

An Academic Perspective on the Globalization of Engineering

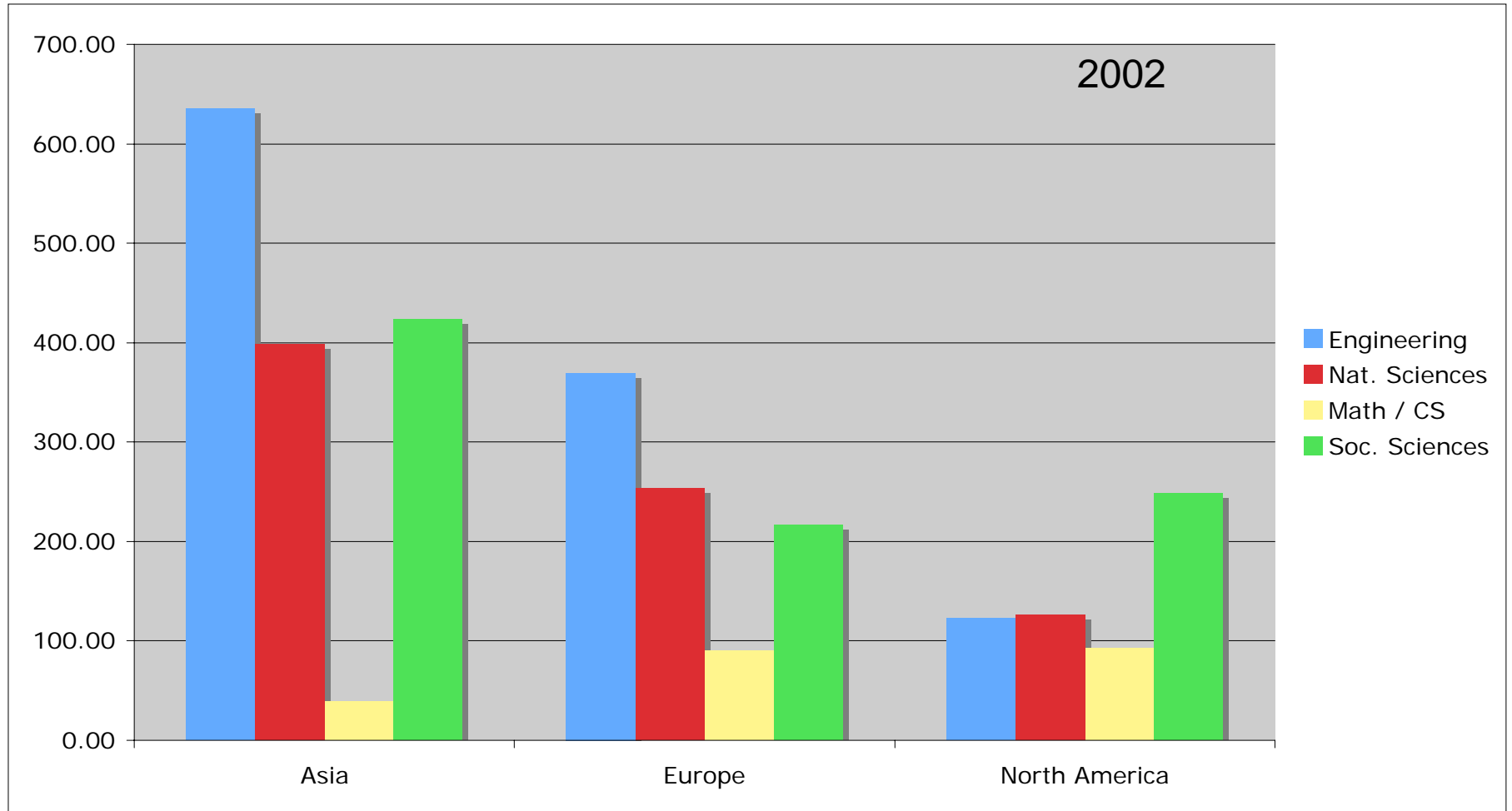
Charles M. Vest
President Emeritus, MIT

The Offshoring of Engineering:
Facts, Myths, Unknowns, and Implications
National Academy of Engineering
Washington, DC
October 24, 2006

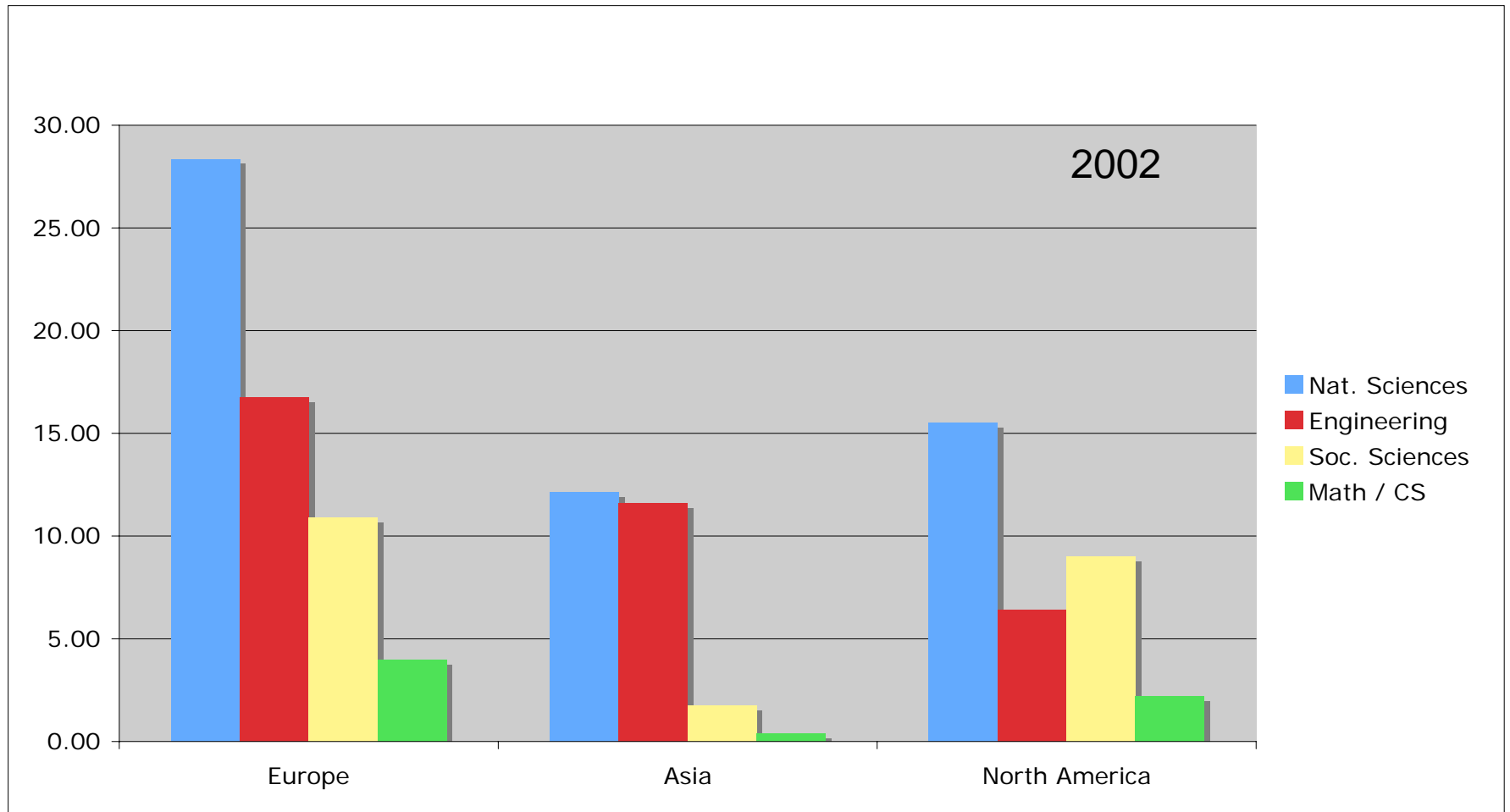
Start with the basics:

