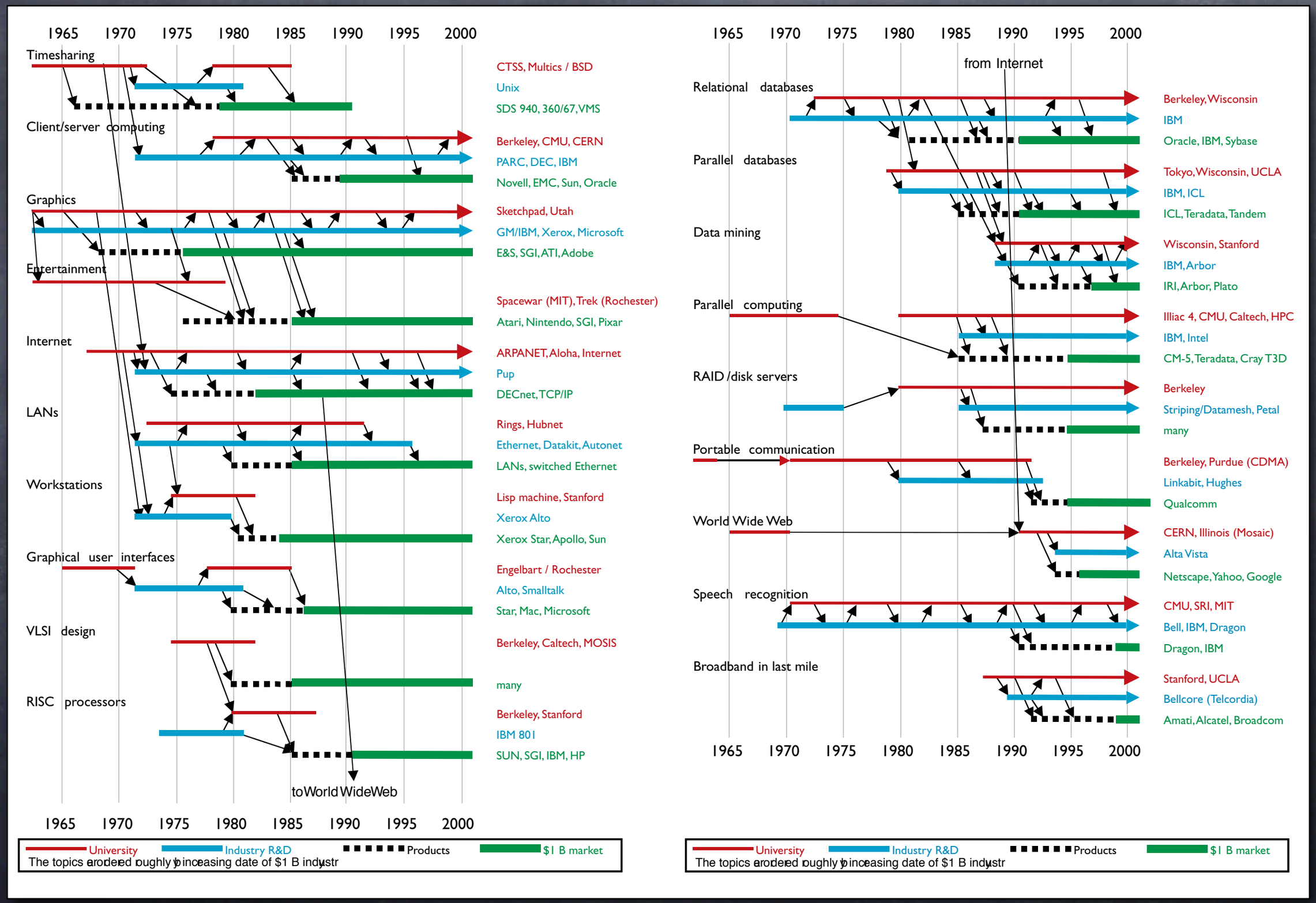
The Broadening of Computer Science

Dr. Erwin Gianchandani
Director, Computing Community Consortium
Computing Research Association

UVa Dept. of Computer Science
Sept. 10, 2010

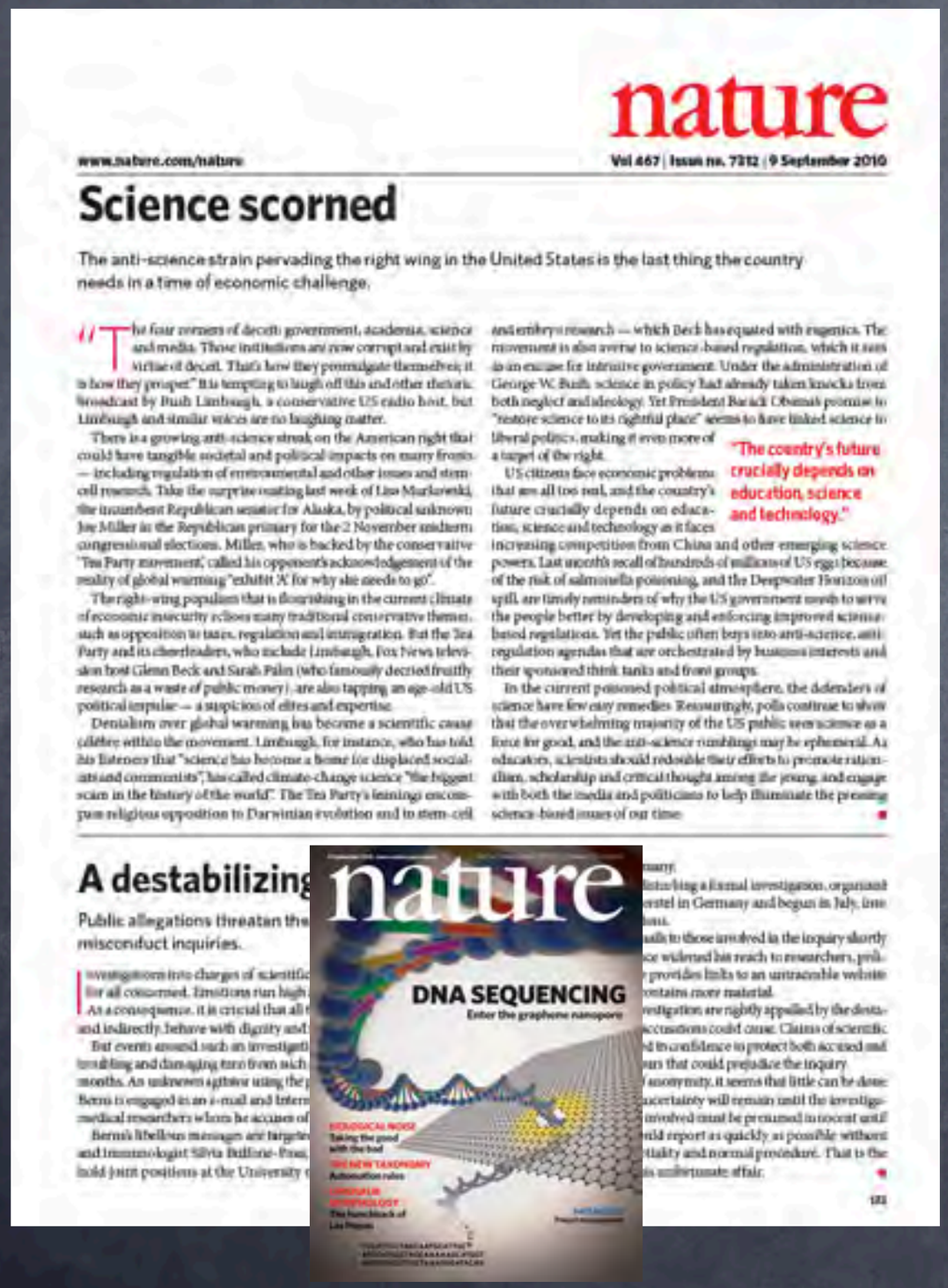
The CCC & CIFellows Project

Research has built the foundation...



Source: From [6], reprinted with permission from the National Academy of Sciences, courtesy of the National Academies Press, Washington D.C. ©2003.

...We must work together to ensure that continues



nature

www.nature.com/nature

Vol 467 | Issue no. 7312 | 9 September 2010

Science scorned

The anti-science strain pervading the right wing in the United States is the last thing the country needs in a time of economic challenge.

"The four corners of deceit: government, academia, science and media. Those institutions are now corrupt and exist by virtue of deceit. That's how they promulgate themselves; it is how they prosper." It is tempting to laugh off this and other rhetoric broadcast by Rush Limbaugh, a conservative US radio host, but Limbaugh and similar voices are no laughing matter.

There is a growing anti-science streak on the American right that could have tangible societal and political impacts on many fronts — including regulation of environmental and other issues and stem-cell research. Take the surprise vanting last week of Lisa Murkowski, the incumbent Republican senator for Alaska, by political unknown Joe Miller in the Republican primary for the 2 November midterm congressional elections. Miller, who is backed by the conservative 'Tea Party movement', called his opponent's acknowledgement of the reality of global warming "exhibit 'A' for why she needs to go".

The right-wing populism that is flourishing in the current climate of economic insecurity echoes many traditional conservative themes, such as opposition to taxes, regulation and immigration. But the Tea Party and its cheerleaders, who include Limbaugh, Fox News television host Glenn Beck and Sarah Palin (who famously decried fruitfly research as a waste of public money), are also tapping an age-old US political impulse — a suspicion of elites and expertise.

Denialism over global warming has become a scientific *cause célèbre* within the movement. Limbaugh, for instance, who has told his listeners that "science has become a home for displaced socialists and communists", has called climate-change science "the biggest scam in the history of the world". The Tea Party's leanings encompass religious opposition to Darwinian evolution and to stem-cell and embryo research — which Beck has equated with eugenics. The movement is also averse to science-based regulation, which it sees as an excuse for intrusive government. Under the administration of George W. Bush, science in policy had already taken knocks from both neglect and ideology. Yet President Barack Obama's promise to "restore science to its rightful place" seems to have linked science to liberal politics, making it even more of a target of the right.

US citizens face economic problems that are all too real, and the country's future crucially depends on education, science and technology as it faces increasing competition from China and other emerging science powers. Last month's recall of hundreds of millions of US eggs because of the risk of salmonella poisoning, and the Deepwater Horizon oil spill, are timely reminders of why the US government needs to serve the people better by developing and enforcing improved science-based regulations. Yet the public often buys into anti-science, anti-regulation agendas that are orchestrated by business interests and their sponsored think tanks and front groups.

"The country's future crucially depends on education, science and technology."

In the current poisoned political atmosphere, the defenders of science have few easy remedies. Reassuringly, polls continue to show that the overwhelming majority of the US public sees science as a force for good, and the anti-science ramblings may be ephemeral. As educators, scientists should redouble their efforts to promote rationalism, scholarship and critical thought among the young, and engage with both the media and politicians to help illuminate the pressing science-based issues of our time. ■

A destabilizing

Public allegations threaten the misconduct inquiries.

nature

DNA SEQUENCING

Enter the graphene nanopore

"As educators, scientists should redouble their efforts to promote rationalism, scholarship, and critical thought among the young, and engage with both the media and politicians to help illuminate the pressing science-based issues of our time."

"Science scorned." Nature **467**(7312): 133 (2010).

Computing was at a crossroads...

- In the mid-2000s, NSF leaders and computing research leaders had similar deep concerns
  - The Federal commitment to research in general, and to computing research in particular
  - Public and policymaker perception that "computer science" is "yesterday's news"
  - Failure to articulate and coalesce around exciting research visions in computer science that could galvanize the public, policymakers, researchers, and students
  - Need to groom the future leadership of the field
  - Decrease in student interest

...So something was done about it...

- Increased focus by NSF leaders and computing research leaders in academia & industry
- A Computing Community Consortium solicitation & proposal
  - "[NSF] will support the CCC as a community proxy responsible for facilitating the conceptualization and design of promising infrastructure-intensive projects..."
  - "The purpose of the CCC is to provide a voice for the national computing research community. The CCC will facilitate the development of a bold, multi-themed vision for computing research and education... [communicating] that vision to ... major stakeholders."

