



THE COUNCIL FOR CHEMICAL RESEARCH

Economic Impact of Investments in Chemical Sciences

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Outline

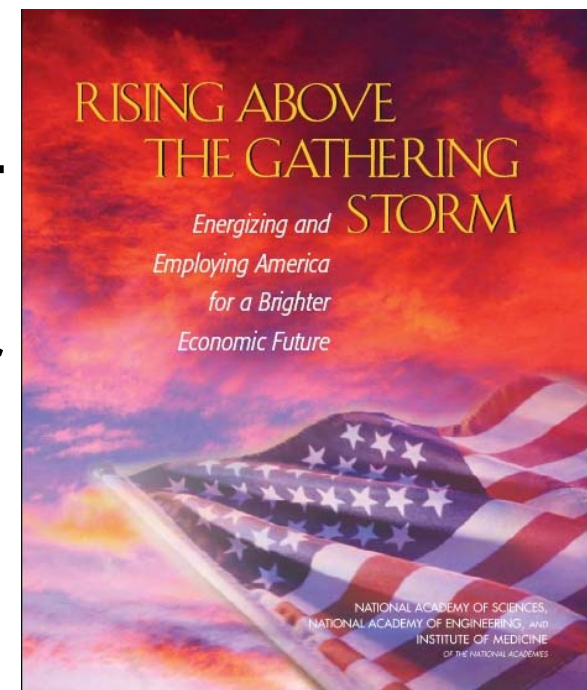
- *S&T infrastructure, Innovation, and Economic Growth*
- *Globalization and Open Innovation*
- *CCR's Role in Promoting Industry-University Partnerships*
- *Economic Impact of Investments in Chemical Sciences*
- *Impact of Chemical Sciences on Other Industry Segments*
- *Conclusions*



...The Gathering Storm

- Increase America's talent pool – improve K-12 science and math education
- Sustain and strengthen the nation's traditional commitment to long-term basic research...
- Make the U.S. the most attractive place...for the best and brightest... from around the world
- Ensure that the U.S. is the premier place in the world to innovate

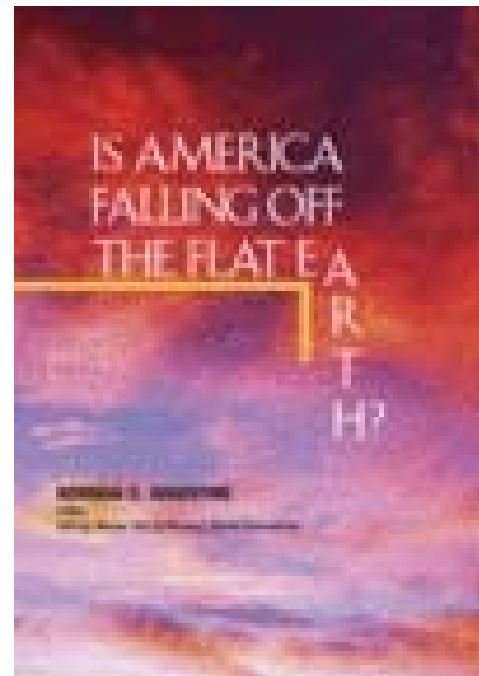
The Council for Chemical Research





Is America Falling off the Flat Earth?

- The U.S. share of world's leading-edge semiconductor manufacturing capacity dropped from 33% to 11% in the past 7 years
- Chemical companies closed more than 100 facilities in the U.S.; 50 new facilities in China; only one in U.S.
- No new refineries built in the U.S. during the last 30 years.
- Toyota ended GM's 75 year reign as the world's largest auto manufacturer





Sustaining America's Competitive Edge

- Fundamental research of the past is critical to technological success of the present
- S&T will assure US leadership in areas of great significance
- Need to respond to the calls for enhancing the investment in basic research
- Need to develop S&E human resources
- S&T tools vital to leadership
- Teamwork between academia and industry must be encouraged

The Council for Chemical Research





Action Items

- Take advantage of the best research universities to promote U.S. innovation
- Promote industry-university partnerships
- Support basic research as the foundation for U.S. innovation and competitiveness
- Research funding is an ***investment*** – it provides excellent return on investment!