**Where the Expertise will be
in the Future**

First University S&E Degrees (Asia Dominates)



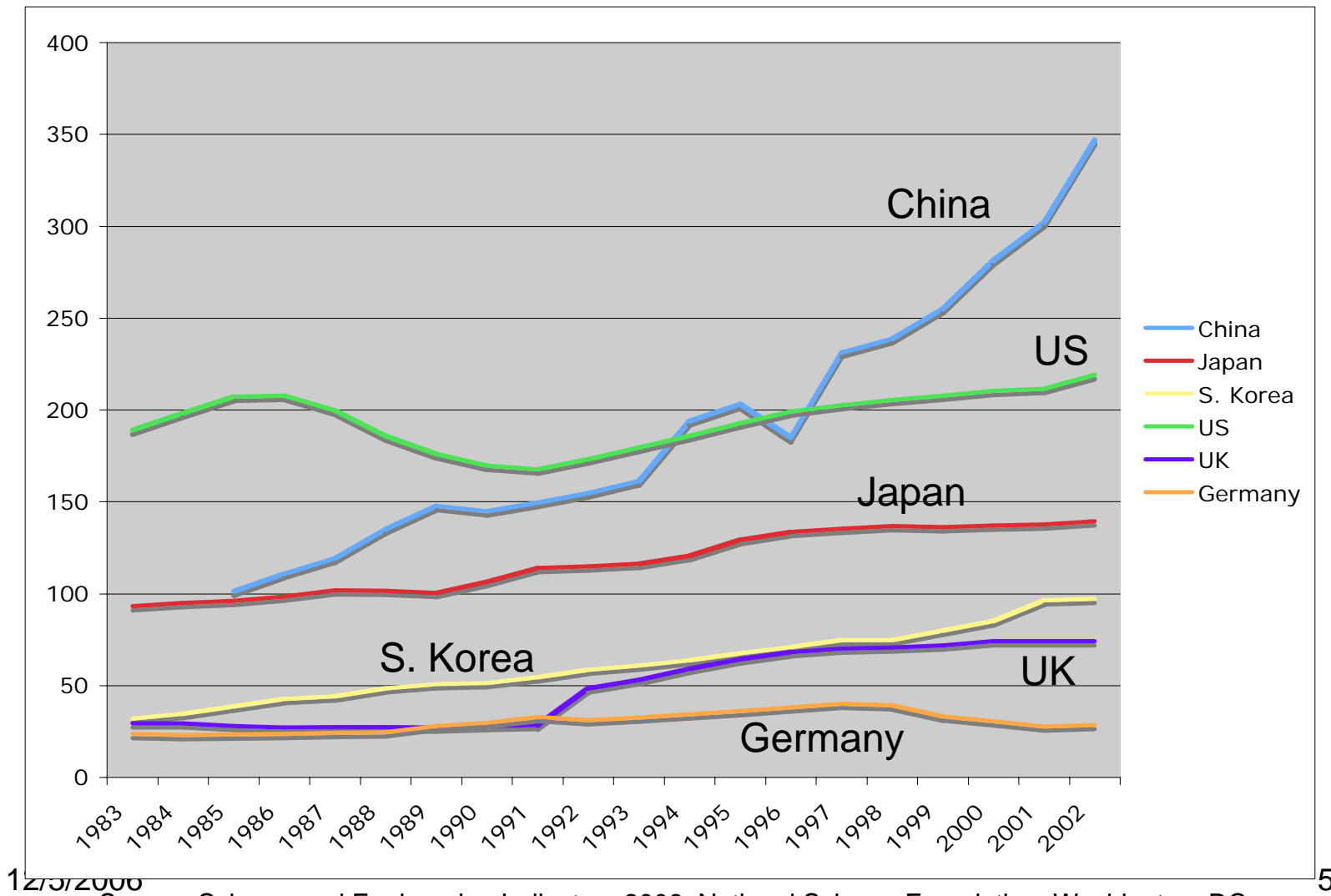
S&E Doctoral Degrees (Europe Leads.)



