

The results of research

The unanticipated results of research are often as important as the anticipated results—for example, electronic mail and instant messaging were by-products of research in the 1960s that was aimed at making it possible to share expensive computing resources among multiple simultaneous interactive users.

The interaction of research ideas multiplies their impact—for example, concurrent research programs targeted at integrated circuit design, computer graphics, networking, and workstation-based computing have strongly reinforced and amplified one another.

Today's research investments are essential to tomorrow's world leadership in new IT technologies and industries.

The economic payoff of research

Past returns on federal investments in IT research have been extraordinary for both U.S. society and the U.S. economy.

When companies create products using the ideas and workforce that result from federally sponsored research, they repay the nation in jobs, tax revenues, productivity increases, and world leadership.

The transformative effects of IT grow as innovations build on one another and as user know-how compounds.

continued investment in IT research

- Personalized health monitoring, such as sensors for everyone.
- Augmented cognition to help people cope with information overload.
- IT-driven advances in all fields of science and engineering, including techniques for storing, retrieving, mining, visualizing, and discovering knowledge from massive data.

COMMITTEE ON DEPICTING INNOVATION IN INFORMATION TECHNOLOGY

- PETER LEE, Microsoft Research, *Chair*
- MARK E. DEAN, IBM Corporation
- DEBORAH L. ESTRIN, University of California, Los Angeles
- JAMES T. KAJIYA, Microsoft Corporation
- PRABHAKAR RAGHAVAN, Google, Inc.
- ANDREW J. VITERBI, Viterbi Group, LLC

Continuing Innovation in Information Technology illustrates how fundamental research in information technology has led to the introduction of entirely new product categories that ultimately became billion-dollar industries. The report features the updated “tire tracks” figure—originally introduced in 1995—depicting the complex partnership between universities, industry, and government. It shows a mutually reinforcing research environment that continues to stimulate U.S. innovation and leadership.

The full report is available at nap.edu. Visit cstb.org for details on the Computer Science and Telecommunications Board (CSTB), a unit of the National Research Council of the National Academies.

This study was supported by the National Science Foundation. Any opinions, findings, conclusions, or recommendations expressed in the report are those of the authors and do not necessarily reflect the views of the agency that provided support for the project.

THE NATIONAL ACADEMIES™

Advisers to the Nation on Science, Engineering, and Medicine

The nation turns to the National Academies—National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and National Research Council—for independent, objective advice on issues that affect people's lives worldwide.

www.national-academies.org

Continuing Innovation in INFORMATION TECHNOLOGY



America's international leadership in IT—leadership that is vital to the nation—springs from a deep tradition of research.

Research as a partnership

The federal government has had and will continue to have an essential role in sponsoring fundamental research in IT—largely university-based—because it does what industry does not and cannot do.

Industrial and governmental investments in research reflect different motivations, resulting in differences in style, focus, and time horizon.

Companies have little incentive to invest significantly in activities whose benefits will spread quickly to their rivals, as is often the case with fundamental research. Instead, most corporate research and development (R&D) addresses product and process development.

Government funding for research has leveraged the effective decision making of visionary program managers and program office directors from the research community, empowering them to take risks in designing programs and selecting grantees.

Government sponsorship of research especially in universities also helps to develop the IT talent used by industry, universities, and other parts of the economy.

The success of the IT research enterprise reflects a complex partnership among government, industry, and universities.

Advances to expect in the future from

- Safer, robotics-enhanced automobiles.
- A more scalable, manageable, secure, and robust Internet.
- Personalized and collaborative educational tools for tutoring and just-in-time learning.

2012 figure inside . . .

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

Fundamental research in IT underpins the creation of billion-dollar-plus IT market segments and a vital U.S. IT industry through a complex partnership between universities, industry, and government.

About the figure

The first version of this figure was published in the 1995 report *Evolving the High Performance Computing and Communications Initiative to Support the Nation's Information Infrastructure*. The original figure, which was updated in 2002 and 2003, dispelled the assumption that the commercially successful IT industry is self-sufficient. It underscored the extent to which industry instead builds on government-funded university research—sometimes through long incubation periods of years and even decades.

As illustrated in this figure from the 2012 report *Continuing Innovation in Information Technology*, computing research and its impacts have since continued to evolve and blossom. The figure illustrates how fundamental research in IT, conducted in industry and universities, has led to the introduction of entirely new product categories that ultimately became billion-dollar industries. It reflects a complex research environment in which concurrent advances in multiple subfields have been mutually reinforcing, stimulating and enabling one another and leading to vibrant, innovative industries exemplified by top-performing U.S. firms. Such research often starts as a search for fundamental knowledge but time and again produces practical technologies that enable significant economic impact.

The gray lines illustrate the rich interplay between academic research, industry research, and products and indicate the cross-fertilization resulting from multi-directional flows of ideas, technologies, and people.

Major investments in basic research in subfields of computing and communications such as these have led to the creation of IT sectors, firms, and products with large economic impact.

