
  - *New tools* move into the economy (WWW)
  - *People!*

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### Justification of Science Research Activity

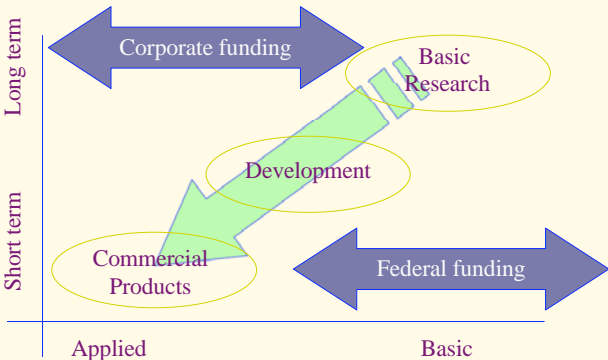
- **Improvements in quality of life**
  - Medical care, technology, creature comforts & gadgets
- **Satisfies our shared natural curiosity**
  - Only valid if scientists communicate effectively!
- **National Security**
  - Avoid technological surprises, etc.
- **Technology “spinoff” fuels the new economy**
  - Computers, WWW
- **Creation of new knowledge = the best education**

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### Basic Research and Applied Science/Technology

#### The Traditional View






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### Technological evolution/revolution

- In 1947, Shockley, Bardeen, and Brattain made the first transistor (called that only starting 1948)
  - 1951 before manufacturable transistor designed
  - 1954 before first transistor radio
  - 1967 first small calculators; 1971 first microprocessor
  - 1999 Pentium III with 10 million transistors, 1-inch sq.
  - long time between science breakthrough and product

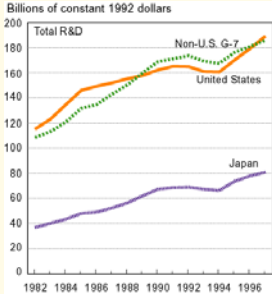
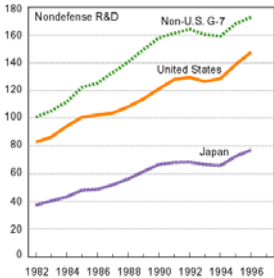




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### Science Spending in the G-7 World

- U.S. on top, more defense spending than most
  - amounts to a few percent of gross-domestic-product

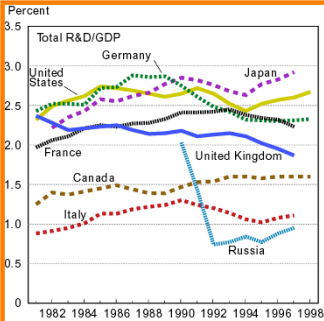
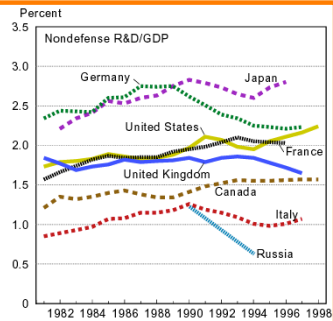



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### Research/Development Dollars Compared (G-8)