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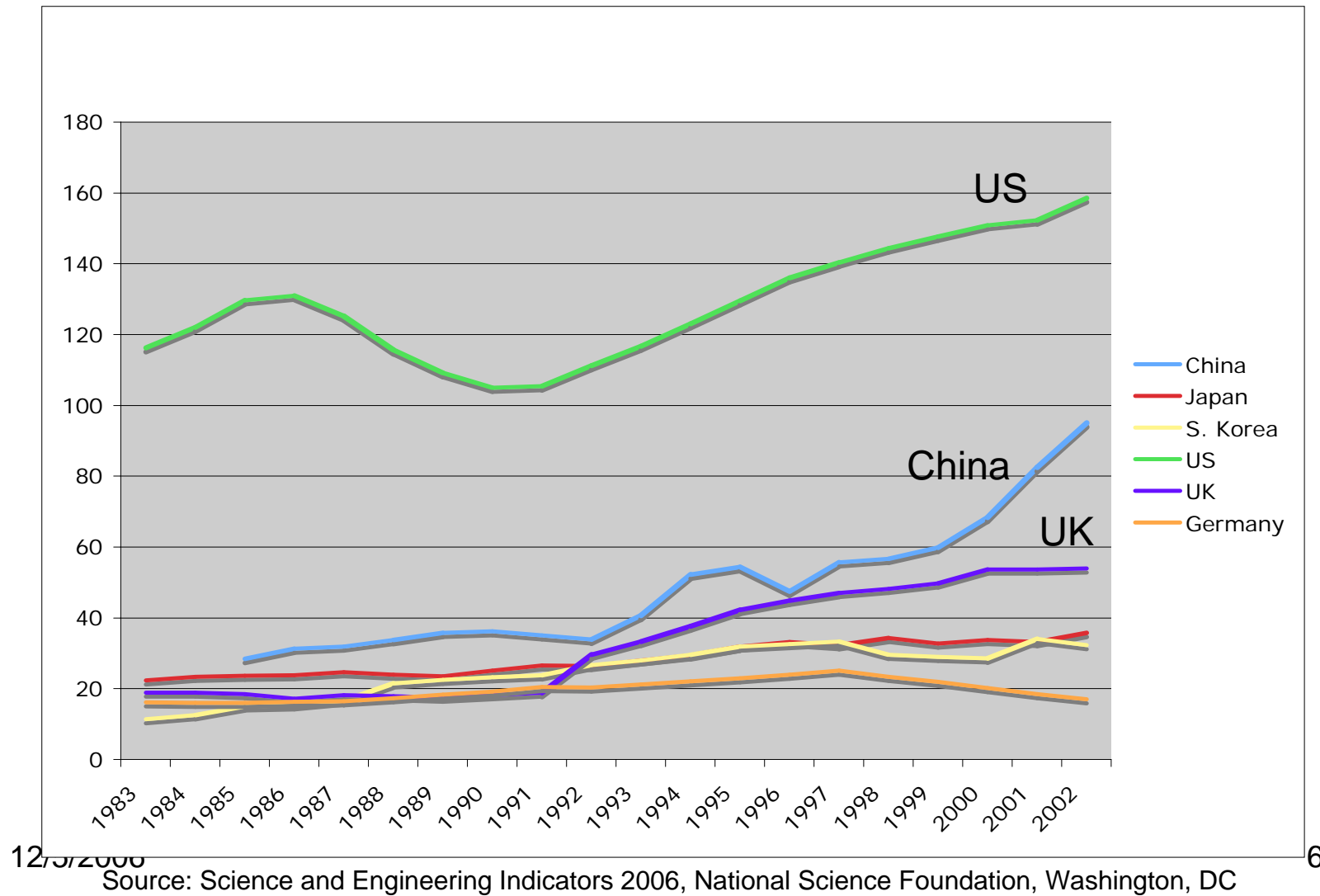
Source: Science and Engineering Indicators 2006, National Science Foundation, Washington, DC

First University S&E Degrees (China Rises.)



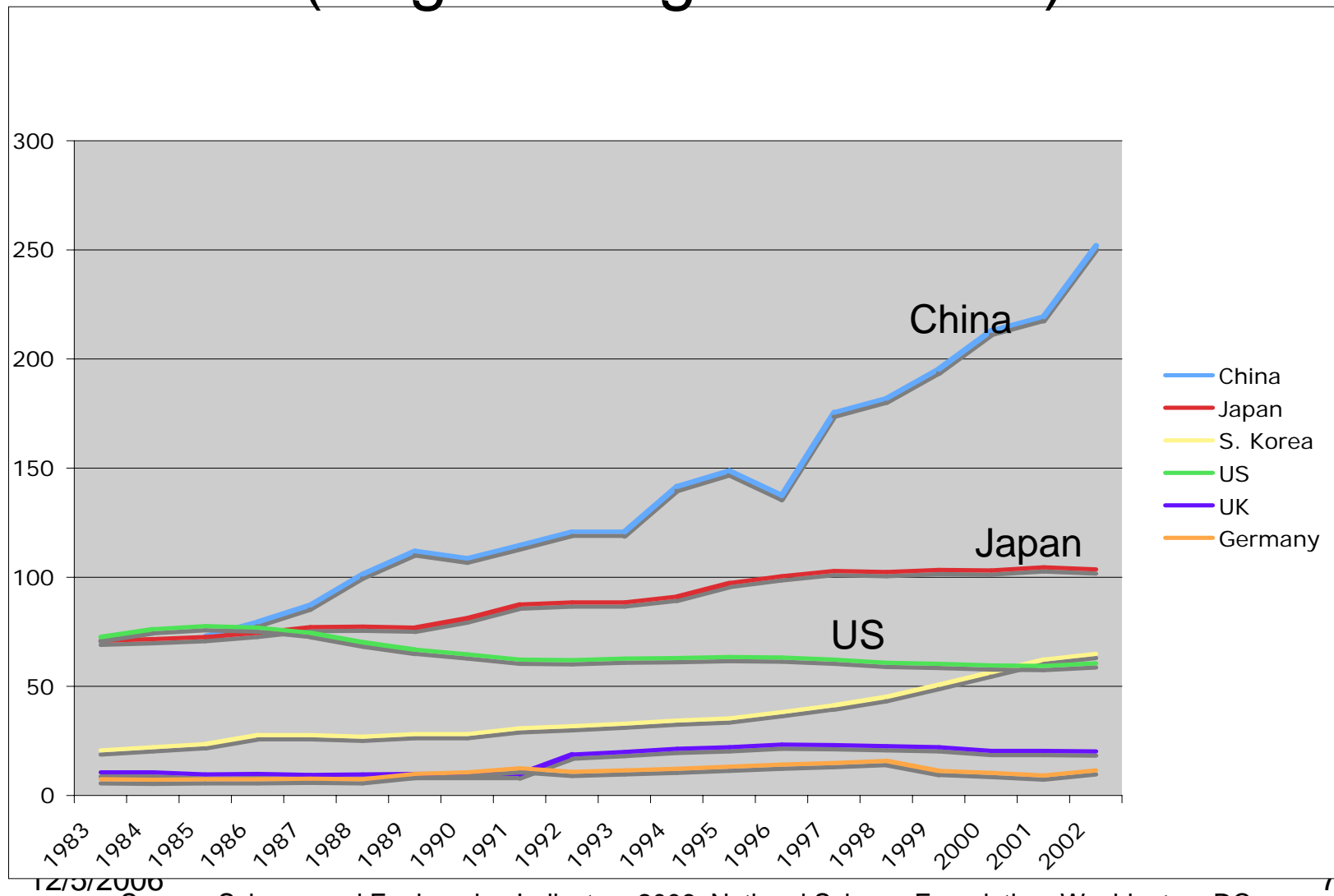
Source: Science and Engineering Indicators 2006, National Science Foundation, Washington, DC

First Natural Science Degrees (Science is one thing ...)