Globalization and Open Innovation

“Open Innovation means that companies should make much greater use of external ideas and technologies in their own business, while letting their unused ideas be used by other companies...With a more open business model, Open Innovation offers the prospect of lower costs, faster times to market and the chance to share risks with others.”

*Open Innovation: The New Imperative for
Creating and Profiting from Technology*

Henry W. Chesbrough

Globalization and open innovation necessitates more effective partnerships between industry, academia and government laboratories



Council for Chemical Research

The Council for Chemical Research (CCR) was created in 1979 to improve trust and collaboration between the public and private research sectors.

“CCR's purpose is to benefit society by advancing research in chemistry, chemical engineering, and related disciplines through leadership collaboration across discipline, institution, and sector boundaries.”



CCR Membership

- Represents research leadership in 3 sectors
 - Industry (~30 corporations)
 - Academia (~130 research universities)
 - Government Labs (~10 national labs)

“Collaboration, Sustainable Feedstocks and the Chemical Enterprise of the Future” – 2007 Annual Meeting

“Chemical Research at the Crossroads: The Impact of Globalization on Innovation, Competitiveness and Education” – 2008 Annual Meeting



Joint Industry-University Activities

- **NIChE Conferences**

- ***“Ionic Liquids: Background, State-of-the-Art, and Applications”***, Feb. 2005
- ***“Advanced Polymers: Developing High-performance Polymeric Materials for the Future”***, Feb 2006
- ***“Biobased Feedstocks”***, June 2007
- ***“Carbon Capture and Sequestration”***, Oct. 2008

- **Workshops**

- ***“Intellectual Property Issues Affecting Industry-University Partnerships”***, April 2008