...NSF asked CRA to create a "CCC"

- To catalyze the computing research community to consider such questions
  - To envision long-range, more audacious research challenges
  - To build momentum around such visions
  - To state them in compelling ways
  - To move them towards funded initiatives
  - To ensure "science oversight" of large-scale initiatives
- A "cooperative agreement" with NSF
  - Close coordination

The CCC Council: a broad slice

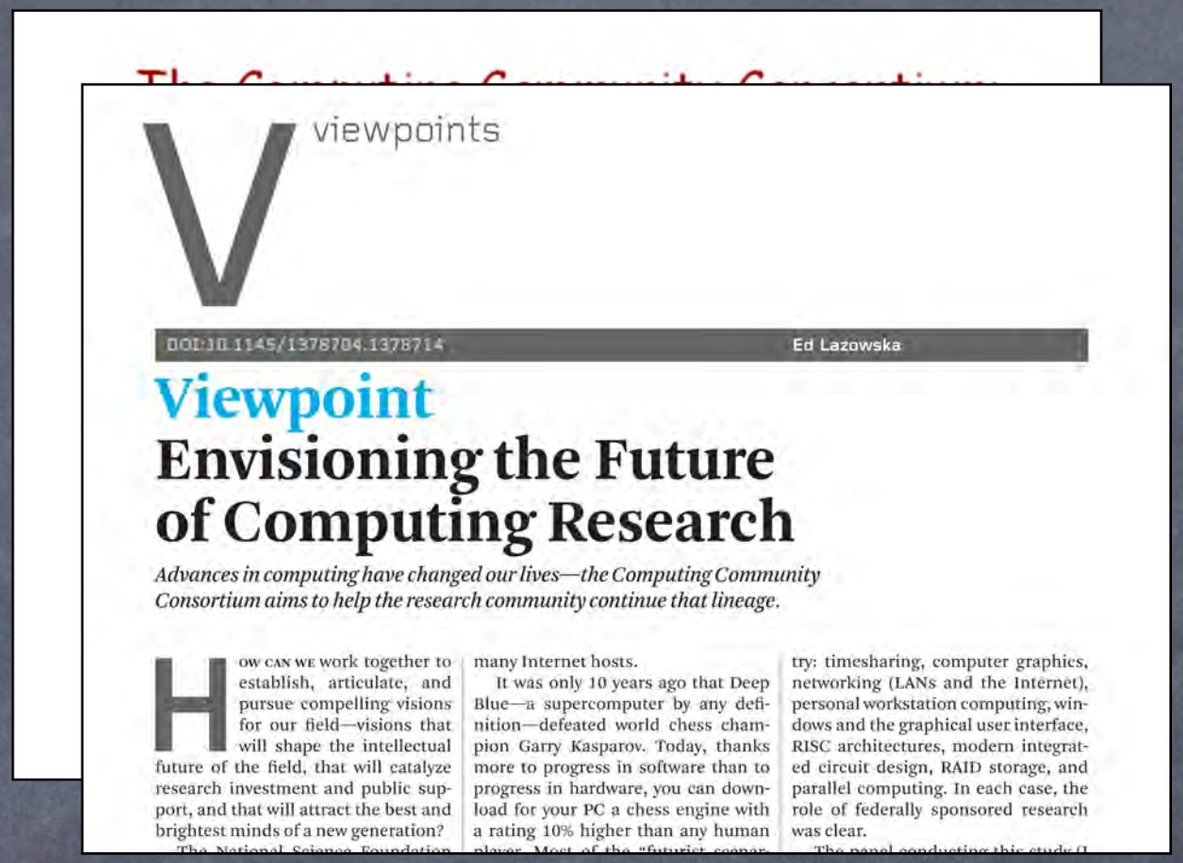
- Director: Erwin Gianchandani
- Chair: Ed Lazowska
- Terms ending 2013
  - Randy Bryant
  - Lance Fortnow
  - Hank Korth
  - Eric Horvitz
  - Beth Mynatt
  - Fred Schneider
  - Margo Seltzer
- Terms ending 2012
  - Stephanie Forrest
  - Chris Johnson
  - Anita Jones
  - Frans Kaashoek
  - Ran Libeskind-Hadas
  - Robin Murphy
- Terms ending 2011
  - Bill Feiereisen
  - Susan Graham (vice-chair)
  - Dave Kaeli
  - John King
  - Bob Sproull
- Ex-officio
  - Andrew Bernat
- Rotated off
  - Dick Karp, 2010
  - Andrew McCallum, 2010
  - Dave Waltz, 2010
  - Greg Andrews, 2009
  - Peter Lee, 2009
  - Karen Sutherland, 2009

Major continuing activities

- Presentations

Major continuing activities

- Presentations
- Articles



viewpoints

DOI:10.1145/1378704.1378714

Ed Lazowska

Viewpoint

Envisioning the Future of Computing Research

Advances in computing have changed our lives—the Computing Community Consortium aims to help the research community continue that lineage.

How can we work together to establish, articulate, and pursue compelling visions for our field—visions that will shape the intellectual future of the field, that will catalyze research investment and public support, and that will attract the best and brightest minds of a new generation?

The National Science Foundation

many Internet hosts.

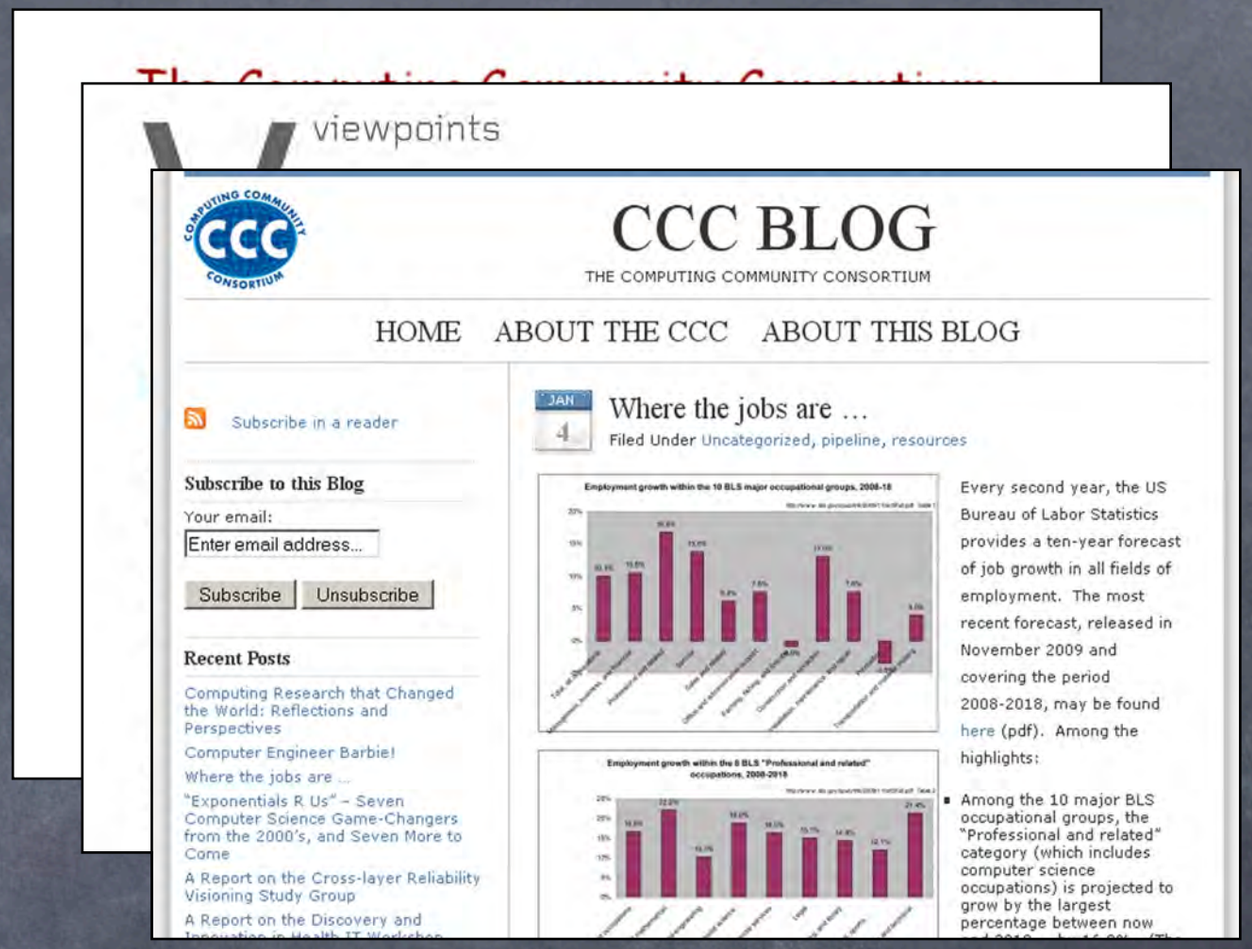
It was only 10 years ago that Deep Blue—a supercomputer by any definition—defeated world chess champion Garry Kasparov. Today, thanks more to progress in software than to progress in hardware, you can download for your PC a chess engine with a rating 10% higher than any human player. Most of the "futuristic scenar-

try: timesharing, computer graphics, networking (LANs and the Internet), personal workstation computing, windows and the graphical user interface, RISC architectures, modern integrated circuit design, RAID storage, and parallel computing. In each case, the role of federally sponsored research was clear.

The panel conducting this study (I

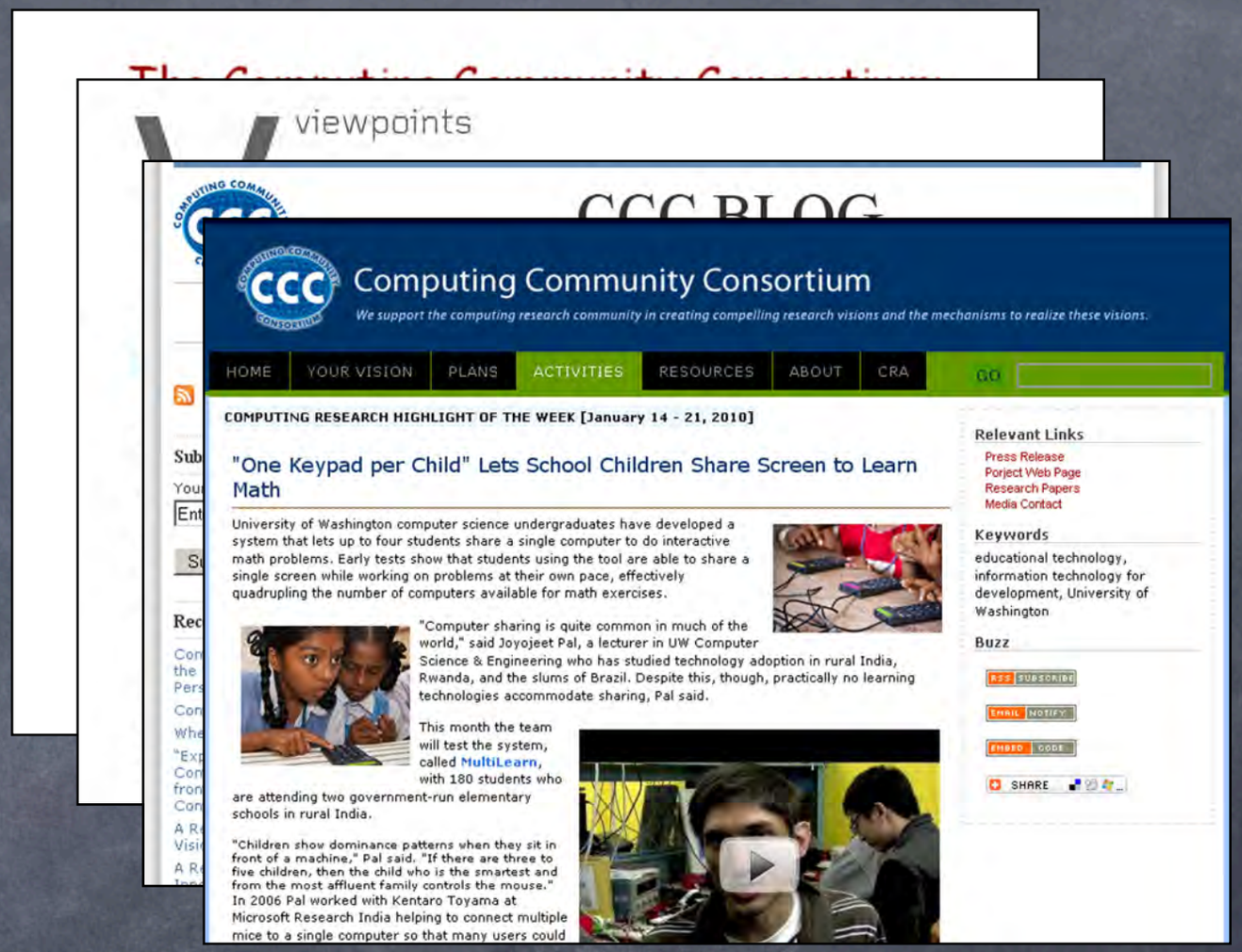
Major continuing activities

- Presentations
- Articles
- CCC Blog



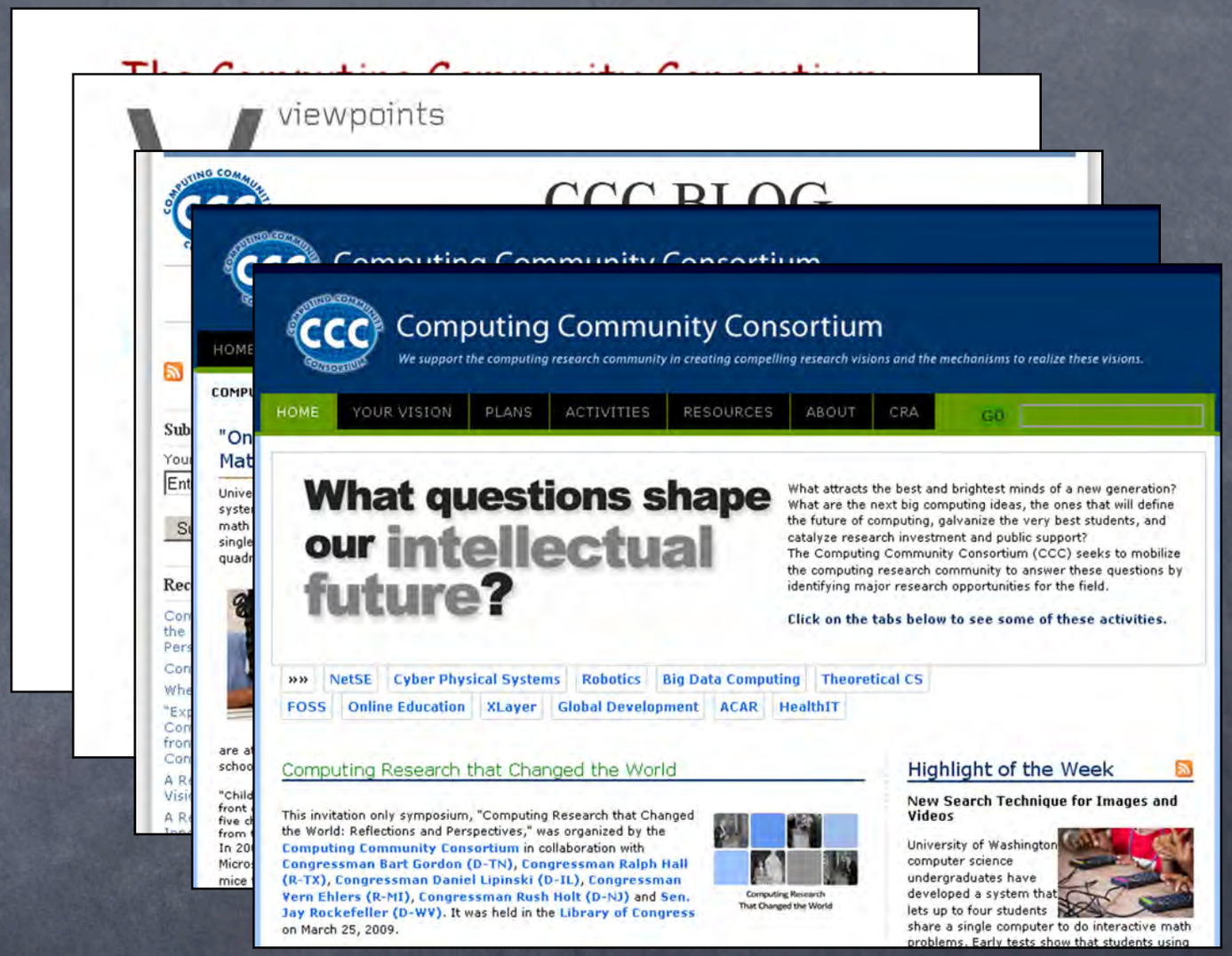
Major continuing activities

- Presentations
- Articles
- CCC Blog
- Computing Research "Highlight of the Week"



