DOI:10.1145/1666420.1666436

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# IT Policy
# Making the Case for Computing

*Seeking funding for current and future computing initiatives requires both a strong argument and a broad community of supporters.*

WHEN IT COMES to distributing trillions in U.S. taxpayer dollars, funding for science joins a crowded field of special interests where competition for federal funding is fierce. Policymakers are ultimately stewards of taxpayer dollars and must make judgments about the areas in which government has a legitimate reason to invest. And because tax dollars are not limitless, policymakers must prioritize federal investments, deciding which programs or which agencies have the most compelling need for funding.

Consequently, every special interest—from researchers to road-builders, health care professionals to hovercraft manufacturers—has an advocacy group urging policymakers to focus federal investment in their particular area. What ties all of these groups together is the need to have a story—a case to make to Congress, the Administration and the American people—that justifies the expenditure of those tax dollars on the things they care about.

## Funding Decisions

The stakes are high. Last year (fiscal year 2009), the U.S. discretionary budget—that is, the amount not automatically committed to federal programs like Social Security or Medicare—was just over $1 trillion. Congress spent that money, as it does every year, by parceling it out to federal agencies and programs in 12 separate pieces of legislation. This is quite literally a zero-sum game. Aggregate spending by Congress is capped, and each of these 12 appropriations bills has its own spending cap. This means that once the spending caps are reached—and they always are—any additional increase in spending for one program must be offset by an equal reduction in another program.

As a result, policymakers find the need to invest in fundamental research in competition with the need to fund agricultural subsidies, or the

Government funding for computing research is tight and the competition plentiful. A new infrastructure for computational oceanography incorporating the VisTrails system created by the University of Utah was among the scientific projects receiving support from The National Science Foundation's Cluster Exploratory (CluE) program in 2009.

VISUALIZATION BY JULIANA FREIRE AND CLAUDIO SILVA, UNIVERSITY OF UTAH need to support ongoing military efforts in Afghanistan and Iraq, or the need to fund sewer projects in their own districts. In fact, it is more stark than that, because Congressional rules stipulate that any increase to a program in one of the 12 appropriations bills must be offset by a decrease to a program in that same bill. So, additional increases in spending for federal science agencies like the National Science Foundation or the National Institutes of Standards and Technology may result in cuts to another science agency like the National Oceanic and Atmospheric Administration, or to a program to subsidize bulletproof vests for local law enforcement, or to the Census Bureau, because they all reside in the same bill.

So just like any other special interest group, advocates for science—advocates for a greater federal investment in fundamental research, and in particular, for computing research—have had to learn to make a case compelling enough to survive in this competition for funding. But unlike other special interest groups, science advocacy groups like the Computing Research Association or ACM's U.S. Public Policy Committee compete at a disadvantage because we lack (due to legal restrictions and organizational cultures) political action committees (PACs) to contribute to the campaigns of members of Congress or vast resources to fly congressional delegations out to exotic locales on fact-finding trips. Our success is based solely on the strength of our arguments and an active community making them.

While we are limited in the tools of influence, we have a powerful case. Fundamental research in information technology has led to tangible breakthroughs that have created entire new industries, driven economic growth, and developed deep and productive relationships between industry and universities.

## Computing Advances

Advances in computing have changed all aspects of our lives: how we conduct commerce, how we learn, our employment, our health care, how we manufacture goods, how government functions, how we preserve our national security, how we communicate, and how we're entertained.

**Computing facilitates innovation because a vital IT R&D ecosystem enables innovation within IT itself.**

Advances in computing drive our economy—not just through the growth of the IT industry, but also through productivity gains across the entire economy. Recent analysis suggests that the remarkable economic growth the U.S. experienced between 1995 and 2002 was spurred by an increase in productivity enabled almost completely by factors related to IT.[2] The processes by which advances in information technology enable productivity growth, enable the economy to run at full capacity, enable goods and services to be allocated more efficiently, and enable the production of higher quality goods and services are now well understood.[1]

Advances in computing enable innovation in all other fields. In business, advances in IT are giving researchers powerful new tools, enabling small firms to significantly expand R&D, boosting innovation by giving users more of a role, and letting organizations better manage the existing knowledge of its employees.[2] In science and engineering, advances in IT are enabling discovery across every discipline—from mapping the human brain to modeling climatic change. Researchers, faced with research problems that are ever more complex and interdisciplinary in nature, are using IT to collaborate across the globe, and to collect, manage, and explore massive amounts of data. Computer modeling, visualization, and data analysis have joined observation, theory and experiment as the drivers of scientific discovery.

Advances in computing continue unabated. Worldwide, there has been no slowdown in the pace of innovation, the production of new ideas, the discovery of additional opportunities to advance products and services for society.

Thus, leadership in computing is essential to the U.S., economically and socially.