1987 Nobel Prize

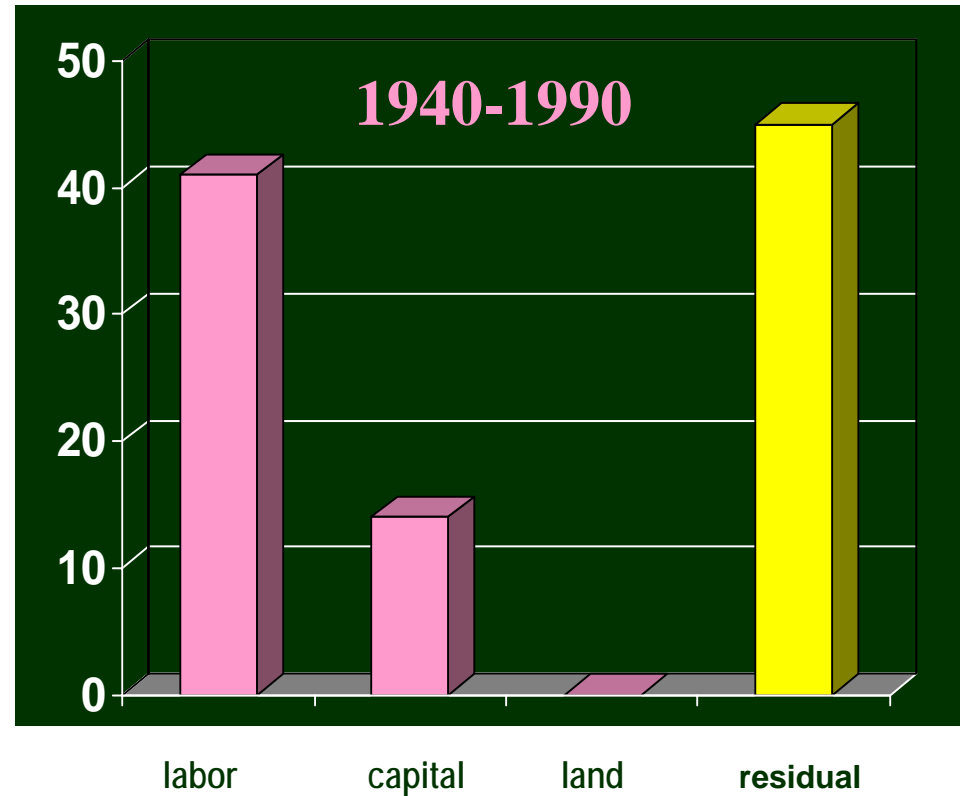
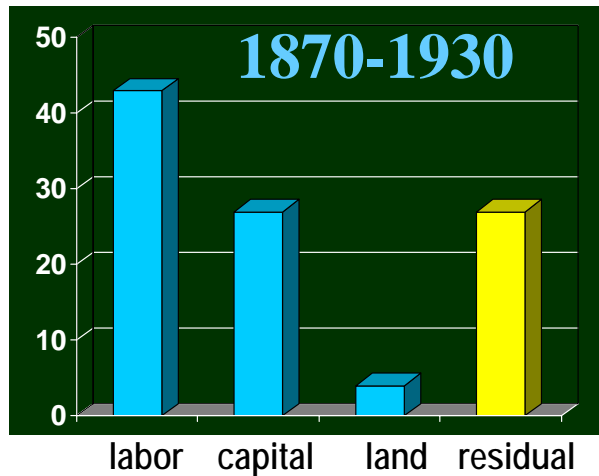
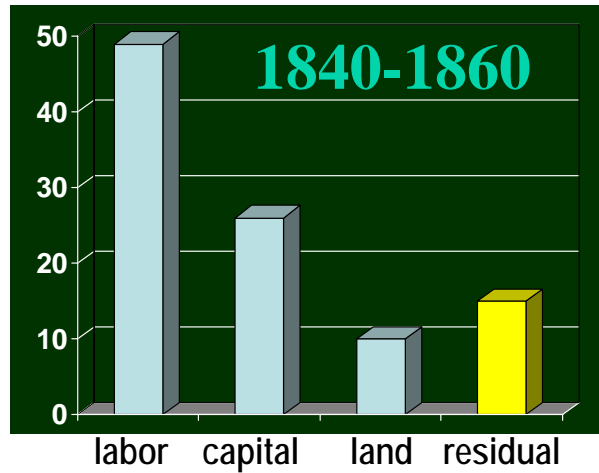
Robert M. Solow, a professor at the Massachusetts Institute of Technology, was awarded the 1987 Nobel Prize for Economics for identifying technological change as the chief factor underlying economic growth.

His 1957 article, "*Technical Change and the Aggregate Production Function*," showed that half of economic growth cannot be accounted for by increases in capital and labor. He then demonstrated that technological change—ignored by mainstream theory—is responsible for that unaccounted-for portion of economic growth—now called the "Solow residual."