Source: Science and Engineering Indicators 2006, National Science Foundation, Washington, DC

First Engineering Degrees (Engineering is another.)



Source: Science and Engineering Indicators 2006, National Science Foundation, Washington, DC

Does it matter?

- Duke Study, etc.:
 - All degrees aren't created equal.
 - In proportion to population, there is no imbalance.
 - The marketplace (salaries) indicate no shortage.
 - Our universities are better.

*Profit Rises 53% at Infosys,
a Top Indian Outsourcing Company*

(NYT Headline October 12, 2006)

Skills Gap hurts Technology Boom In India

(NYT Headline October 17, 2006)

“A study commissioned by a trade group, the National Association of Software and Service Companies, or Nasscom, found **only one in four engineering graduates to be employable**. The rest were deficient in the required technical skills, fluency in English or ability to work in a team or deliver basic oral presentations.”

I think it does matter, because ...

We must compete in the global economy
and maintain our standard of living!

Prospering in the Knowledge Age requires
People with Knowledge.

The discussion is about the next generation.

An Important Debate
Location

Industry, R&D, and Innovation

Location Does Not Matter.

- *“The World is Flat”* -- Tom Friedman
 - In 1989 the Berlin Wall came down, and Microsoft’s Windows went up.
 - \$1.5 trillion worth of optical fiber connects the world.
 - Globalization has *“accidentally made Beijing, Bangalore, and Bethesda next door neighbors.”*
 - Many jobs are now just a *“mouse click”* away from anywhere..

Location Does Matter.

- The power of regional innovation clusters
- Proximity of small companies and corporate labs to universities
- Venture capital networks

Both are correct. But in any event, ... Globalization is the new reality.

Manufacturing Migration

- From the U.S.
 - To Taiwan
 - To Korea
 - To China
 - » To Viet Nam ...
- An Inevitable Flow?

Inevitable or not, this is serious business.

- Between 2000 and 2003, foreign firms built 60,000 manufacturing plants in China.
- In 2004 chemical companies closed 70 facilities in the U.S. and have tagged 40 more for shutdown.
- 120 major chemical plants are under construction.
 - One is in the U.S.
 - 50 are in China.

Or consider American IT manufacturing jobs

- 400,000 jobs were lost from Jan. 2000 - Dec. 2002.
- Overall U.S. manufacturing declined 6% 1997-2001, but computer manufacturing declined 20 %.

And consider U.S. corporate innovation and R&D

- 1970s: Central Corporate Research Labs
- 1980s: R&D Absorbed and Transformed into Product Development
- 1990s: Purchase High-Tech Startups to acquire Innovation

Holmdel Parking Lot during a Business Day in 2006

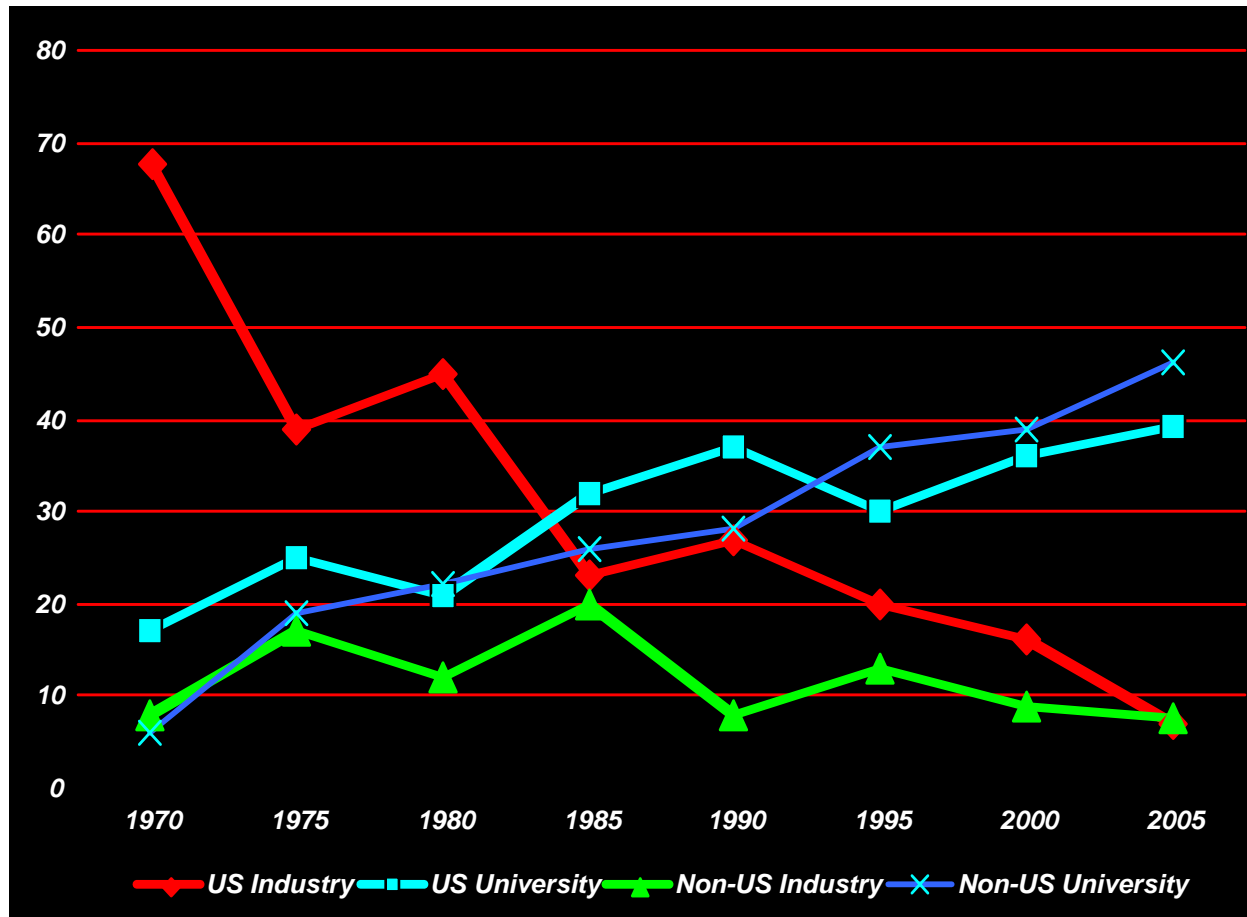


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Source: Robert C. Lucky

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Percent Authorship of Papers in IEEE Transactions on Communications