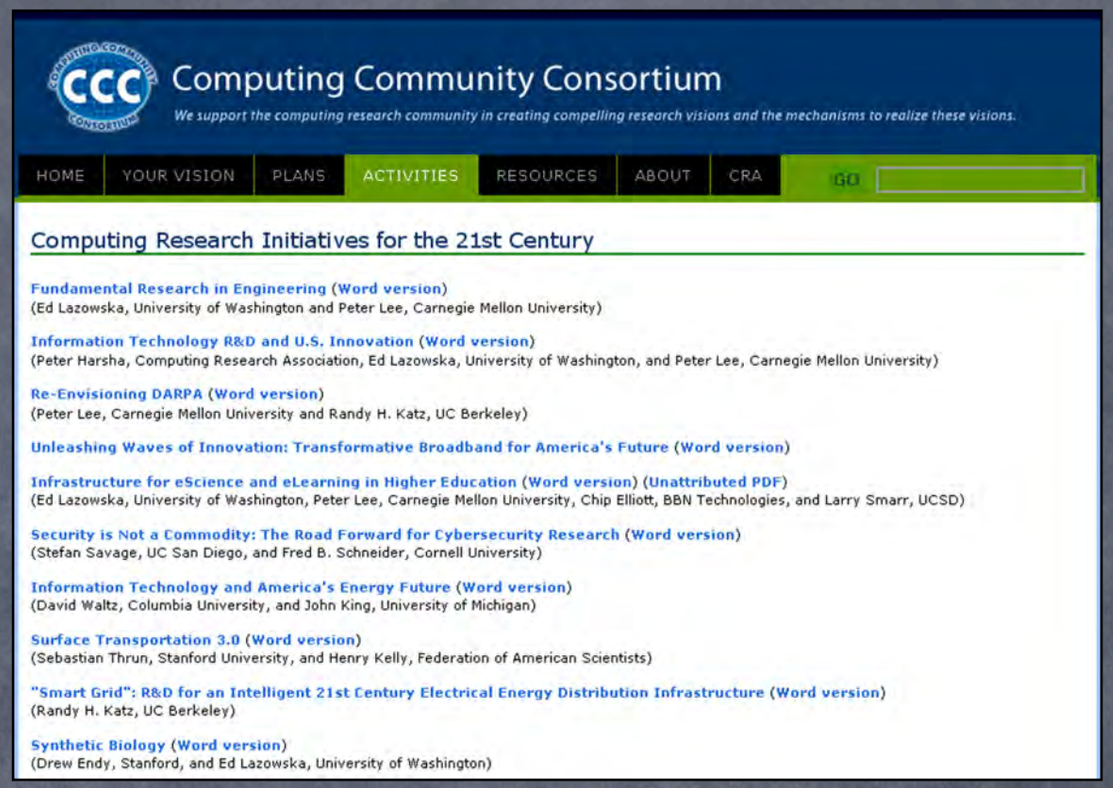
Major continuing activities

- Presentations
- Articles
- CCC Blog
- Computing Research "Highlight of the Week"
- Community visioning exercises



Major special initiatives

- "Transition Team" white papers



Computing Community Consortium

We support the computing research community in creating compelling research visions and the mechanisms to realize these visions.

HOME | YOUR VISION | PLANS | ACTIVITIES | RESOURCES | ABOUT | CRA | GO

Computing Research Initiatives for the 21st Century

Fundamental Research in Engineering (**Word version**)
(Ed Lazowska, University of Washington and Peter Lee, Carnegie Mellon University)

Information Technology R&D and U.S. Innovation (**Word version**)
(Peter Harsha, Computing Research Association, Ed Lazowska, University of Washington, and Peter Lee, Carnegie Mellon University)

Re-Envisioning DARPA (**Word version**)
(Peter Lee, Carnegie Mellon University and Randy H. Katz, UC Berkeley)

Unleashing Waves of Innovation: Transformative Broadband for America's Future (**Word version**)

Infrastructure for eScience and eLearning in Higher Education (**Word version**) (**Unattributed PDF**)
(Ed Lazowska, University of Washington, Peter Lee, Carnegie Mellon University, Chip Elliott, BBN Technologies, and Larry Smarr, UCSD)

Security is Not a Commodity: The Road Forward for Cybersecurity Research (**Word version**)
(Stefan Savage, UC San Diego, and Fred B. Schneider, Cornell University)

Information Technology and America's Energy Future (**Word version**)
(David Waltz, Columbia University, and John King, University of Michigan)

Surface Transportation 3.0 (**Word version**)
(Sebastian Thrun, Stanford University, and Henry Kelly, Federation of American Scientists)

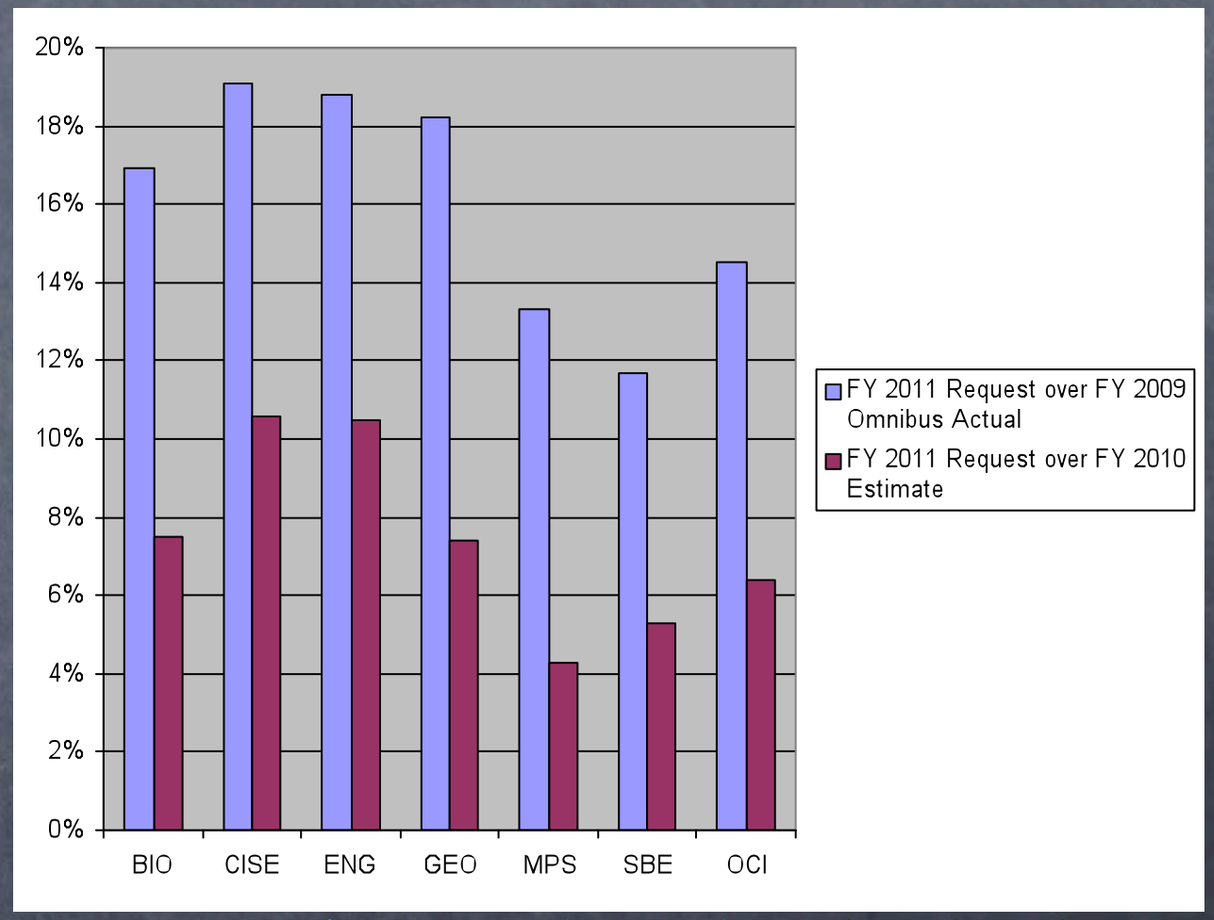
"Smart Grid": R&D for an Intelligent 21st Century Electrical Energy Distribution Infrastructure (**Word version**)
(Randy H. Katz, UC Berkeley)

Synthetic Biology (**Word version**)
(Drew Endy, Stanford, and Ed Lazowska, University of Washington)

"Transition Team" white papers

- Sensed and seized an opportunity to influence Federal science policy through the Presidential Transition Team
  - 19 papers produced in late 2008 & early 2009
  - 30 separate authors
  - Many highly influential:
    - Re-envisioning DARPA -- Peter Lee, Randy Katz
    - Infrastructure for eScience & eLearning/Unleashing waves of innovation -- Ed Lazowska, Peter Lee, Chip Elliott, Larry Smarr
    - Security is not a commodity -- Stefan Savage, Fred Schneider
    - Synthetic biology -- Drew Endy, Ed Lazowska
    - Big-data computing -- Randy Bryant, Randy Katz, Ed Lazowska
    - The ocean observatories initiative -- John Delaney, John Orcutt, Robert Weller
    - Cyber-Physical Systems -- Janos Sztipanovits, Jack Stankovic

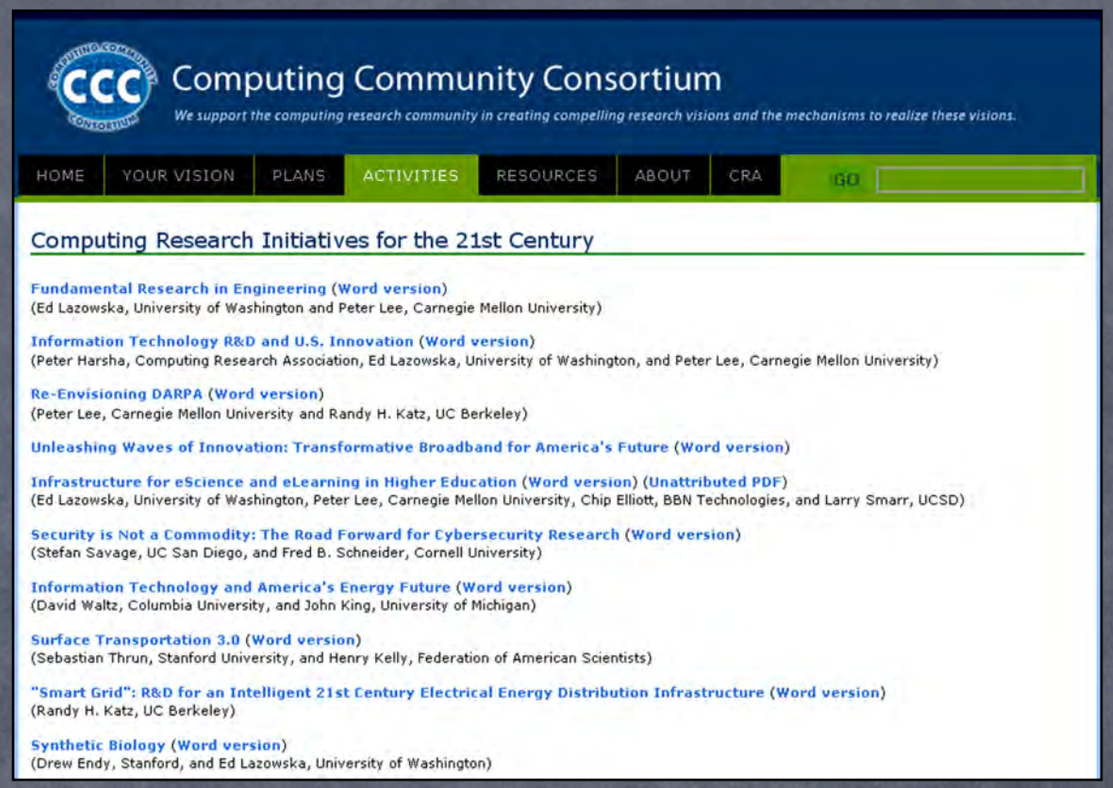
A role in FY 11?



NSF budget numbers, by Directorate

Major special initiatives

- "Transition Team" white papers



Computing Community Consortium

We support the computing research community in creating compelling research visions and the mechanisms to realize these visions.