Measuring the “Solow” Residual

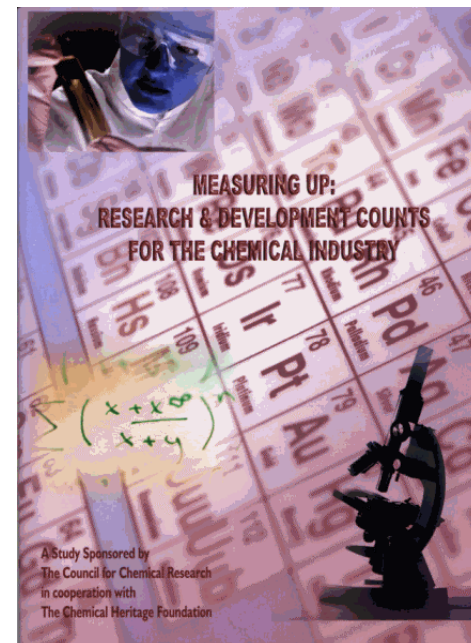




Phase I Results

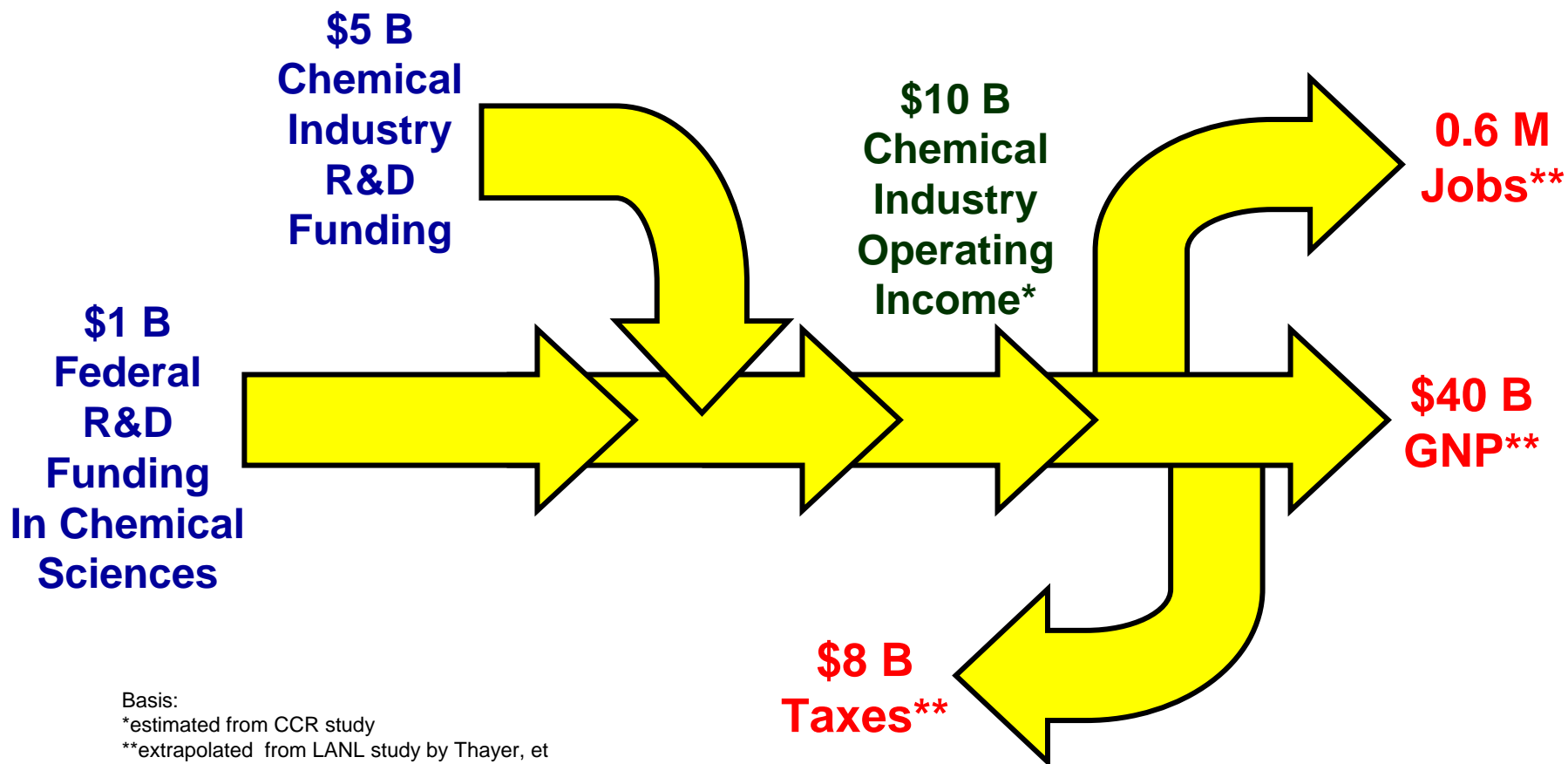
- **\$2 Operating income per \$1 R&D invested**
 - 17% after tax return
- **Publicly funded science links highly to chemical patents, 6 citations per patent**
- **Published Summer, 2001:**