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Source: Robert C. Lucky

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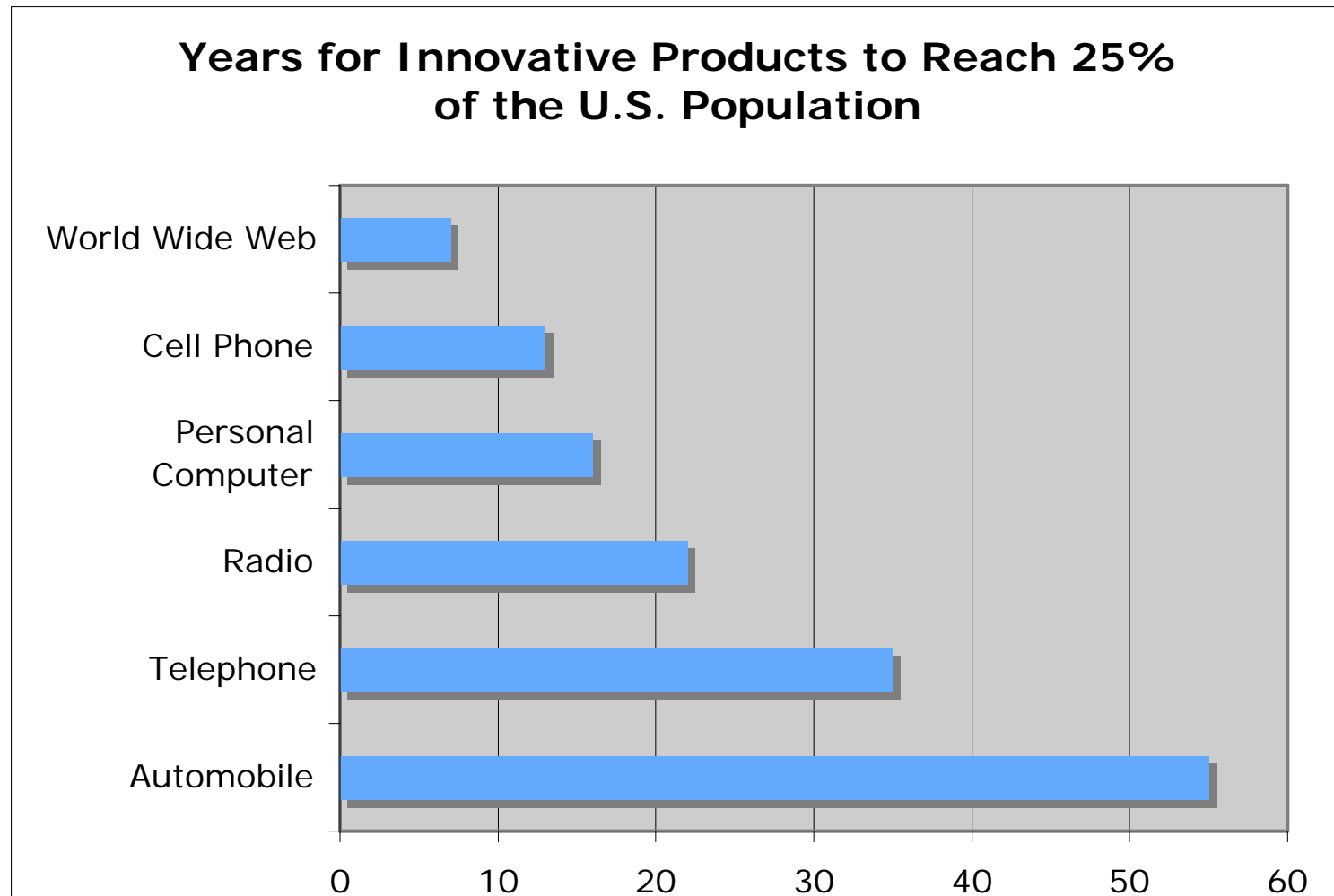
Industry, R&D, and Innovation are Migrating and Morphing. Why?

- Economics and Wage Rates
- The Internet and World Wide Web
- Tax and Trade Policies
- But also ...

Industry, R&D, and Education are Migrating and Morphing. Why?