HOME | YOUR VISION | PLANS | ACTIVITIES | RESOURCES | ABOUT | CRA | GO

Computing Research Initiatives for the 21st Century

Fundamental Research in Engineering (**Word version**)
(Ed Lazowska, University of Washington and Peter Lee, Carnegie Mellon University)

Information Technology R&D and U.S. Innovation (**Word version**)
(Peter Harsha, Computing Research Association, Ed Lazowska, University of Washington, and Peter Lee, Carnegie Mellon University)

Re-Envisioning DARPA (**Word version**)
(Peter Lee, Carnegie Mellon University and Randy H. Katz, UC Berkeley)

Unleashing Waves of Innovation: Transformative Broadband for America's Future (**Word version**)

Infrastructure for eScience and eLearning in Higher Education (**Word version**) (**Unattributed PDF**)
(Ed Lazowska, University of Washington, Peter Lee, Carnegie Mellon University, Chip Elliott, BBN Technologies, and Larry Smarr, UCSD)

Security is Not a Commodity: The Road Forward for Cybersecurity Research (**Word version**)
(Stefan Savage, UC San Diego, and Fred B. Schneider, Cornell University)

Information Technology and America's Energy Future (**Word version**)
(David Waltz, Columbia University, and John King, University of Michigan)

Surface Transportation 3.0 (**Word version**)
(Sebastian Thrun, Stanford University, and Henry Kelly, Federation of American Scientists)

"Smart Grid": R&D for an Intelligent 21st Century Electrical Energy Distribution Infrastructure (**Word version**)
(Randy H. Katz, UC Berkeley)

Synthetic Biology (**Word version**)
(Drew Endy, Stanford, and Ed Lazowska, University of Washington)

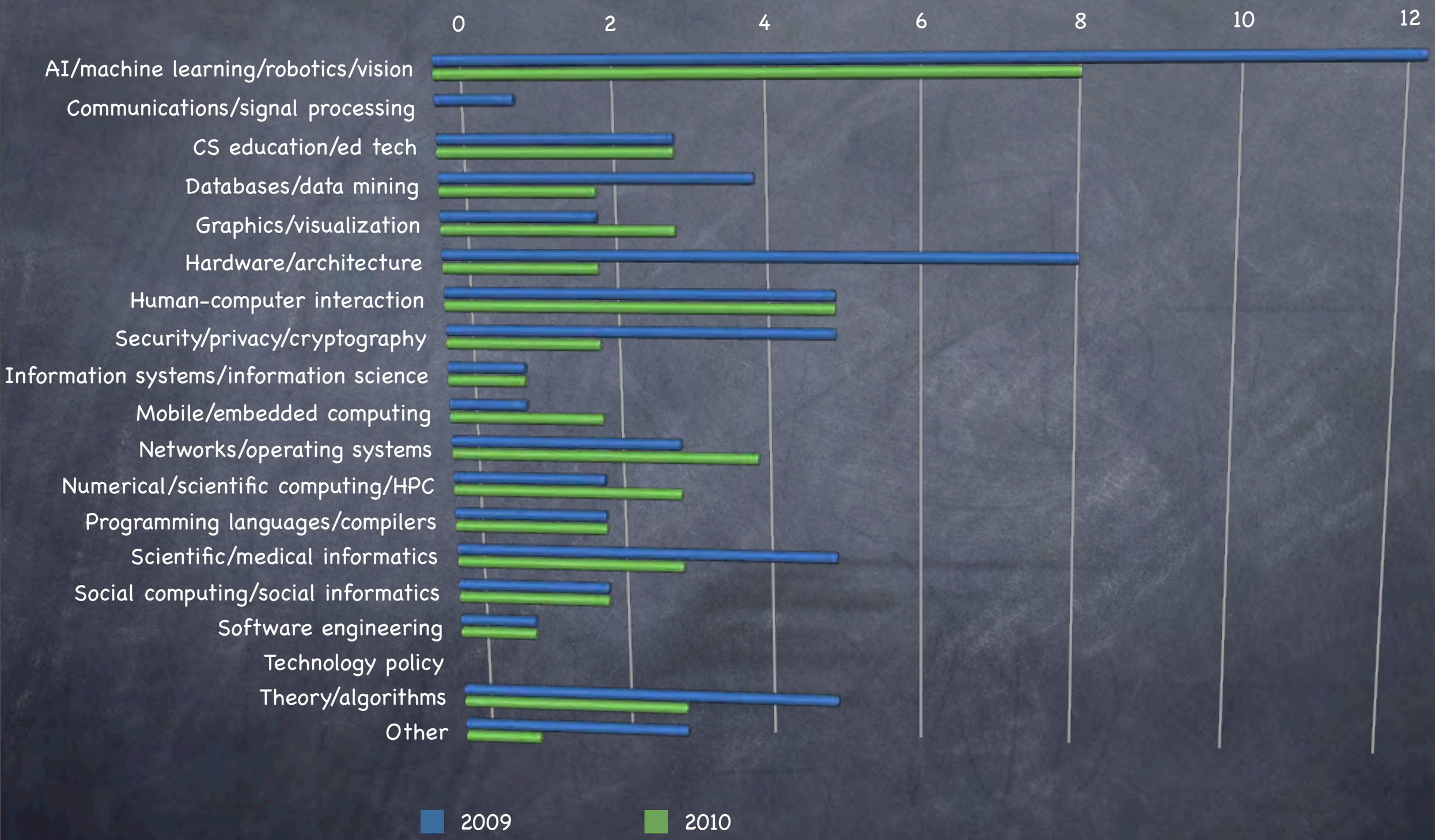
Major special initiatives

- "Transition Team" white papers
- Library of Congress Symposium

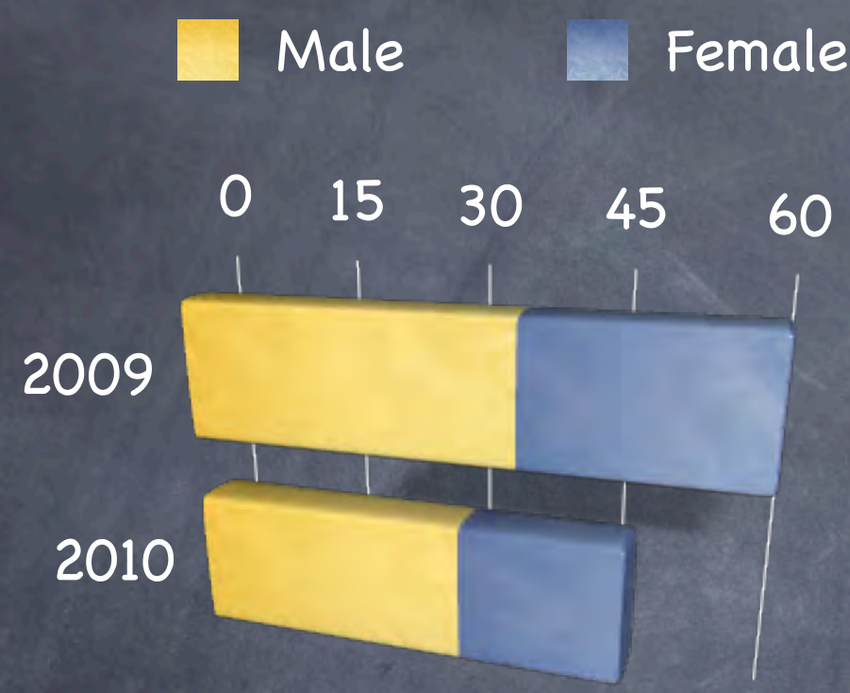
Major special initiatives

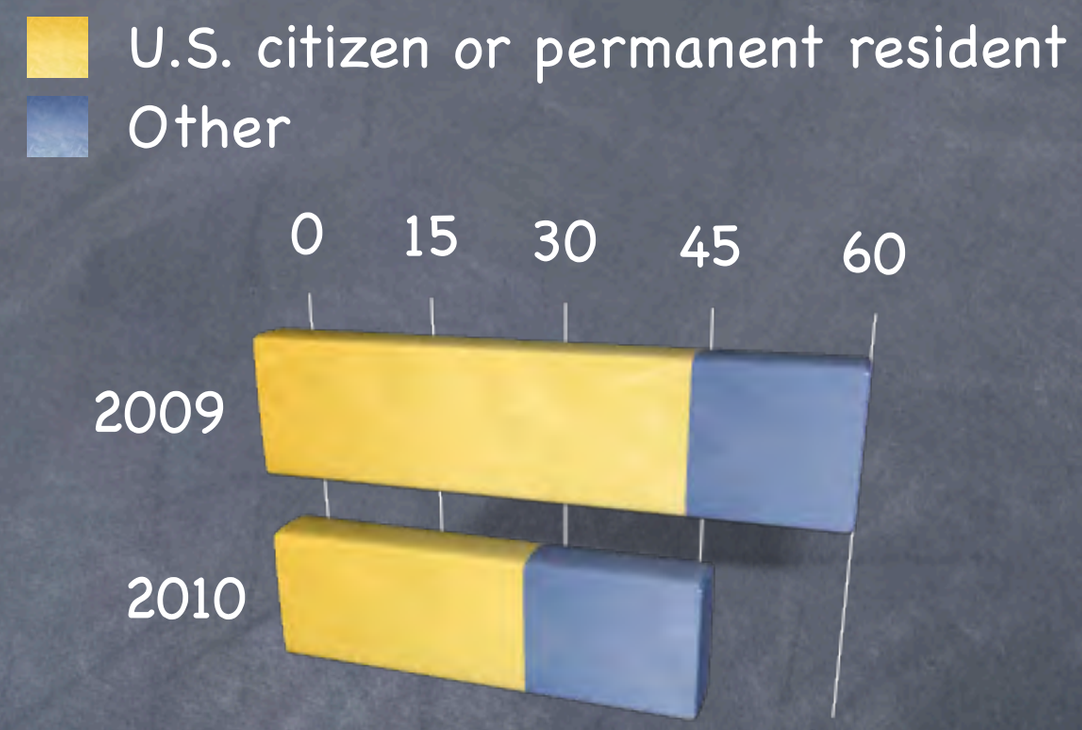
- "Transition Team" white papers
- Library of Congress Symposium
- Computing Innovation Fellows (CIFellows)