“Measuring Up: R&D Counts for the Chemical Industry”





Macroeconomic Implications



Basis:

*estimated from CCR study

**extrapolated from LANL study by Thayer, et al., April 2005 using REMI economic model



Phase II Study

- **Published February 2006**

***“Measure for Measure:
Chemical R&D Powers
the U.S. Innovation
Engine”***

***MEASURE FOR MEASURE:
CHEMICAL R&D POWERS
THE U.S. INNOVATION ENGINE***

A Study Sponsored by
The Council for Chemical
Research



Phase II Study

- **What are the financial payoffs for technology quality, innovation speed and strong scientific links?**
- **What industries are significantly impacted by the chemical sciences?**
- **How long does it take for public funded science to yield commercial innovation?**



Conclusion: Strong Technology Pays Off

Chemical companies with strong patent portfolio indicators tend to exhibit consistently strong financial performance, such as higher stock market valuations (35-60% higher on average)

- Correlation between CII (patent impact) and financial performance is particularly strong**
- Correlations between financial performance and SL (science linkage) and IS (innovation speed) are also positive**



The 15 Industries (1151 companies)

- **Automotive*** (90)
 - **Biotechnology*** (41)
 - **Chemicals*** (143)
 - **Computers & Semiconductors*** (164)
 - **Electrical & Electronics*** (116)
 - **Energy** (34)
 - **Engineering, Oil Field Services** (5)
 - **Food, Beverage & Tobacco*** (28)
 - **Forest, Paper, Textiles*** (37)
 - **Health Care** (78)
 - **Instruments & Optical** (49)
 - **Materials** (24)
 - **Metals & Mechanical** (238)
 - **Pharmaceuticals*** (58)
 - **Telecommunications*** (46)
- * - denotes names that are very similar to the names of a technology