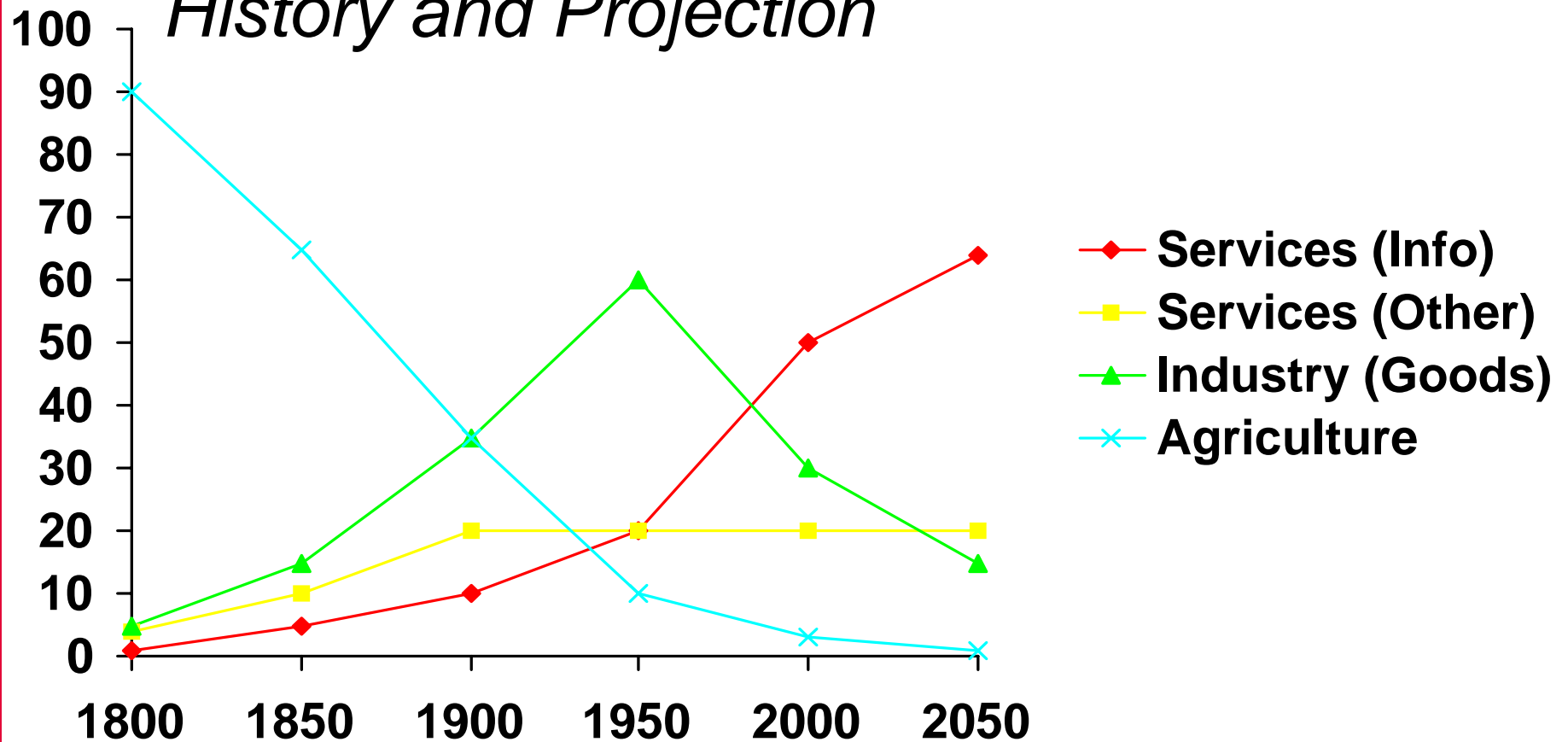
- Economics and Wage Rates
- The Internet and World Wide Web
- Tax and Trade Policies
- But also ... **Speed and Complexity**

Why Everyone is in a Hurry.



U.S. % Employment by Sector

History and Projection



Source: Stuart Feldman, IBM Research, Presentation at Carnegie-Mellon University, 29 June, 2005

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Population and development are shifting rapidly.

Goldman Sachs analysts estimate that in about a decade 80% of the world's *middle-income* consumers will live in nations outside the currently industrialized world.

Add to all this Two Facts

- People everywhere are smart and capable.
- The Internet and World Wide Web are democratizing forces.

And New Models Emerge:

For example:

Harry Chesbrough

(Harvard Business school)

- ***Open Innovation***

- Companies today must integrate the best ideas, no matter where they originate.
 - In other countries
 - In other companies or laboratories
 - Even in competing organizations.
- New, dynamic business models are needed for an open, connected world.
 - Licensing
 - Partnering
 - Joint Venturing

Or
Sam Palmisano
(CEO, IBM)

- ***The Globally Integrated Enterprise***
 - Supercedes the multinational corporation
 - Driven by globally shared technologies and standards built on global IT
 - Focus shifted from products to production
 - New borderless strategy, management, and operations for integrated production and value delivery.

Life today isn't simple.

- Sony and Toshiba Excel at Computer Games
- IBM excels at sophisticated chips.

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Los Alamos orders
Largest Supercomputer
Based on these chips

An Important Debate
Location

So what about Education?

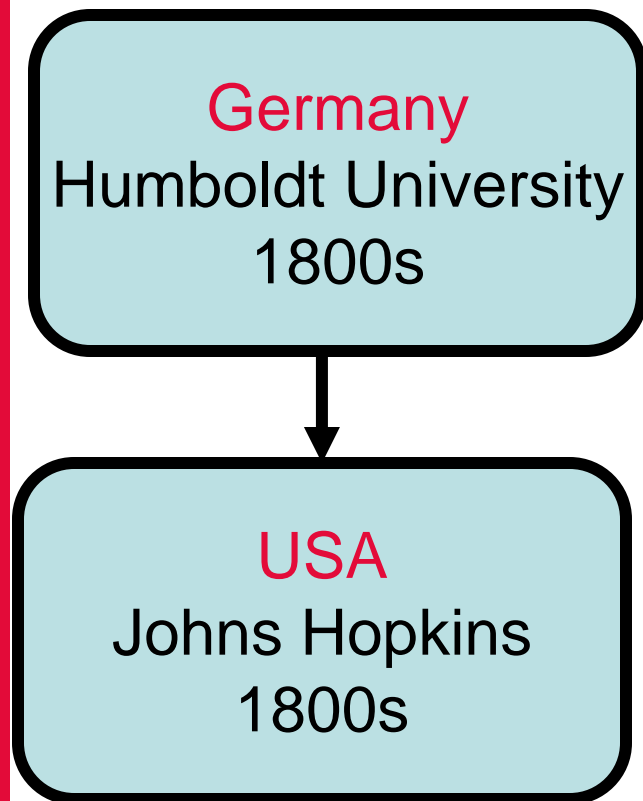
Well, ...