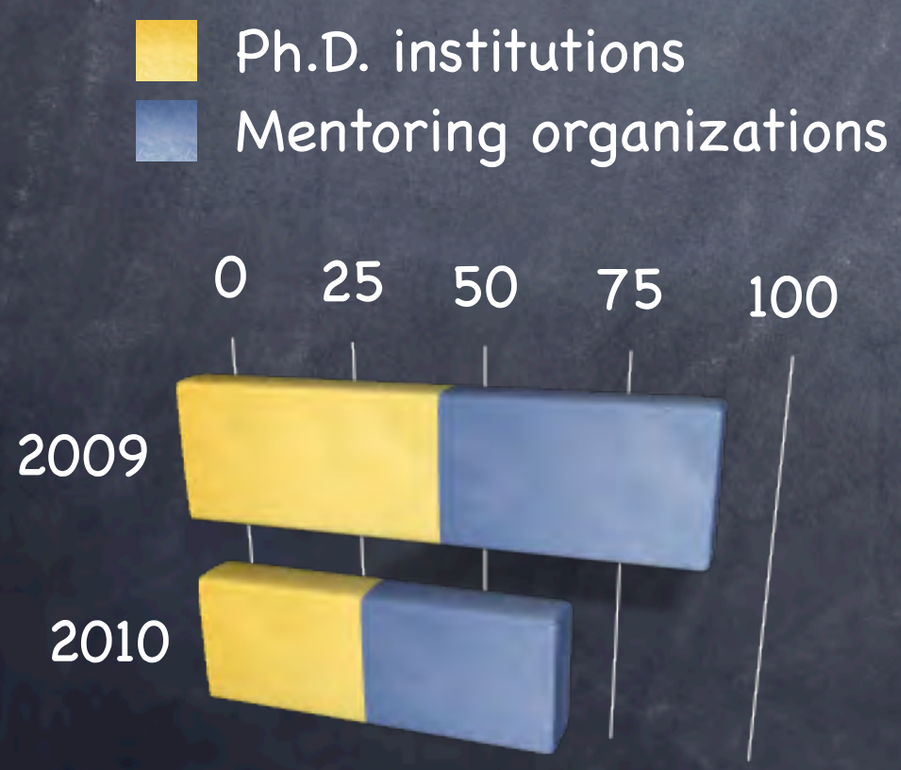
2009 & 2010 CIFellows Projects

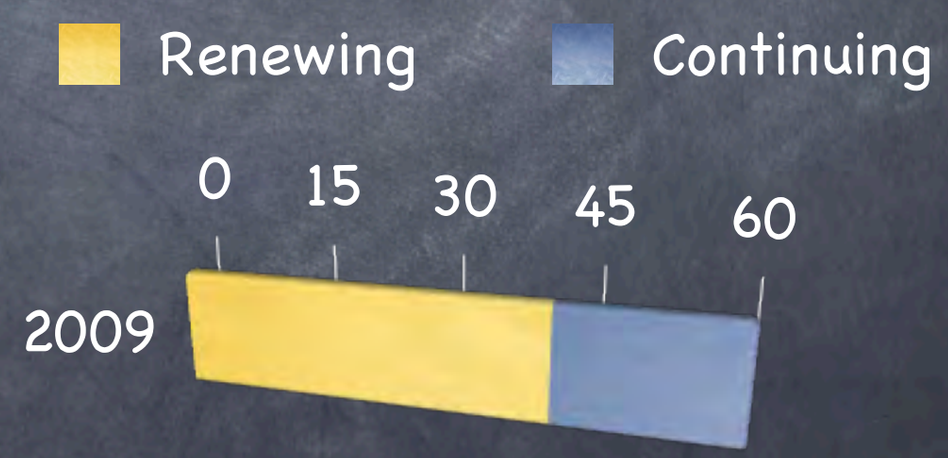


CIFellows Projects by the numbers

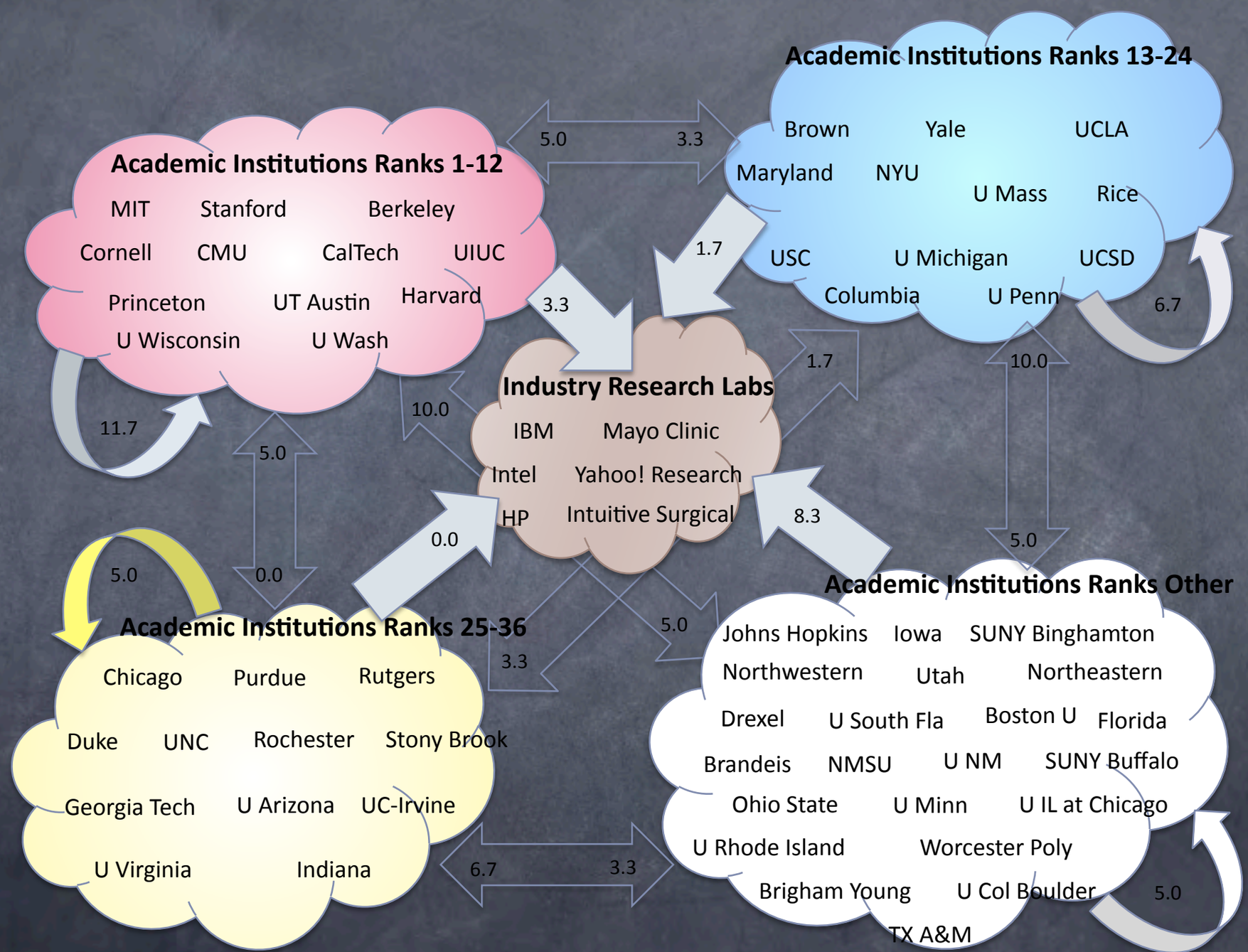








CIFellows Project I ('09) cross-flow

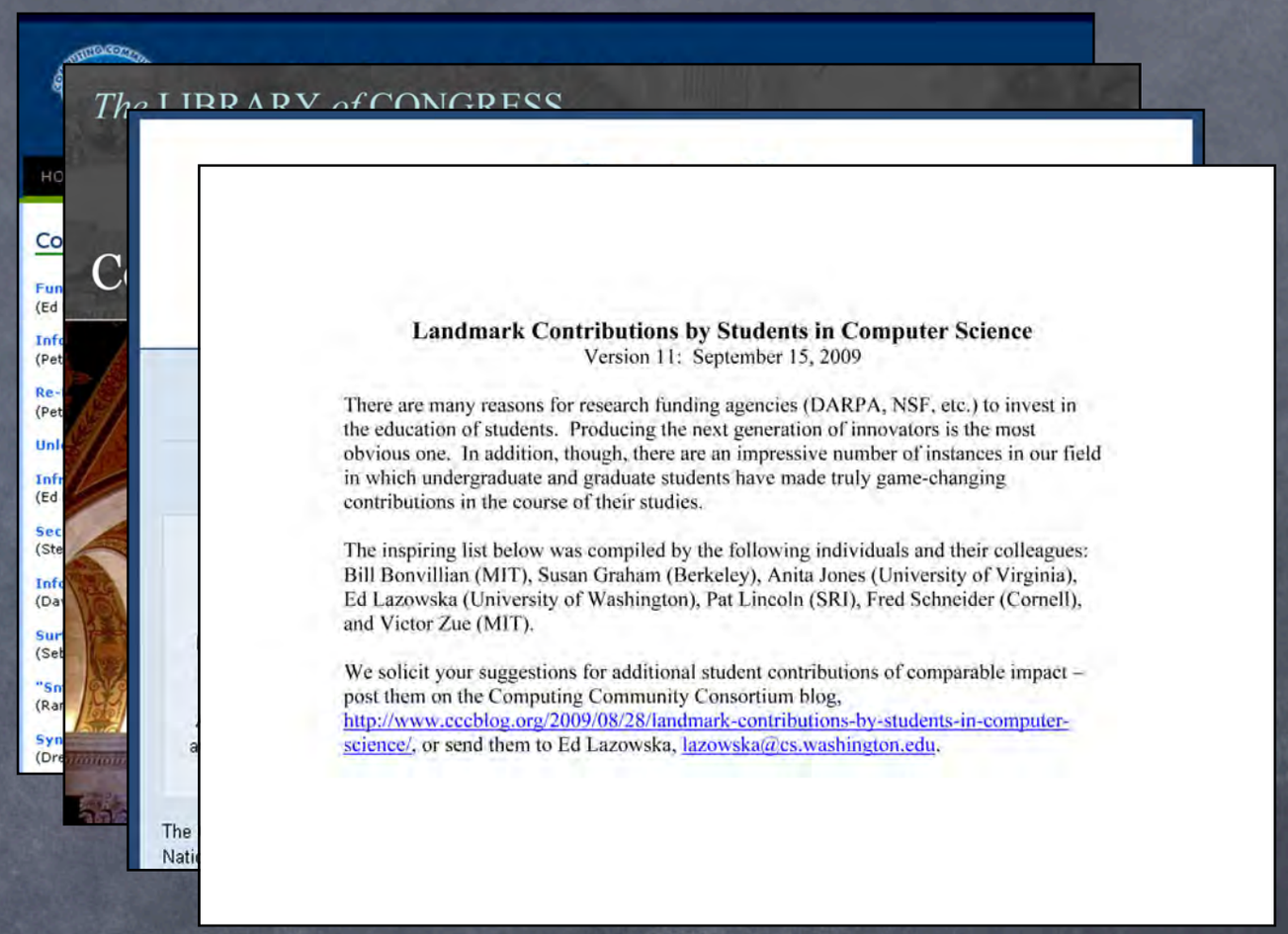


Major special initiatives

- "Transition Team" white papers
- Library of Congress Symposium
- Computing Innovation Fellows (CIFellows)

Major special initiatives

- "Transition Team" white papers
- Library of Congress Symposium
- Computing Innovation Fellows (CIFellows)
- Landmark Contributions by Students



Landmark Contributions by Students in Computer Science
Version 11: September 15, 2009

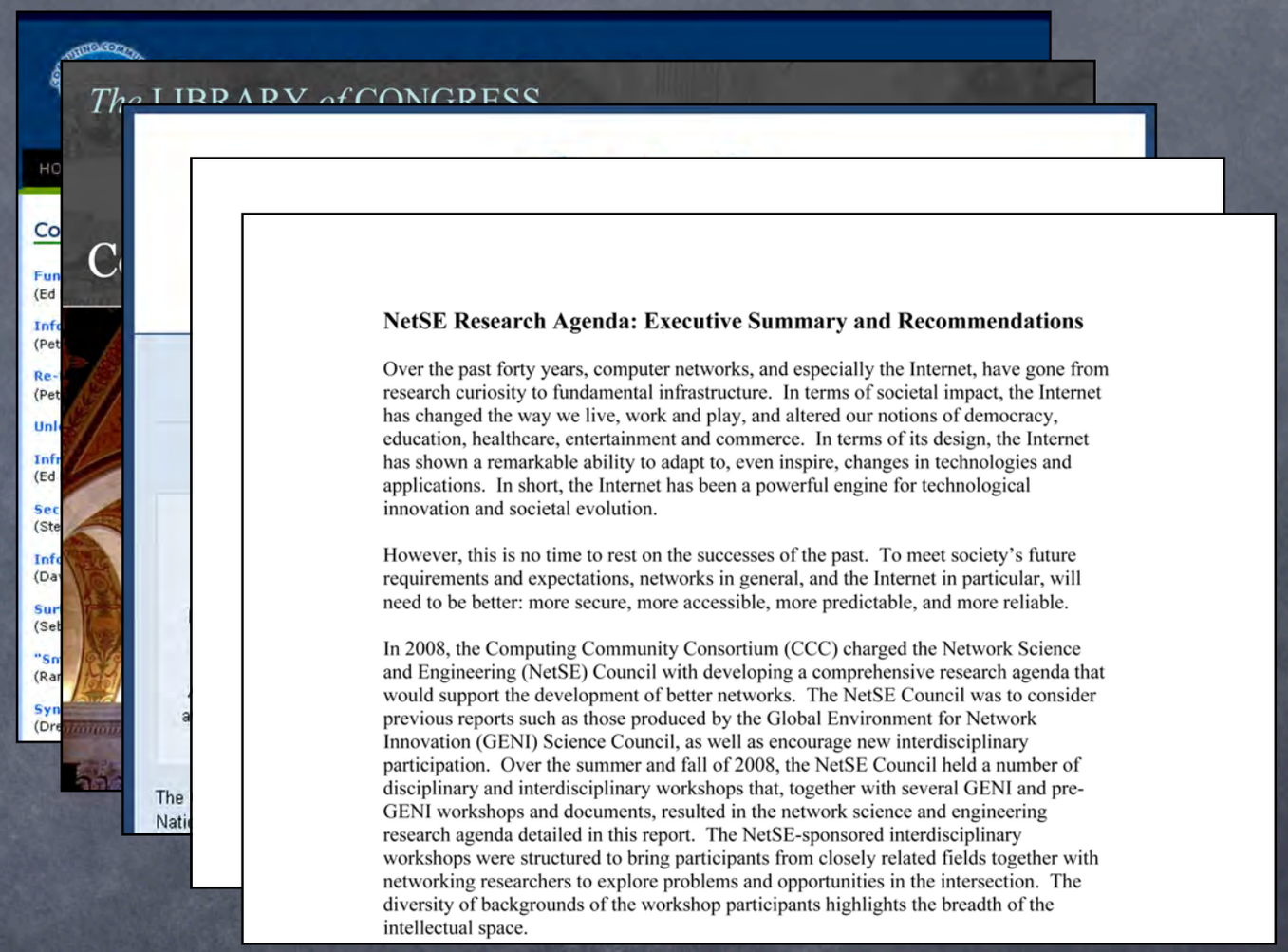
There are many reasons for research funding agencies (DARPA, NSF, etc.) to invest in the education of students. Producing the next generation of innovators is the most obvious one. In addition, though, there are an impressive number of instances in our field in which undergraduate and graduate students have made truly game-changing contributions in the course of their studies.

The inspiring list below was compiled by the following individuals and their colleagues: Bill Bonvillian (MIT), Susan Graham (Berkeley), Anita Jones (University of Virginia), Ed Lazowska (University of Washington), Pat Lincoln (SRI), Fred Schneider (Cornell), and Victor Zue (MIT).

We solicit your suggestions for additional student contributions of comparable impact – post them on the Computing Community Consortium blog, http://www.cccblog.org/2009/08/28/landmark-contributions-by-students-in-computer-science/, or send them to Ed Lazowska, lazowska@cs.washington.edu.