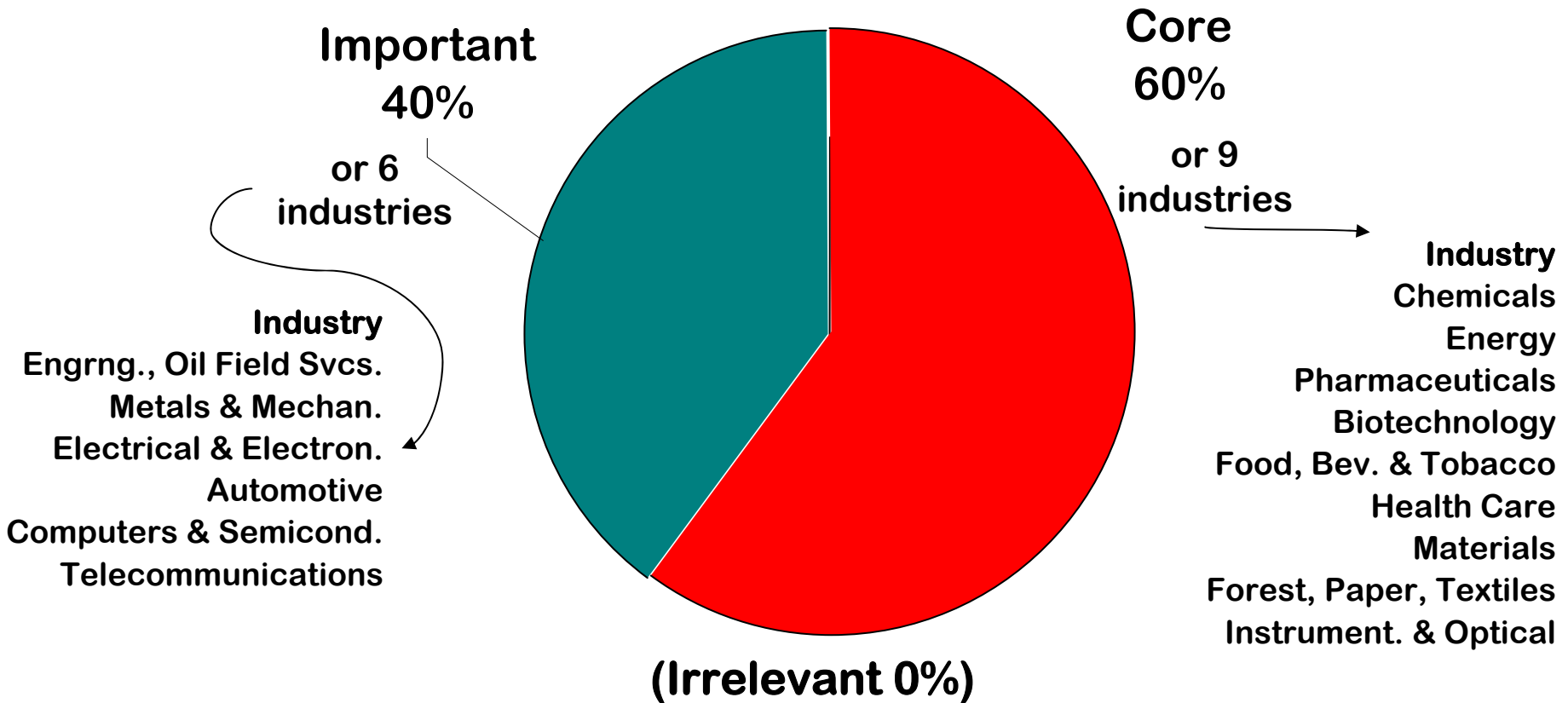
The 29 Technologies

- **Aerospace & Parts**
 - **Agriculture**
 - **Biotechnology***
 - **Chemicals, Plastics, Polymers & Rubber***
 - **Computers & Peripherals***
 - **Electrical Appliances & Components**
 - **Fabricated Metals**
 - **Food & Tobacco***
 - **Glass, Clay & Cement**
 - **Heating, Ventilation & Refrigeration**
 - **Industrial Machinery & Tools**
 - **Industrial Process Equipment**
 - **Measurement & Control Equipment**
 - **Medical Electronics**
 - **Medical Equipment**
 - **Miscellaneous Machinery**
 - **Motor Vehicles & Parts***
 - **Office Equipment & Cameras**
 - **Oil & Gas, Mining**
 - **Other**
 - **Other Transport**
 - **Pharmaceuticals***
 - **Power Generation & Distribution**
 - **Primary Metals**
 - **Semiconductors & Electronics***
 - **Telecommunications***
 - **Textiles & Apparel***
 - **Wood & Paper***
- * – denotes names that are very similar to the names of an industry