Research University Globalization Part I

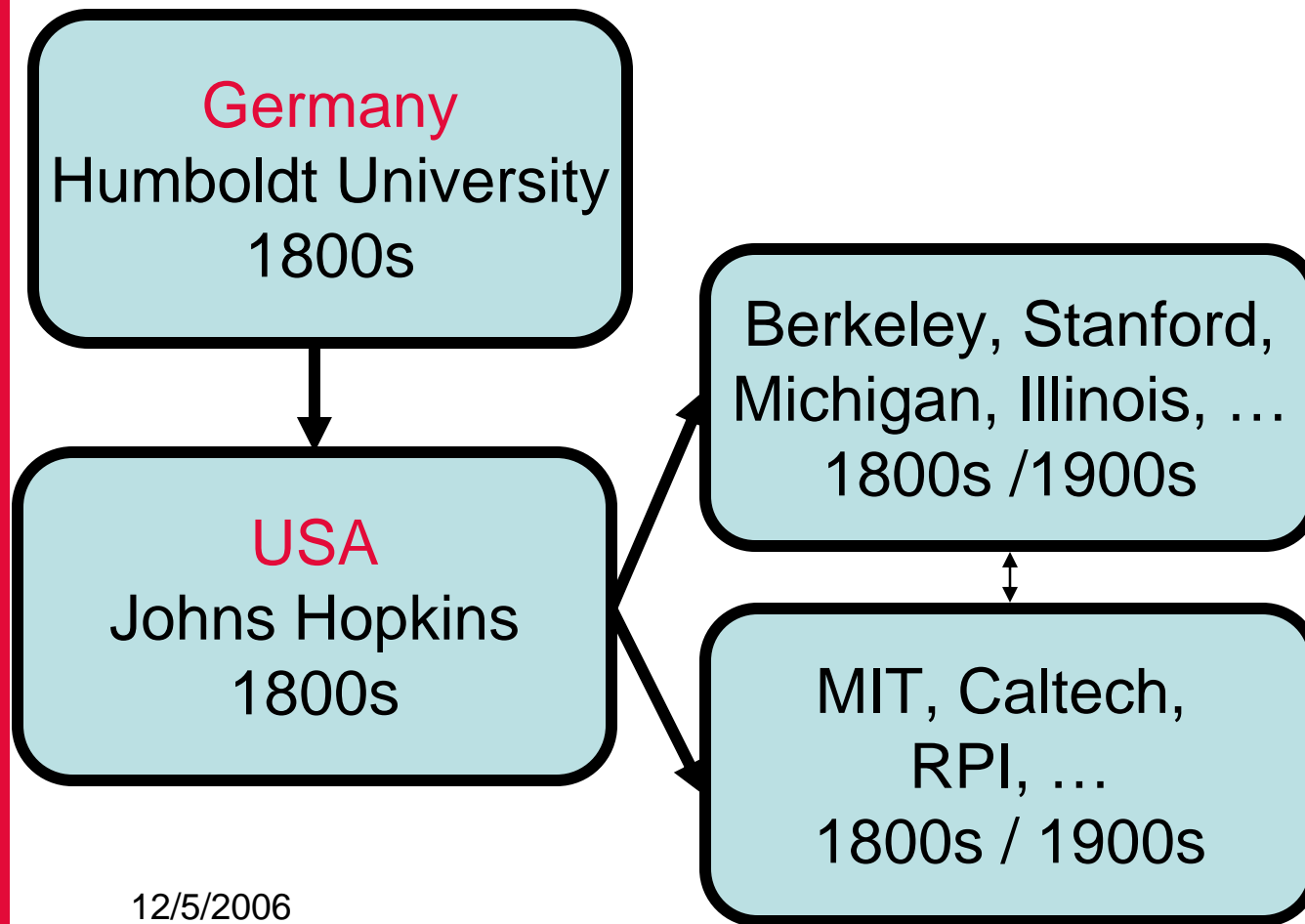
Germany

Humboldt University
1800s

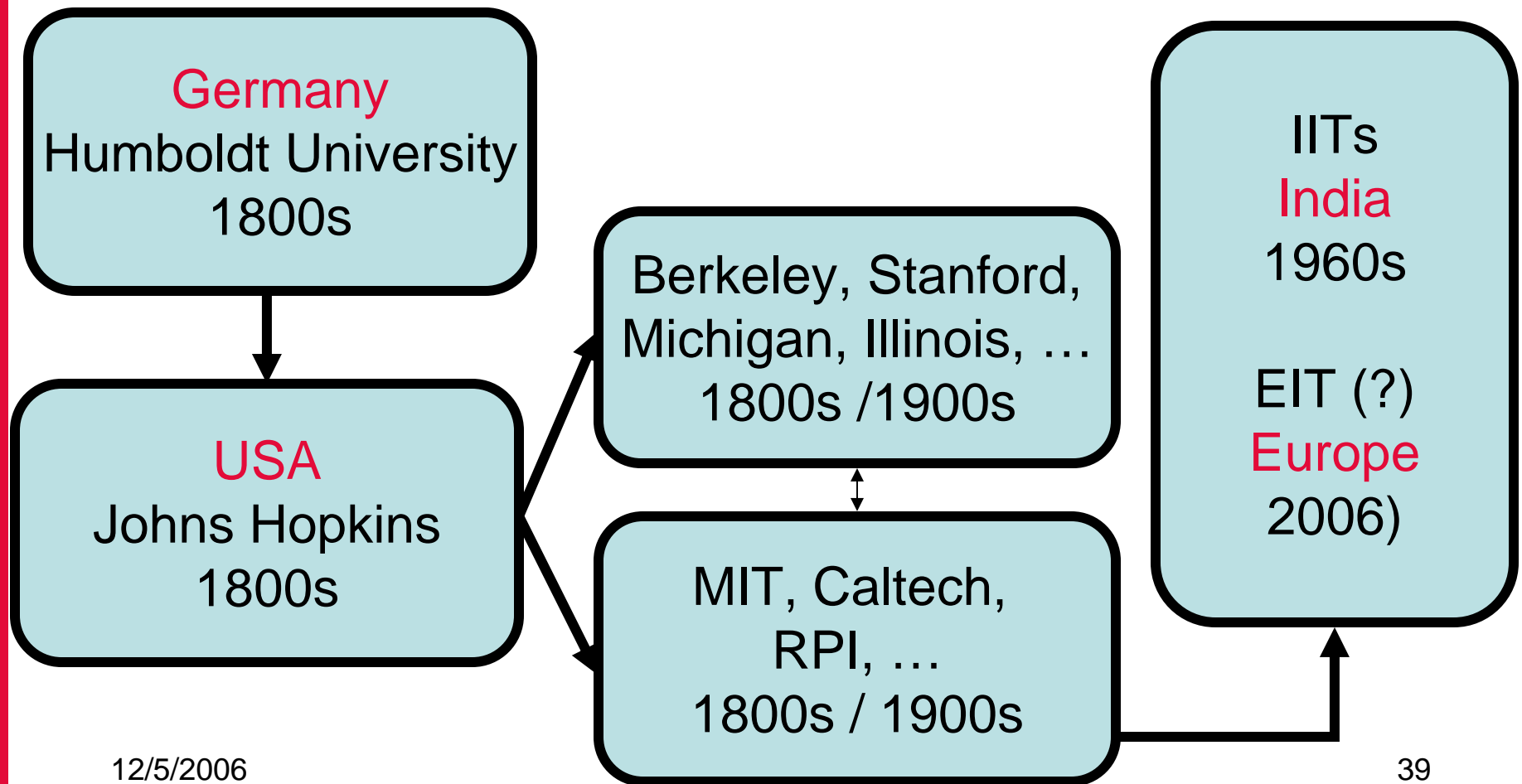
Research University Globalization Part I