Major special initiatives

- "Transition Team" white papers
- Library of Congress Symposium
- Computing Innovation Fellows (CIFellows)
- Landmark Contributions by Students
- NetSE Research Agenda



NetSE Research Agenda: Executive Summary and Recommendations

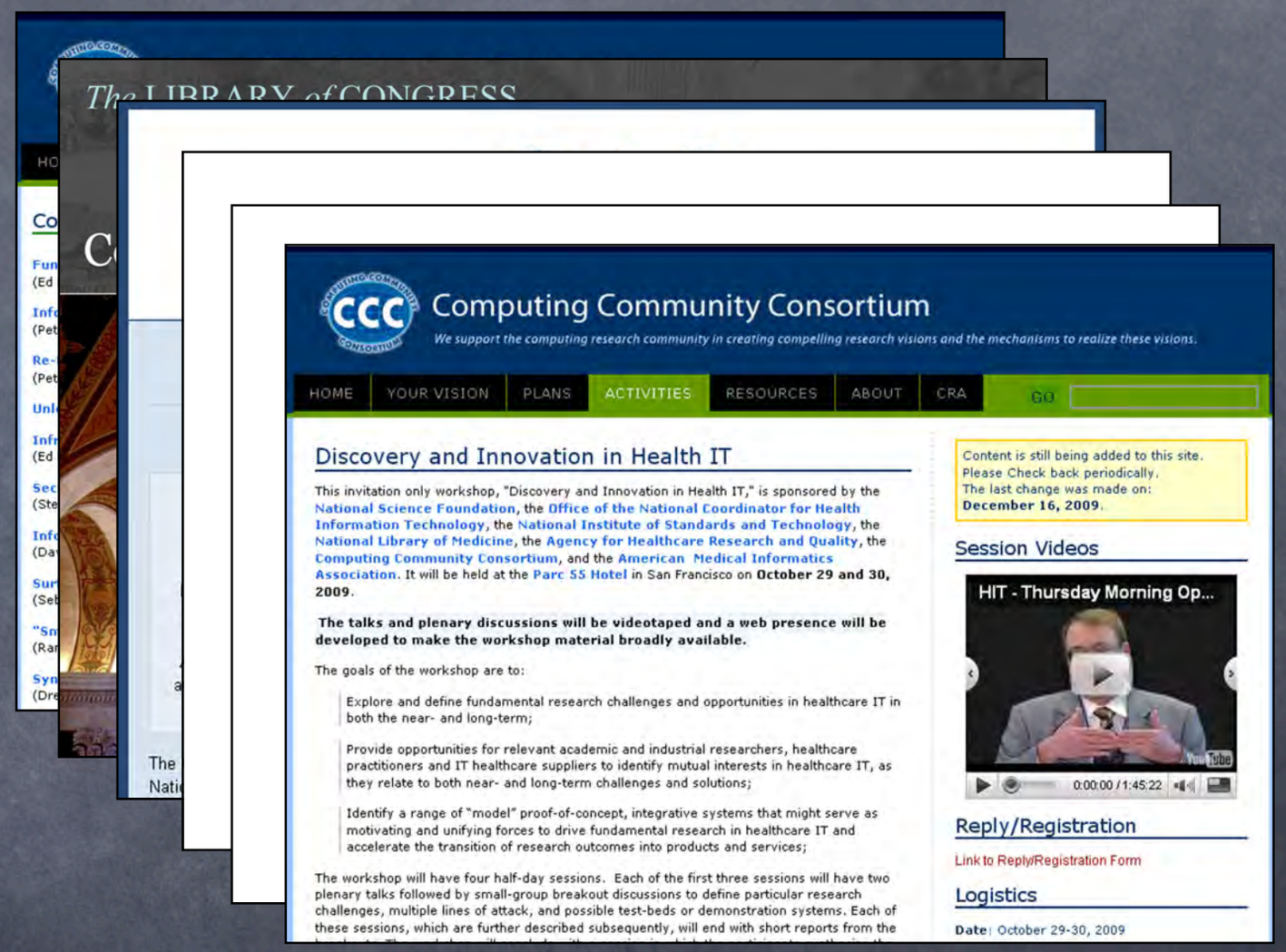
Over the past forty years, computer networks, and especially the Internet, have gone from research curiosity to fundamental infrastructure. In terms of societal impact, the Internet has changed the way we live, work and play, and altered our notions of democracy, education, healthcare, entertainment and commerce. In terms of its design, the Internet has shown a remarkable ability to adapt to, even inspire, changes in technologies and applications. In short, the Internet has been a powerful engine for technological innovation and societal evolution.

However, this is no time to rest on the successes of the past. To meet society's future requirements and expectations, networks in general, and the Internet in particular, will need to be better: more secure, more accessible, more predictable, and more reliable.

In 2008, the Computing Community Consortium (CCC) charged the Network Science and Engineering (NetSE) Council with developing a comprehensive research agenda that would support the development of better networks. The NetSE Council was to consider previous reports such as those produced by the Global Environment for Network Innovation (GENI) Science Council, as well as encourage new interdisciplinary participation. Over the summer and fall of 2008, the NetSE Council held a number of disciplinary and interdisciplinary workshops that, together with several GENI and pre-GENI workshops and documents, resulted in the network science and engineering research agenda detailed in this report. The NetSE-sponsored interdisciplinary workshops were structured to bring participants from closely related fields together with networking researchers to explore problems and opportunities in the intersection. The diversity of backgrounds of the workshop participants highlights the breadth of the intellectual space.

Major special initiatives

- "Transition Team" white papers
- Library of Congress Symposium
- Computing Innovation Fellows (CIFellows)
- Landmark Contributions by Students
- NetSE Research Agenda
- Health IT



...And lots of visioning activities

Community visioning activities	Participants	Organizations
NetSE	109	44
Cyber-physical systems	100	47
Robotics	141	79
Big data computing	81	46
Theoretical CS	39	26
Global development	56	37
Education technology	55	30
Health information technology	121	102
Cross-layer reliability	121	45
Free and open source software	42	35
Advancing computer architecture	New in 2010	
Interactive technologies	New in 2010	

What other topics should we cover?
Tell us!

OSTP's FY 12 priorities...

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

THE DIRECTOR

July 21, 2010

M-10-30

MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES

FROM: Peter R. Orszag
Director, Office of Management and Budget

John P. Holdren
Director, Office of Science Technology Policy

SUBJECT: Science and Technology Priorities for the FY 2012 Budget

Scientific discovery, technological breakthroughs, and innovation are major engines for expanding the frontiers of human knowledge and are indispensable for promoting sustainable economic growth, improving the health of the population, moving toward a clean energy future, addressing global climate change challenges, managing competing demands on the environment, and safeguarding our national security.

This memorandum follows up on OMB Memorandum M-10-19 by outlining the Administration's science and technology (S&T) priorities for formulating FY 2012 Budget submissions to the Office of Management and Budget (OMB). These priorities for research and development (R&D) investments and other S&T investments build on priorities already reflected in the American Recovery and Reinvestment Act, the FY 2010 and 2011 Budgets, and key Administration policy guidance such as the President's *Strategy for American Innovation*. This memorandum also provides program guidance for S&T activities in Executive Departments and Agencies.

Prioritizing key S&T activities

...Aligning our activities

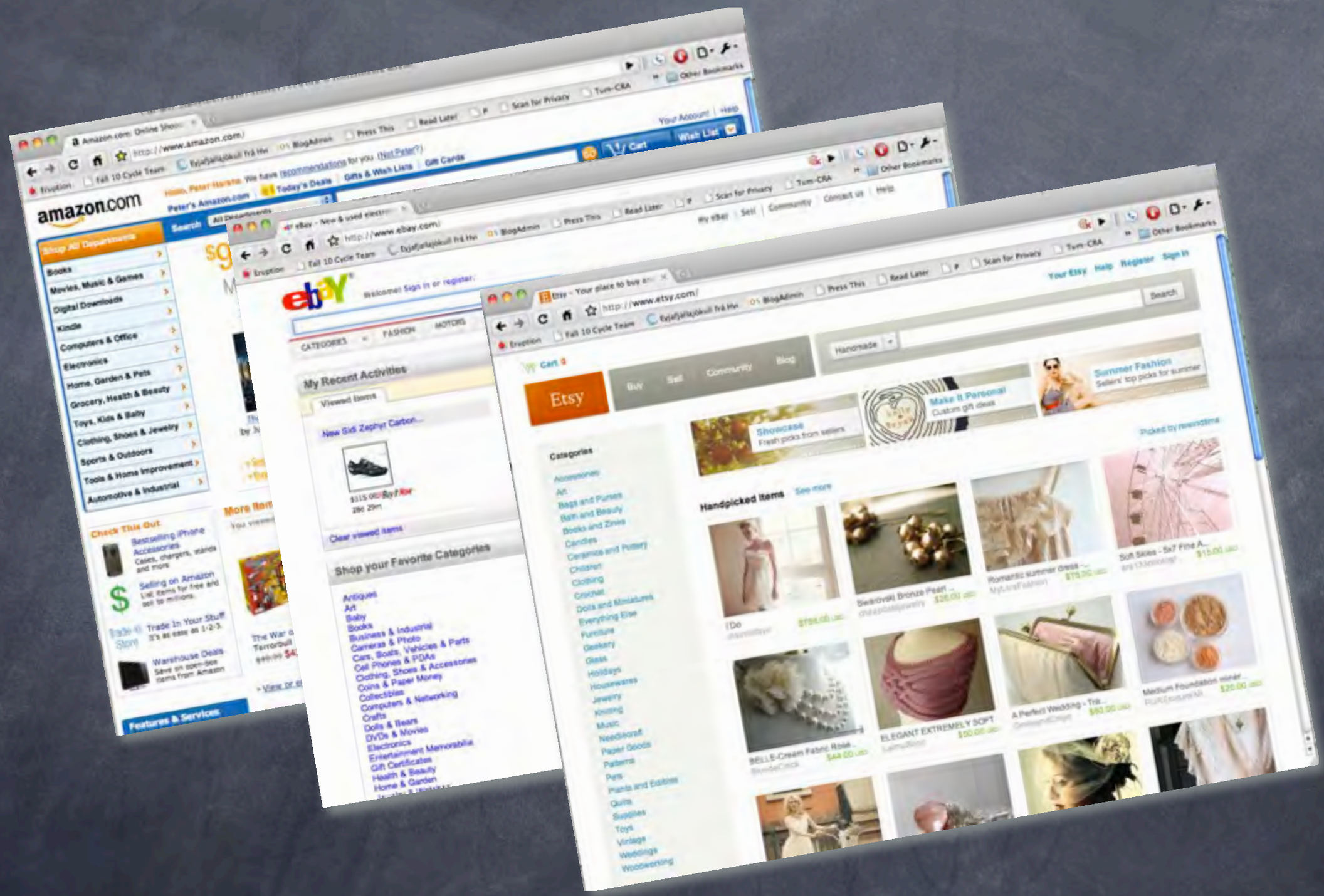
"In the 2012 Budget, agencies should focus on ... six challenges."

Economic growth and job creation NITRD -- "inferences from enormous quantities of data"	Data analytics WPs Big data visioning activity NSF CDI
Achieving better health outcomes	Health IT workshop ONC discussions NSF/CISE SHB NIH discussions
Moving toward a clean energy future	Multiple WPs
Impacts of global climate change	NSF CRI
Improved sustainability and biodiversity	NSF SEES
National security Cybersecurity	Multiple WPs

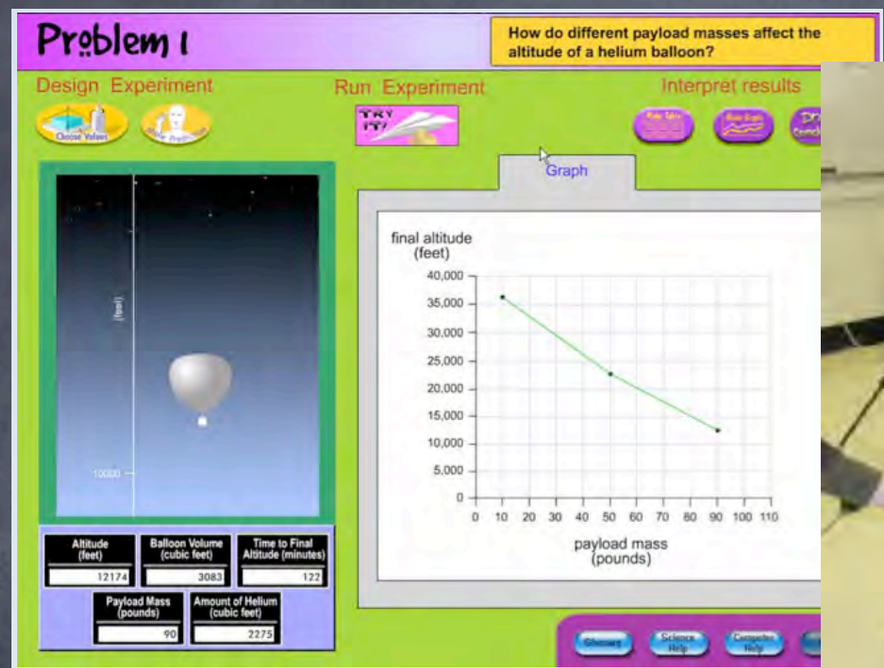
Ultimately,

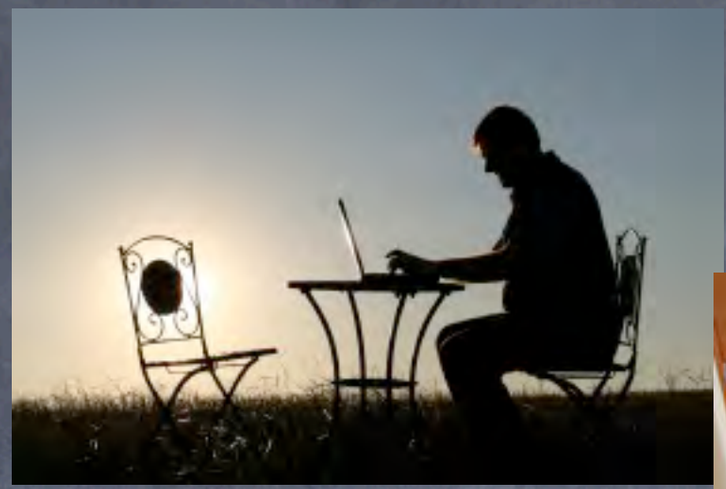
basic research drives...

...how we conduct commerce...