Chemical technology creation is core or important in all 15 of the industries

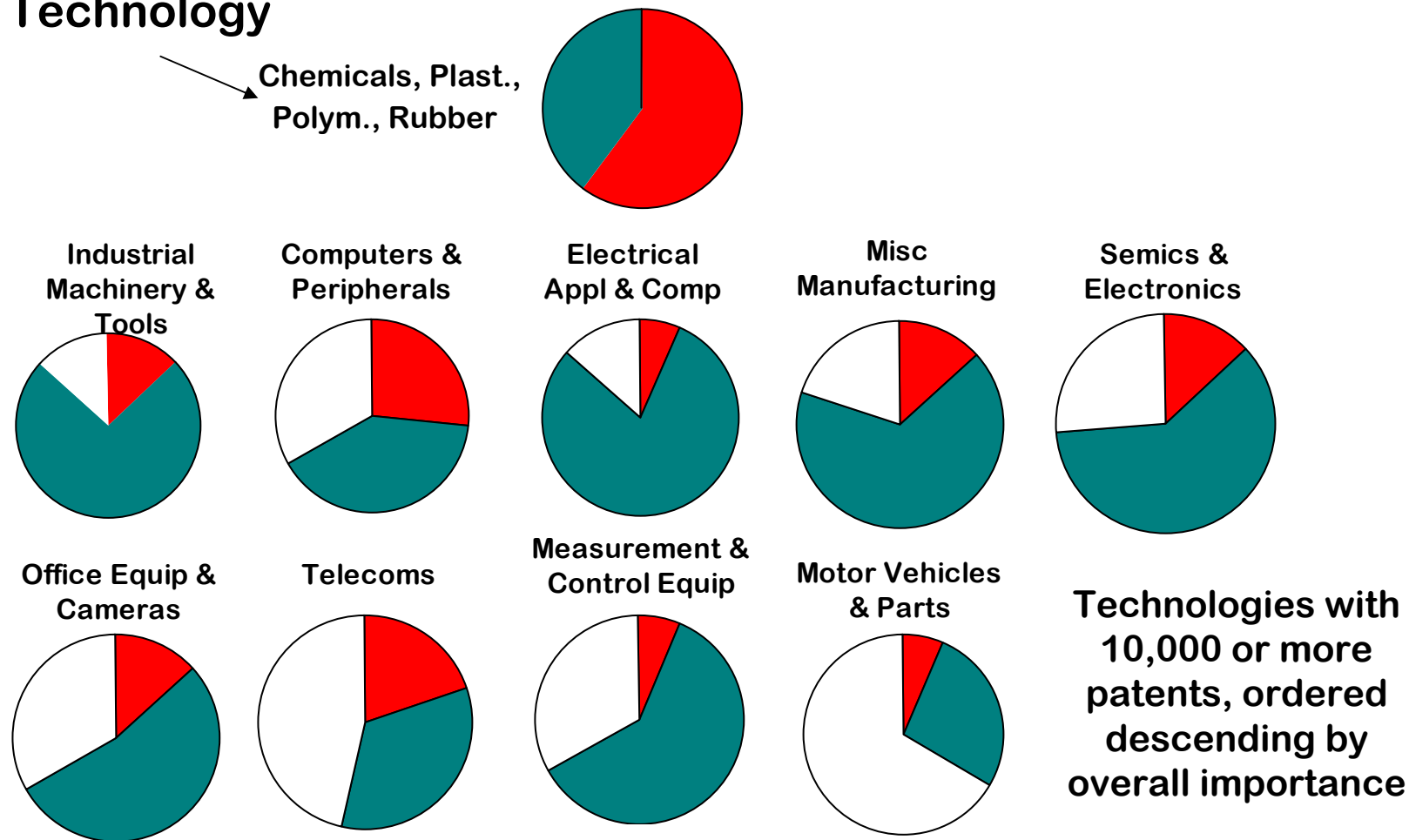
Chemicals, Plast., Polym., Rubber





No other technology comes close

Technology





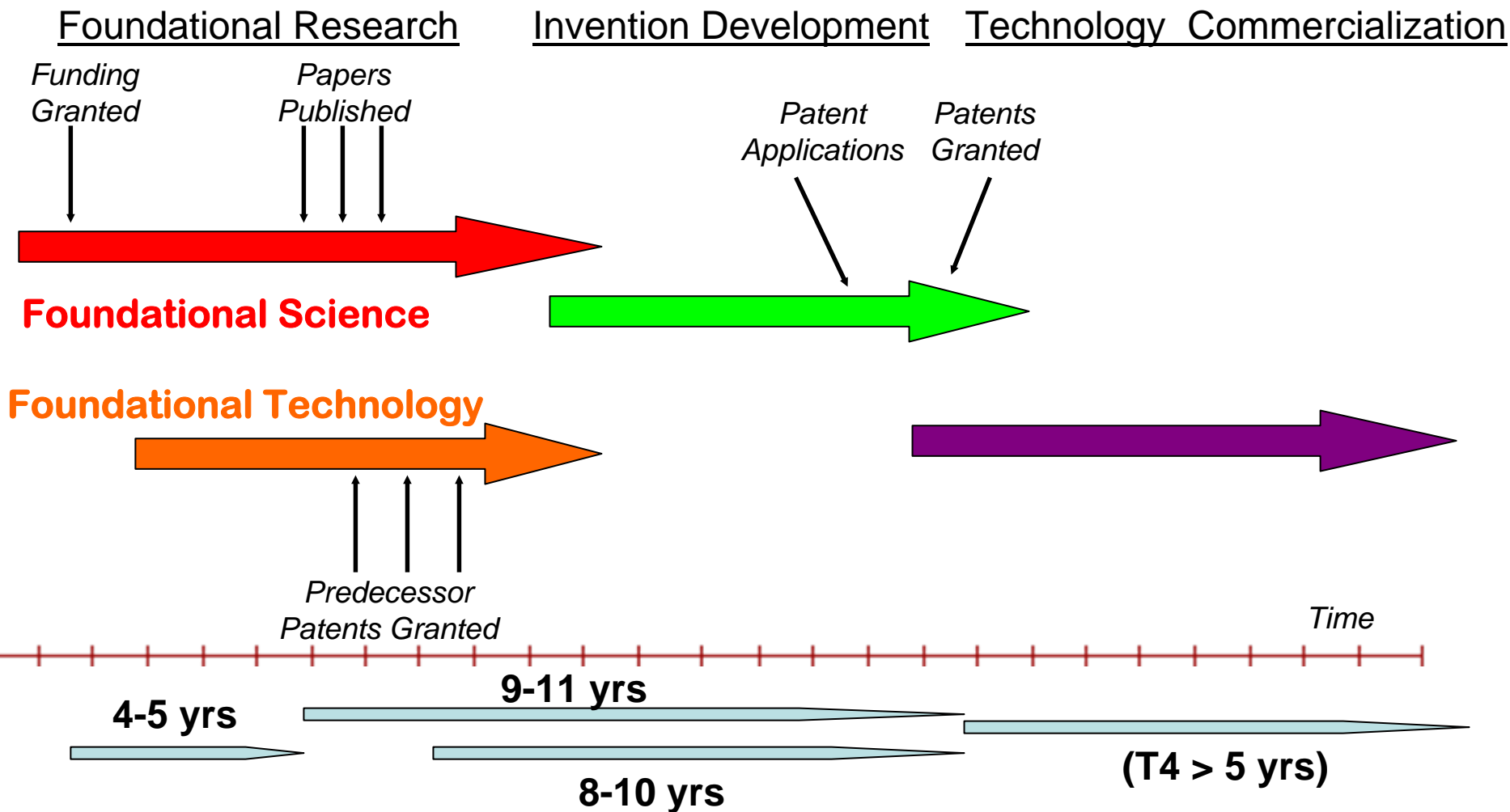
Conclusion: Chemistry is the most enabling science / technology

More than any other technology:

- All industries create chemical technology.
Evidence: patent counts
- The underpinning of all industries' technology relies on chemical technology.
Evidence: industry-to-technology patent citations
- Chemistry is an important part of the science base of all industries.
Evidence: patent-to-paper citations



Timeline from Conception to Market





Conclusion: Big Opportunity to Reduce Innovation Cycle Time

- Industry focused on later stages of innovation, in particular, applied research and patenting to commercialization
- Limited collaboration at basic research stage
- Significant upside financial value if 20 year innovation cycle is shortened
- *Closer industry-university partnerships could help reduce the time to market*



CCR Studies - Overall Conclusions

- Chemical companies get \$2 of operating income for every \$1 of R&D invested; that's a 17% after tax return
- Chemical technology is highly dependent on publicly funded chemical science research
- U.S. economy gains roughly \$40 dollars in GDP growth and \$8 in increased tax revenues for every dollar of federal investment in chemical sciences research
- **Technology quality, innovation speed and strong scientific links deliver greater shareholder value**
- **All industries are significantly impacted by the chemical sciences. It is the most enabling science and technology**
- The big opportunity is to reduce the 20-year innovation time lag from initial public research funding to commercialization



Action Items

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- Promote industry-university partnerships
- Support basic research as the foundation for U.S. innovation and competitiveness
- Research funding is an ***investment*** – and it provides excellent return on investment!