- U.S. no longer on top in this representation

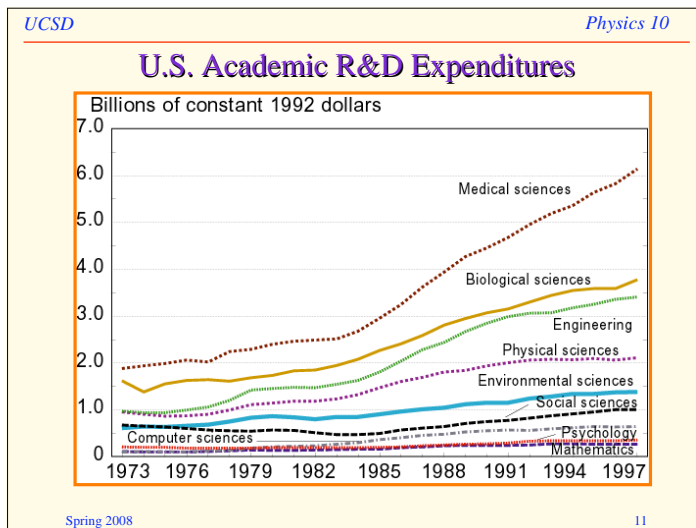
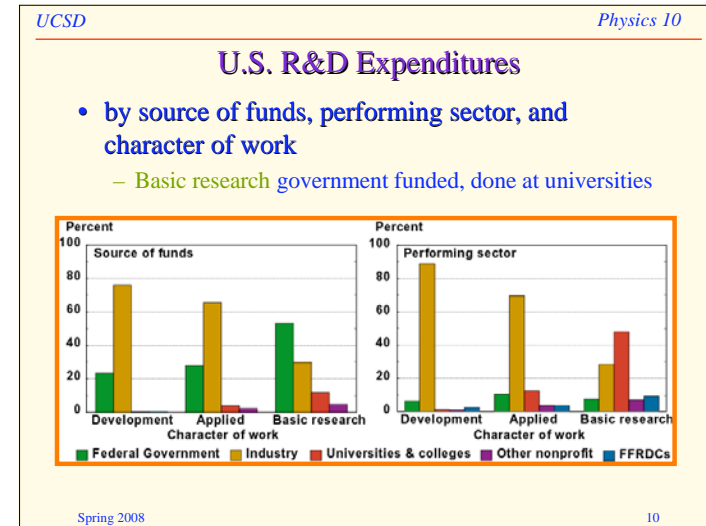
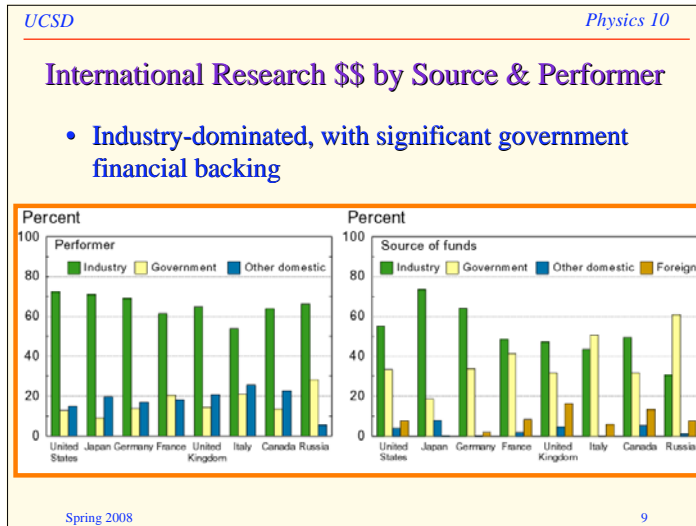
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### Present U.S. Science Funding Policy

- Foster science driven by scientists, as opposed to “directed” research
- Rigorous system of peer review (very competitive)
- Support *projects*, not people or institutions
- Diversity of federal agencies provide funding
  - National Science Foundation (NSF)
  - National Institutes of Health (NIH)
  - Department of Energy (DOE)
  - Department of Defense (DOD)
- No “Dept. of Science” or “Dept. of Technology”

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### A Typical University Research Grant

- Typical “single-investigator” physics research grant (1 yr):
  - Graduate student + benefits/tuition 40K\$
  - Travel funds 5K\$
  - Summer salary for Prof. 10K\$
  - Computing costs 5K\$
  - Equipment 40K\$
  - “overhead” at 50% (not eqpt) 30K\$
  - 100K\$/yr total
  - ~130K\$/yr total

This is a “small-scale” research project. They also come in X-L size.

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### Science Education in the U.S.