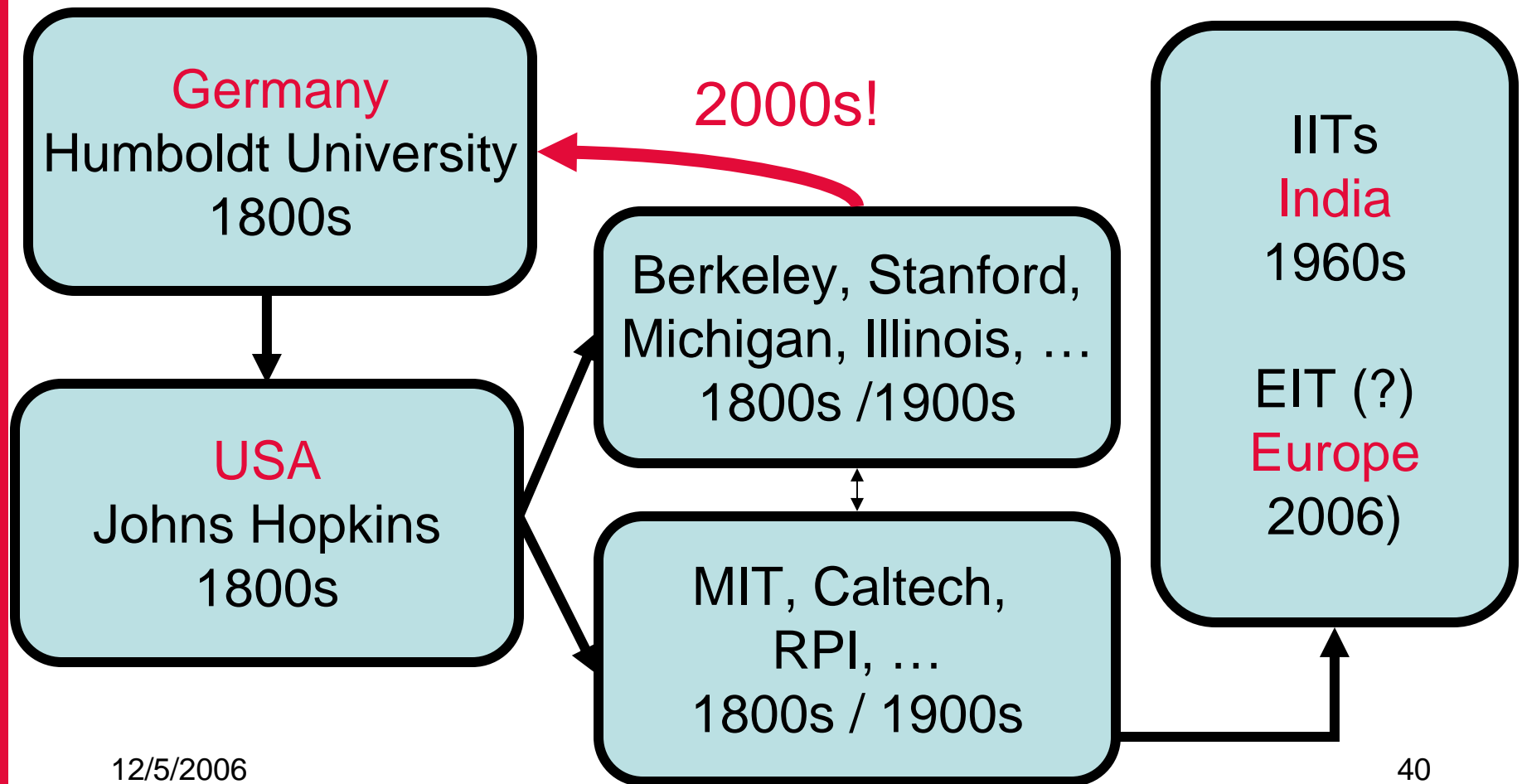
Research University Globalization Part I



Research University Globalization Part I



Research University Globalization Part I



Research University Globalization Part II

- Physical Presence in Other Countries
 - Campuses
 - Laboratories

Research University Globalization Part II

- Physical Presence in Other Countries
 - Campuses
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- Strategic Alliances Between Universities

Research University Globalization Part II

- Physical Presence in Other Countries
 - Campuses
 - Laboratories
- Strategic Alliances Between Universities
- Virtual Presence in Other Countries
 - Distance Education
 - Synchronous
 - Asynchronous
 - Open Content: The Emerging Meta-University
 - Teaching Materials
 - Telepresent Laboratories

Res. Univ. Globalization Part III

Global Engineering Excellence

Educating Engineers for the 21st Century

- Sponsor: Continental
- Study Team:
 - ETH Zurich
 - Georgia Tech
 - MIT
 - Shanghai Jiao Tong
 - Tech. Univ. Darmstadt
 - Tsinghua
 - E. P. U. Sao Paulo
 - Univ. of Tokyo

Summary

Research University Globalization

- Propagation / Emulation
- Overseas Campuses / Research Facilities
- Multinational Alliances
- Distance Education
- The Meta-University (Digital Convergence)
- Redefining Curricula / Goals for Globalization

Looming Policy Clouds

- Deemed Exports Controls
- Continuing Visa Issues
- Overdependence on foreign graduate students

Closing Comment

- The U.S. is the most innovative nation on the planet.
- We have the best research universities.
- We are king of the hill in R&D.
- We have comparative advantages:
 - Strong S&T base
 - Free-market economy
 - Democracy and freedom.
- But ...

The enemy I fear most is

The enemy I fear most is

COMPLACENCY.

So don't forget:



RISING ABOVE THE GATHERING STORM

*Energizing and
Employing America
for a Brighter
Economic Future*

NATIONAL ACADEMY OF SCIENCES,
NATIONAL ACADEMY OF ENGINEERING, AND
INSTITUTE OF MEDICINE
OF THE NATIONAL ACADEMIES

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Thank you.