## Future Opportunities

While the history of computing-related contributions to shaping our world is a compelling topic, future opportunities in computing—where the field might go and what problems it might tackle—are perhaps even more compelling. Whether it's creating the future of networking, revolutionizing transportation, delivering personalized education, enabling the smart grid, empowering the developing world, improving health care, or driving advances in all fields of science and engineering—all national priorities—computing has key contributions to make and key roles to play. In March 2009, the National Academy of Engineering unveiled 14 "Grand Challenges for Engineering" for the 21st century (see http://www.engineeringchallenges.org/). The majority of these—the majority of the "Grand Challenges" for *all of engineering*—have either substantial or predominant information technology content:

- Secure cyberspace
- Enhance virtual reality
- Advance health information systems
- Advance personalized learning
- Engineer better medicines
- Engineer the tools of scientific discovery
- Reverse engineer the brain
- Prevent nuclear terror (to a great extent a sensor network and data mining problem)

And there are many more information technology challenges of equally high impact:

- Create the future of networking
- Empower the developing world through appropriate information and communication technology
- Revolutionize transportation safety and efficiency
- Build truly scalable computing systems, and devise algorithms for extracting knowledge from massive volumes of data
- Engineer advanced "robotic pros-

thetics" and, more broadly, enhance people's quality of life

- Instrument your body as thoroughly as your automobile
- Engineer biology (synthetic biology)
- Revolutionize our electrical energy infrastructure: generation, storage, transmission, and consumption
- Achieve quantum computing

It is impossible to imagine a field with greater opportunity to change the world.

Computing facilitates innovation because a vital IT R&D ecosystem enables innovation within IT itself. At the heart of this ecosystem is federally sponsored research. A 1995 study by the National Research Council (NRC) describes the "extraordinarily productive interplay of federally funded university research, federally and privately funded industrial research, and entrepreneurial companies founded and staffed by people who moved back and forth between universities and industry." That study, and a subsequent 1999 report by the President's Information Technology Advisory Committee, emphasized the "spectacular" return on the federal investment in long-term IT research and development. Indeed, a 2003 NRC study identified 19 multibillion-dollar IT industries—industries that are transforming our lives and driving our economy—that were enabled by federally sponsored research (see http://books.nap.edu/openbook.php?record_id=10795&page=5).

### Academia and Industry

Beyond transforming society and bolstering economic growth, funding for computing research and the subsequent development of the U.S. IT sector has created particularly strong relationships between universities and industry. Robust funding for research has allowed university research to assume the role of focusing on fundamental questions and long-term problems, without supplanting industrial research and development. While industry research, geared primarily toward short-term development, does not supplant university research.

In fact, industry generally avoids long-term research because it entails risk in a couple of unappealing ways. First, it is difficult to predict the outcome of fundamental research. The value of the research may surface in unanticipated areas. Second, fundamental research, because it is published openly, provides broad value to all players in the marketplace. It is difficult for any one company to "protect" the fundamental knowledge gleaned from long-term research and capitalize on it without everyone in the marketplace having a chance to incorporate the new knowledge into their thinking.

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A sustained, robust commitment to long-term, fundamental research is also necessary because the innovations that drive the new economy today are the fruits of investments the federal government made in fundamental research 10, 15, or even 30 years ago. Essentially every aspect of information technology upon which we rely today—the Internet, Web browsers, public key cryptography for secure credit card transactions, parallel database systems, high-performance computer graphics, portable communications...essentially every billion-dollar sub-market—is a product of this commitment and bears the stamp of federally supported research.

Computing has a compelling story, and fortunately one that finds a lot of support in Congress and in the Administration. The federal government currently invests more than $3 billion per year in information technology R&D across 13 different agencies, and that figure could increase significantly if the Obama administration follows its plan to increase funding at key science agencies and Congress concurs. However, looking forward, making our case will be more important than ever.

Not only is society faced with grand challenges that will require fundamental breakthroughs in computing, but competition for scarce federal dollars is going to be more intense than ever. The competitive environment we've described was largely in the era of U.S. federal deficits of billions of dollars; today the federal deficit is over a trillion dollars with major spending proposals—such as health care reform—currently winding through Congress. The budget politics driving these issues are the same politics that can affect spending for fundamental research. Without a strong case and support from a broad community (industry, higher education, and scientific societies) in making it, research funding and the innovations it enables will face a chilly reception among policymakers.

With your help, we'll continue to make the case for computing research wherever we can. We encourage you to take advantage of any opportunities you might have in your own community to do the same.

*Authors' Note:* The inspiration for this column, and indeed some of the text, came from a white paper prepared by Peter Harsha along with Edward Lazowska (University of Washington) and Peter Lee (Carnegie Mellon University). The white paper ("Information Technology R&D and U.S. Innovation") was one of a series prepared in December 2008 at the request of the Obama Administration by the Computing Community Consortium, to aid in the transition of Presidential Administrations. The collected series of white papers, entitled *Computing Research Initiatives for the 21st Century*, is available at http://www.cra.org/ccc/initiatives.

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