- US schoolchildren have skills consistent with international average in science and mathematics while in elementary school
- By the time they leave high school, performance in advanced math has fallen to the *bottom* of all countries tested in 1995 (TIMSS)
  - see [nces.ed.gov/timss/](http://nces.ed.gov/timss/) for more info

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### Public understanding of science terms/concepts, 1999

- Look how far ahead you guys are!

Statement	1999 (%)	1995 (%)	1997 (%)
Understands the term “molecule”	~15	~10	~10
Understands the term “DNA”	~30	~15	~15
Knows lasers do not work by focusing sound waves	~45	~15	~15
Electrons are smaller than atoms	~45	~15	~15
The Earth goes around the Sun once a year	~50	~15	~15
Earliest humans did not live at the time of the dinosaurs	~50	~15	~15
Knows that all radioactivity is not manmade	~70	~15	~15
Light travels faster than sound	~75	~15	~15
The continents are moving slowly about on the face of the Earth	~80	~15	~15

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### Public perception of astrology as scientific

Year	Not at all scientific (%)	Sort of scientific (%)	Very scientific (%)	Don't know (%)
1979	~50	~35	~10	~5
1981	~50	~35	~10	~5
1983	~55	~35	~10	~5
1985	~60	~30	~10	~5
1987	~60	~30	~10	~5
1989	~60	~30	~10	~5
1991	~60	~30	~10	~5
1993	~60	~30	~10	~5
1995	~60	~30	~10	~5
1997	~60	~30	~10	~5
1999	~60	~30	~10	~5

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### Where the U.S. prevails in education:

- While pre-college science/math education faces considerable challenges, U.S. higher education in technical fields is highly sought after worldwide
  - though this shows disturbing downward trend of late...
- The fact that *research* is done within U.S. Universities (like this one!) is likely the reason
- Provides opportunities to wrestle with real world challenges using/developing cutting-edge tools and techniques.
  - seek out these opportunities!
- Gives students solid experience in solving problems
  - you get out what you put in!

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### Science/Eng. PhDs awarded in U.S. per year

- About 40% foreign, many of whom stay in the U.S.

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### R&D labor force as fraction of total labor

- U.S. is among the best here, at just less than 1%

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### People are the Key

- Educated individuals constitute a vital pathway for technology transfer between academia and industry
  - no better way to master a technology than to employ that technology's master
- An increasingly educated and versatile workforce is (in my own view) *essential* to continued economic viability
  - alternative is stagnation, or playing “follow the leader”

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## Science and its Impact on Human Thought

- **Science offers fresh, often surprising perspectives**
  - the Universe is describable by mathematics
  - space and time are wrapped up inextricably together
  - uncertainty principle: impossible to know everything
  - the act of looking changes the nature of nature
  - we may have more dimensions than meets the eye
  - parallel universes?
  - extra-solar planets!
  - our place in the cosmos (speck on speck)
  - our very brief appearance on this planet

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## Impacts of Science

- **These often bizarre, unexpected ideas permeate our culture: uncertainty, relativity, parallel universes, evolution, possibility of life elsewhere...**
- **Often misused, but who cares? It's still an impact.**
  - especially in the hands of lawyers and film-makers
- **Impact on religion**
  - science discoveries don't adhere to our pre-conceptions
- **Science education impacts world politics**
  - harder to pull the wool over our eyes; can't have a leader sweep educated nation into emotional fervor

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## References, Announcements

- **References**
  - [www.pbs.org/transistor/](http://www.pbs.org/transistor/) for the story of the transistor as a prime example
  - <http://www.nsf.gov/statistics/>
    - NSF Indicators of Science & Engineering: lecture graphs from this source
- **Assignments**
  - Last Q/O due Fri. 6/06, by midnight
    - still opportunity for late submission through time of the final exam
- **Announcements**
  - Final Exam Fri. June 13, 3:00–6:00, WLH 2005
    - bring light-red half-sheet scantron, #2 pencil, calculator
  - Study guide posted online
  - **Study sessions in Solis 104: Wed. 8–10 PM, Thu. 8–10 PM**

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