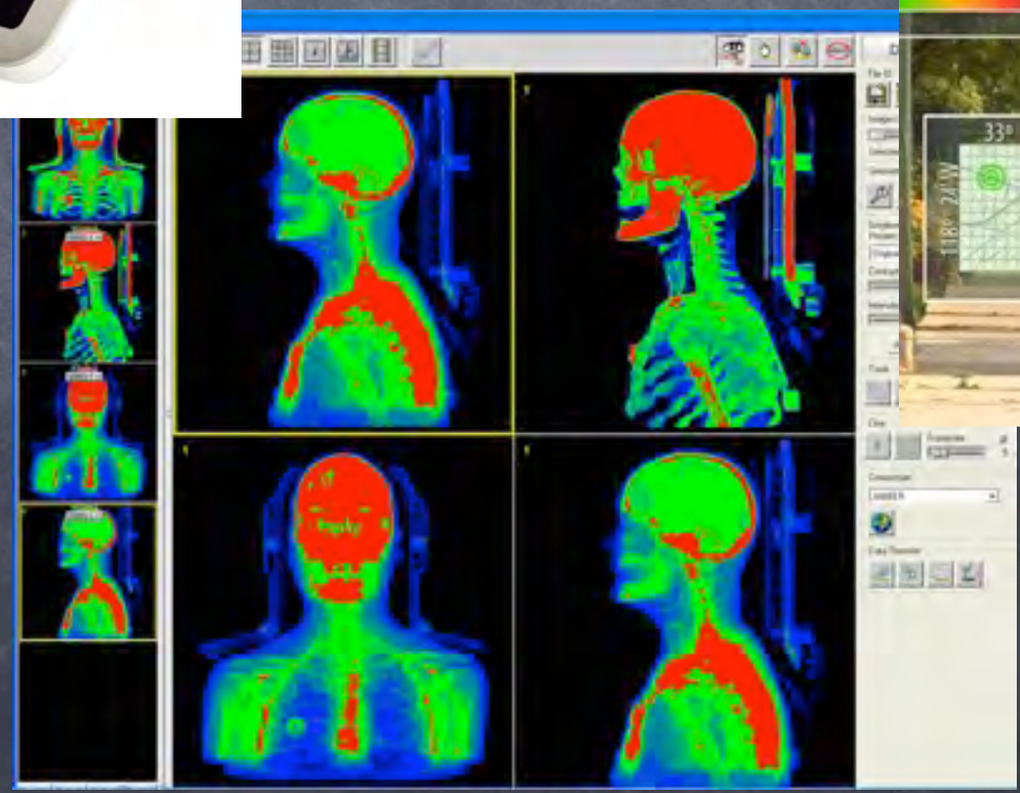
...how we learn...


Problem 1
How do different payload masses affect the altitude of a helium balloon?
Design Experiment
Run Experiment
Interpret results
Graph
final altitude (feet)
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0 10 20 30 40 50 60 70 80 90 100 110
payload mass (pounds)
Altitude (feet)
12174
Balloon Volume (cubic feet)
3083
Time to Final Altitude (minutes)
122
Payload Mass (pounds)
90
Amount of Helium (cubic feet)
2275

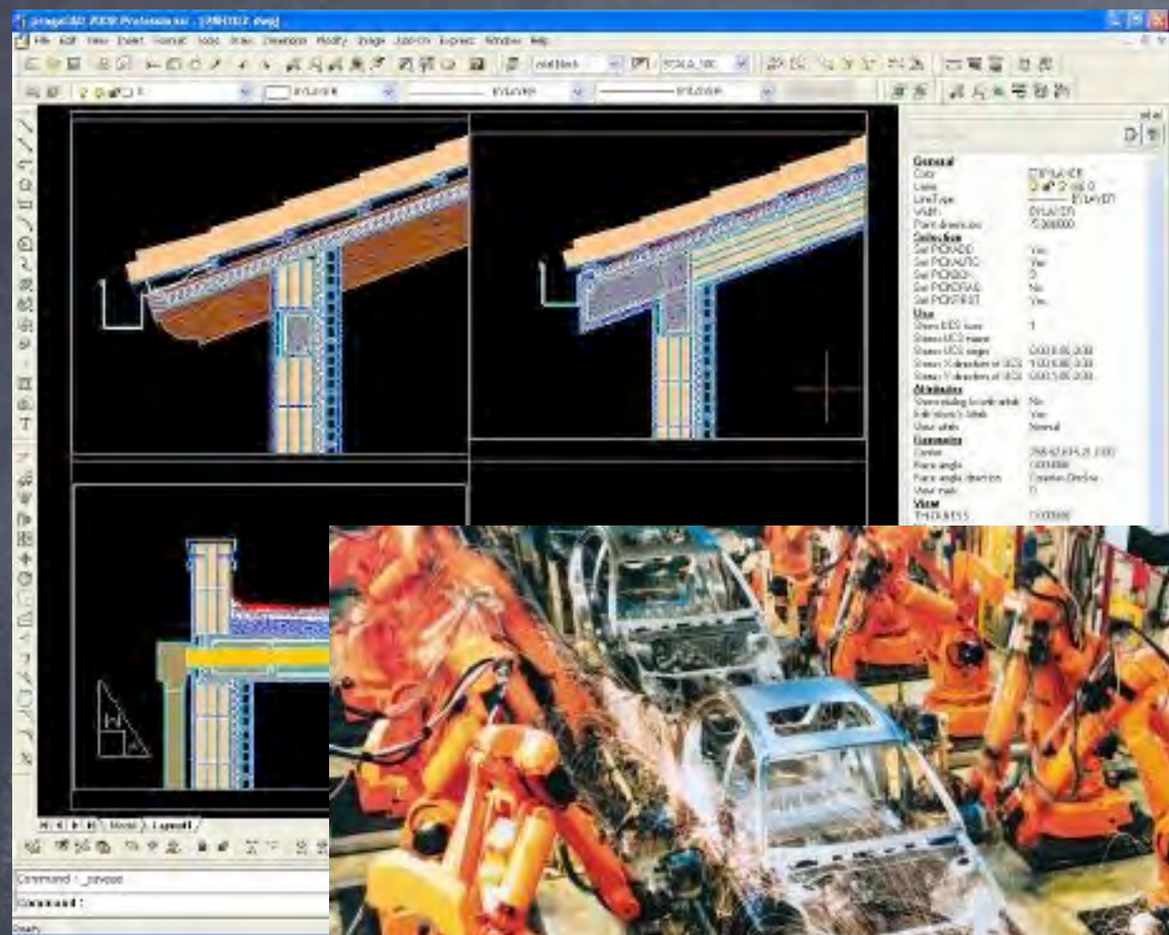


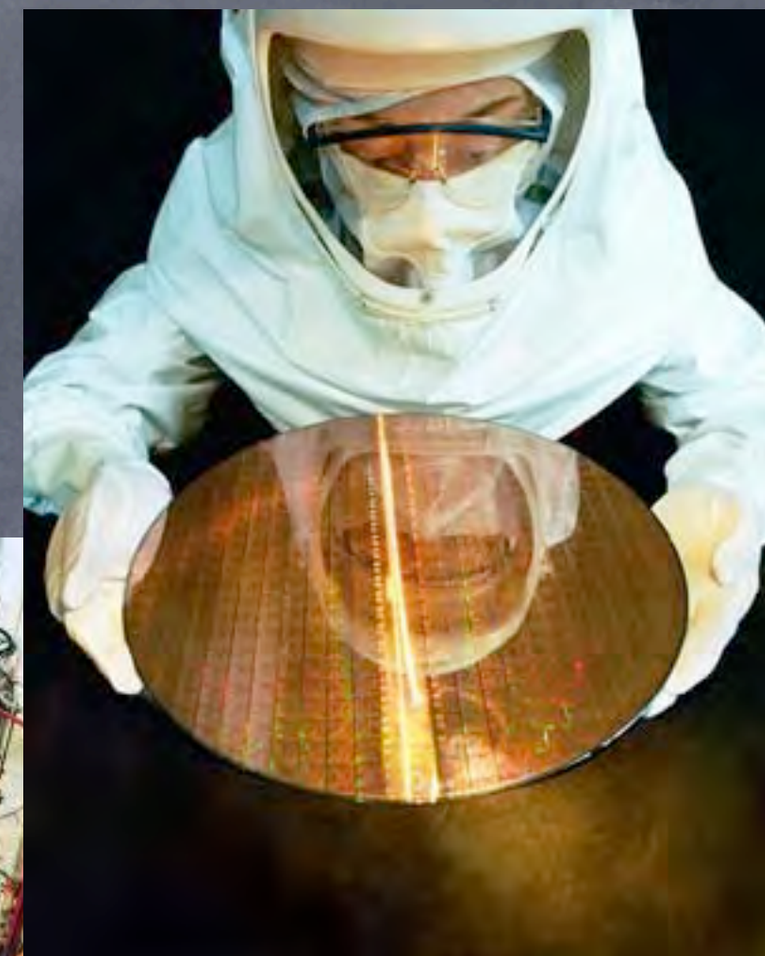
...how we work...

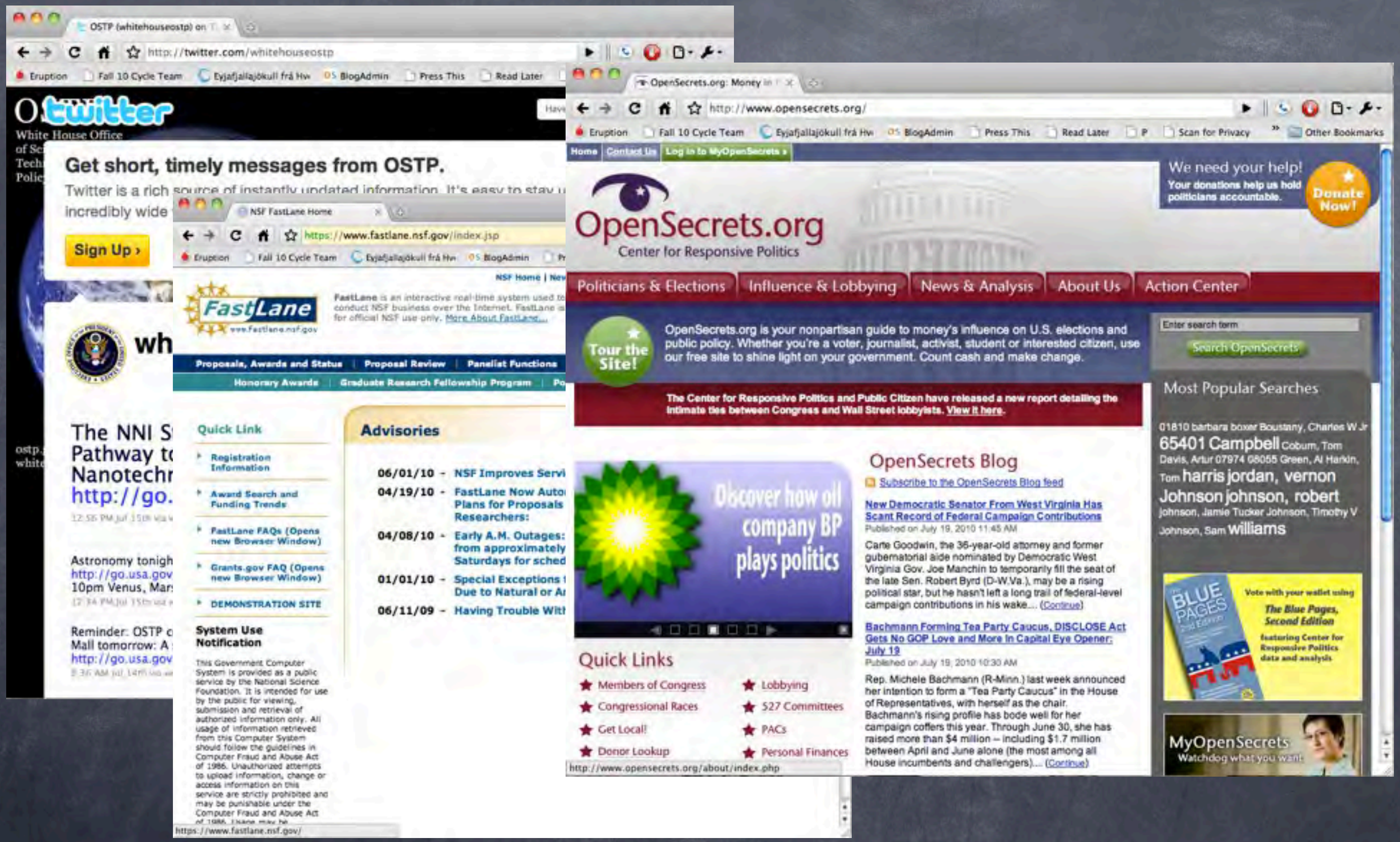
...how we care for ourselves...



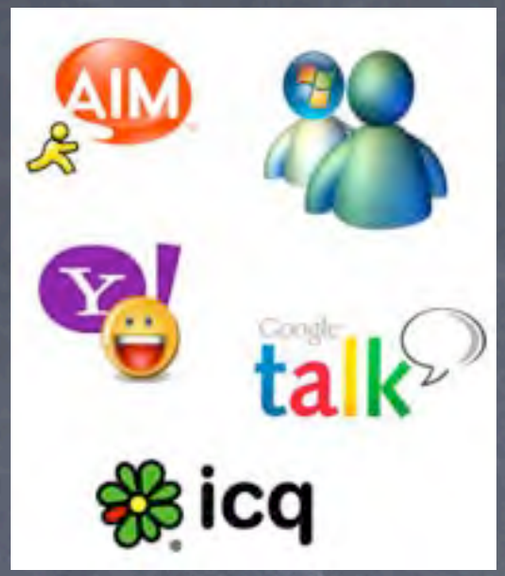
...how we manufacture...

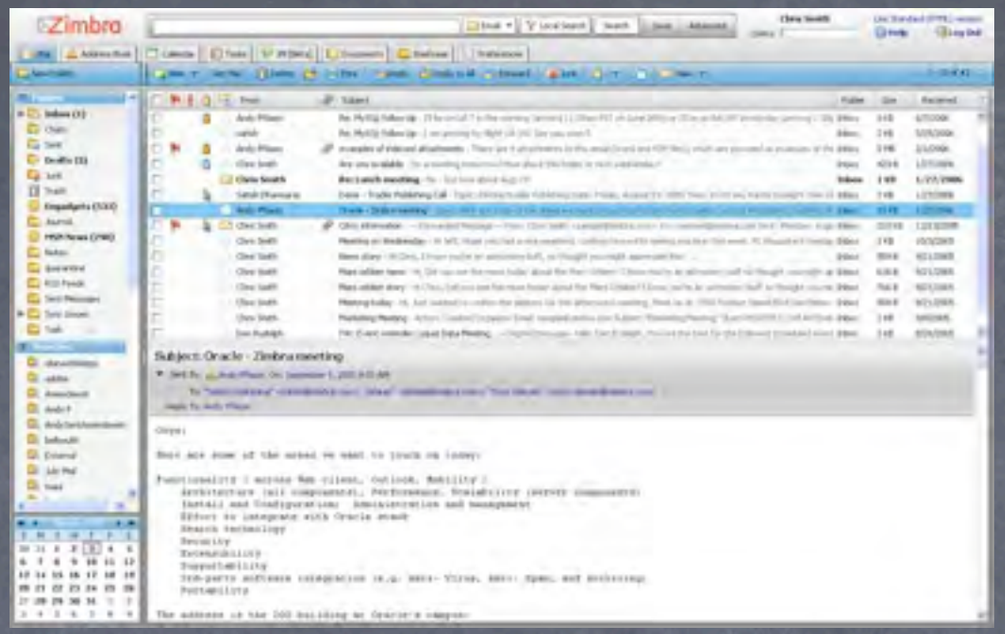


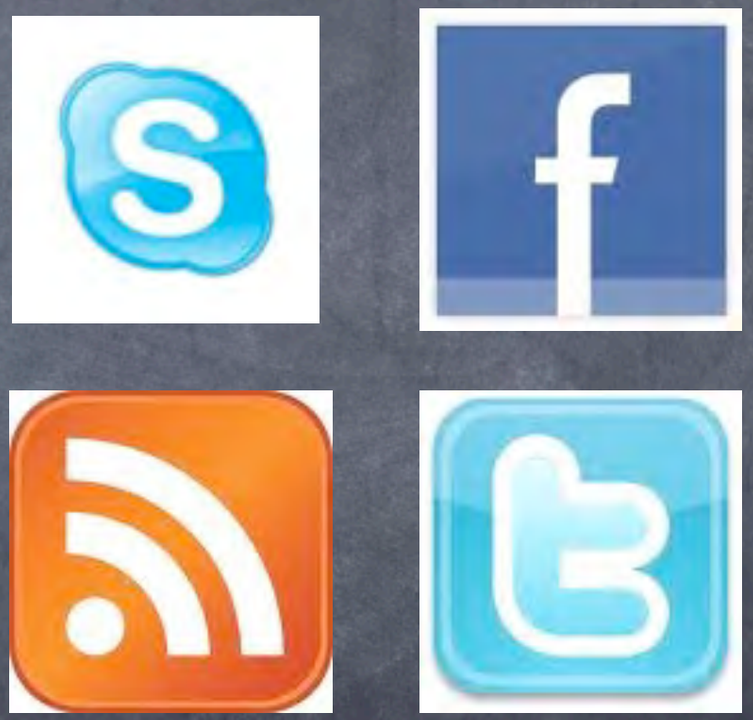




…how our governments function…



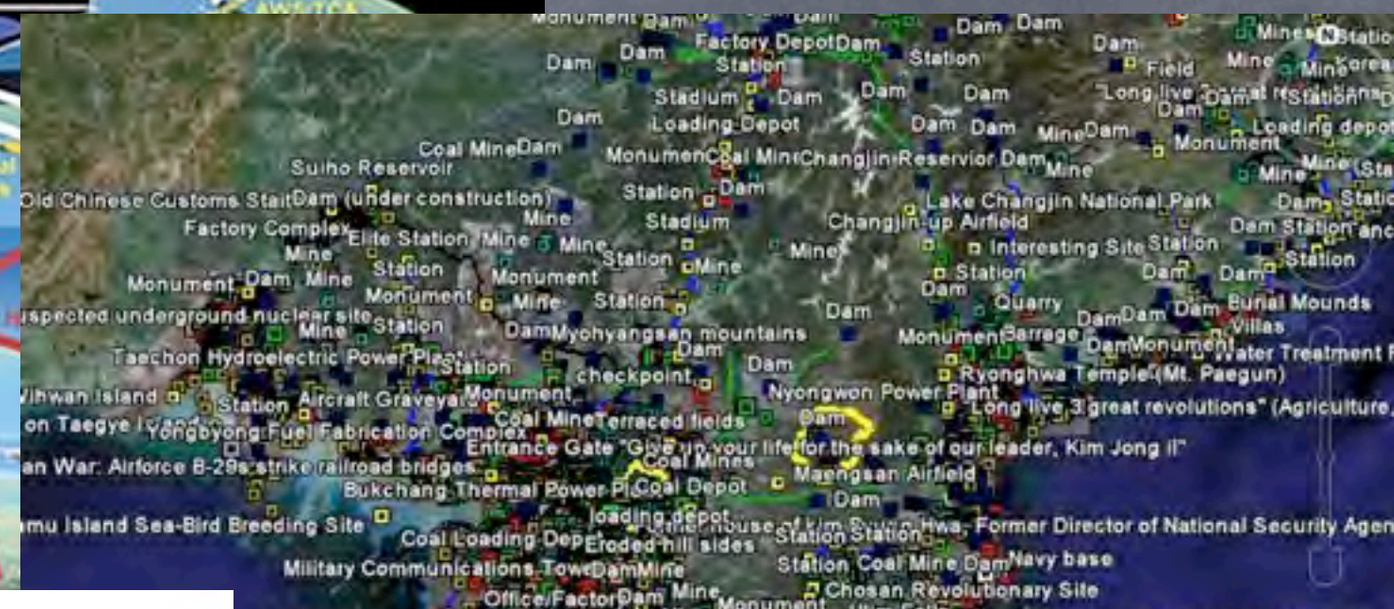


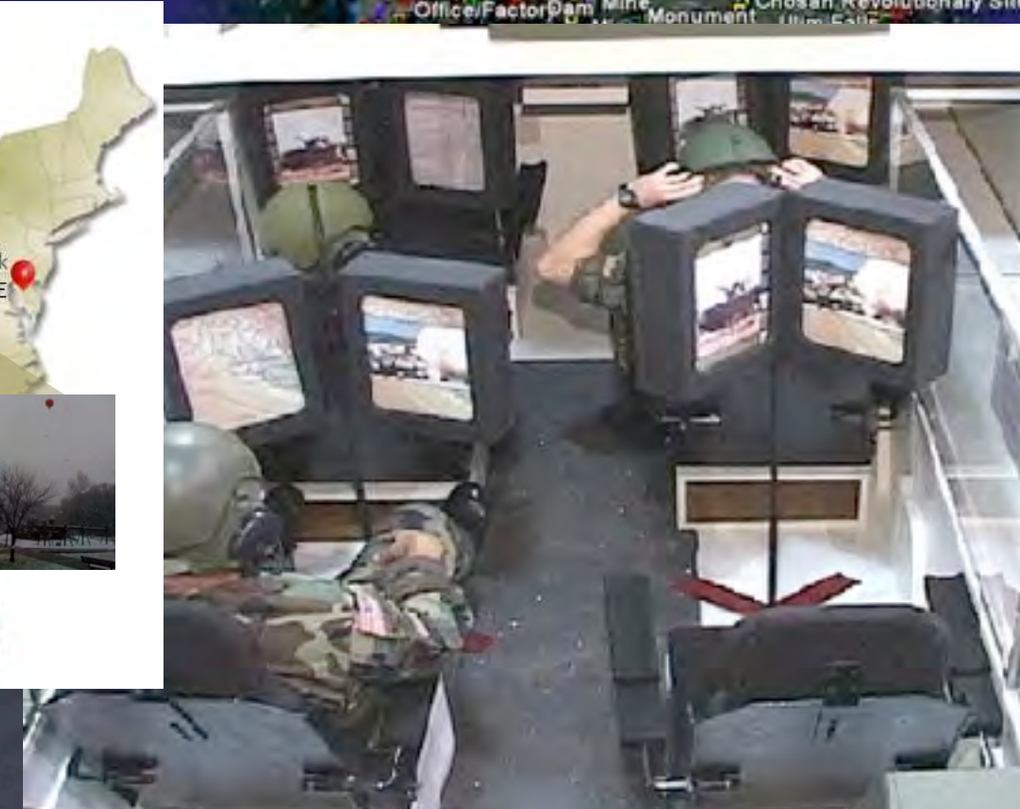


...how we communicate...

...how we're entertained...

...and how we preserve our nation's security.



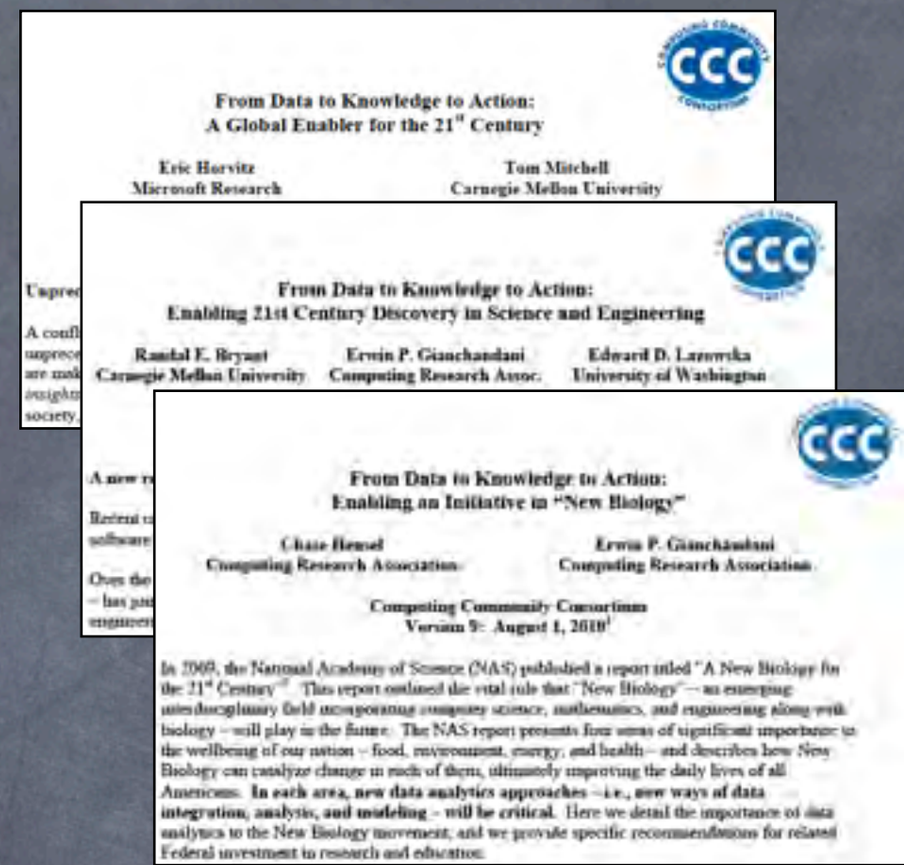


Courtesy
Peter Lee,
DARPA

So we have to make a case for
Federal investment in
basic computing research...

Current ongoing activities

- Data analytics
  - Overview
  - eScience
  - Healthcare
  - Energy
  - Education technology
  - New Transportation
  - Intelligence
  - New Biology
  - Robotics & emergency response



From Data to Knowledge to Action:
A Global Enabler for the 21st Century

Eric Horvitz, Microsoft Research
Tom Mitchell, Carnegie Mellon University

From Data to Knowledge to Action:
Enabling 21st Century Discovery in Science and Engineering

Randal E. Bryant, Carnegie Mellon University
Erwin P. Gianchandani, Computing Research Assoc.
Edward D. Lazowska, University of Washington

From Data to Knowledge to Action:
Enabling an Initiative in "New Biology"

Chaze Henzel, Computing Research Association
Erwin P. Gianchandani, Computing Research Association

Computing Community Consortium
Version 9: August 1, 2010[1]

In 2009, the National Academy of Science (NAS) published a report titled "A New Biology for the 21st Century". This report outlined the vital role that "New Biology" — an emerging interdisciplinary field incorporating computer science, mathematics, and engineering along with biology — will play in the future. The NAS report presents four areas of significant importance to the wellbeing of our nation – food, environment, energy, and health – and describes how New Biology can catalyze change in each of them, ultimately improving the daily lives of all Americans. **In each area, new data analytics approaches – i.e., new ways of data integration, analysis, and modeling – will be critical.** Here we detail the importance of data analytics to the New Biology movement, and we provide specific recommendations for related Federal investment in research and education.

- Ongoing visioning activities
  - Robotics
  - Collective intelligence/how the brain is engineered & functions
  - Energy
  - Computing at the margins/global development
  - …

Last but not least...

...A call to service

- There's value to serving as a program officer
  - Some fields view this role in higher regard than others
- Learning how DC works can make us better scientists, researchers, and educators
  - We know what to propose and how to propose it
  - We know the skills set required of our graduates
- We must make sure there's a constant stream of people heading to DC -- they become "advocates" for the field
- **Stay involved -- even if you can't make it to DC**

Questions?

- E-mail: erwin@cra.org
- Phone: (202) 266-2936
- Online: www.cra.org/ccc