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## Computing Research That Changed The World



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## Computing Research That Changed The World

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March 25, 2009

## Changing the World!



Ed Lazowska

Bill & Melinda Gates Chair in Computer Science & Engineering University of Washington

Chair, Computing Community Consortium



## Computing has changed the world

- Advances in computing change the way we live, work, learn, and communicate
- Advances in computing drive advances in nearly all other fields
- Advances in computing power our economy
  - Not just through the growth of the IT industry through productivity growth across the entire economy











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## Life Changers

The top innovations of the last 30 years, according to judges at the Wharton School of the University of Pennsylvania.

> In response to the shouted-out questing, "What are some of the greatest inventions of all time? In arby office workers in a recent informal survey yave the following an every the which, the engine, the ballpoint pen, diapers and the cheese Donish.

> > were very different.

#### Life Changers

The top innovations of the last 30 years, according to judgee at the Wharton School of the University of Pennsylvania

1. Internet, broadband 2. PC and laptop computers

3 Mobile phones

4. E-mail 5. DNA lesting and sequencing

6. Magnetic resonance imaging

7. Micróprocessors

8 Fiber optics

9. Office software

10. Laser/robetic surgery

11. Open-source software 12. Light-emitting diodes

13. Liquid crystal display

14. GPS devices

15 E-commerce and auctions

16. Media file comprension

17 Microfinance 18. Photovoltaic solar energy

19. Large-scale wind turbines

20. Internet social networking

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Next Article in Business (22 of 29) +

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Parents Spe Trinters Over Prep School's Shutdown Doctoral Caudidates Asticipate Hard Times

In the survey, the Internet was voted the biggest innovation of the last three decades, followed by computers, mobile phones and e-mail. The survey was sponsored by Knowledge@Wharton, the school's business publication, and PBS's "Nightly Business Report."

Good, important choices all, but for classic, long-lasting appeal, they still can't beat the wheel. PHYLLIS KORKKI

School of the University of Pennsylvania was required to go back only 30 years not to the dawn of history - when asked a ACADEMY AWARD WIGHT similar question. So its answers, of course,

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# Imagine spending a day without information technology

- A day without the Internet and all that it enables
- A day without diagnostic medical imaging
- A day during which automobiles lacked electronic ignition, antilock brakes, and electronic stability control
- A day without digital media without wireless telephones, high-definition televisions, MP3 audio, DVD video, computer animation, and videogames
- A day during which aircraft could not fly, travelers had to navigate without benefit of GPS, weather forecasters had no models, banks and merchants could not transfer funds electronically, factory automation ceased to function, and the US military lacked technological supremacy

# Imagine spending a day without information technology

- A day without the Internet and
- A day without diagnostic medic
- A day during which automobiles antilock brakes, and electronic
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## Research has built the foundation

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Evolving the High Performance Computing and Communications Initiative to Support the Nation's Information Infrastructure

NATIONAL RESEARCH COUNC



NATIONAL RESEARCH CORPORE





## The future is full of opportunity

- Creating the future of networking
- Driving advances in all fields of science and engineering
- Revolutionizing transportation
- Personalized education
- The Smart Grid
- Predictive, preventive, personalized medicine
- Quantum computing
- Empowerment of the developing world
- Personalized health monitoring => quality of life
- Neurobotics
- Synthetic biology





















## Today

- Game-changing advances of the recent past
- Advances that are on the horizon, and what will be needed to achieve them
- Lessons that can further increase the already remarkable effectiveness of the IT R&D ecosystem
- Synthesis (and some demonstrations)

#### Session 1: The Internet and the World Wide Web

9:00 - 10:20

Why We're Able to Google Alfred Spector (Google)

The Magic of the "Cloud": Supercomputers for Everybody, Everywhere Eric Brewer (University of California, Berkeley)

Human Computation Luis von Ahn (Carnegie Mellon University)

Discussion by the speakers of future challenges and synergies



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



Internet and the World Web Panel, March 25, 2009 Computing Research that Changed the World



# The Magic of the Cloud: Supercomputers for Everyone, Everywhere Prof. Eric A. Brewer UC Berkeley

# Human Computation

# Luis von Ahn

# **Carnegie Mellon University**



#### Session 2: Evolving Foundations

10:40 - 12:00

Security of Online Information Barbara Liskov (Massachusetts Institute of Technology)

Learning to Improve Our Lives Daphne Koller (Stanford University)

Global Information Networks Jon Kleinberg (Cornell University)

Discussion by the speakers of future challenges and synergies



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



Barbara Liskov MIT CSAIL March 2009





# to improve our lives

# Daphne Koller Stanford University



## **Global Information Networks**

## Jon Kleinberg

Cornell University





Jon Kleinberg Global Information Networks



 Session 3: The Transformation of the Sciences via Computation
 1:00 - 2:20

 Supercomputers and Supernetworks are Transforming Research

 Larry Smarr (University of California, San Diego)

Computing and Visualizing the Future of Medicine Chris Johnson (University of Utah)

**200ming In On Life** Gene Myers (Howard Hughes Medical Institute)

Discussion by the speakers of future challenges and synergies



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## Supercomputers and Supernetworks are Transforming Research







Dr. Larry Smarr Director, California Institute for Telecommunications and Information Technology Harry E. Gruber Professor, Dept. of Computer Science and Engineering Jacobs School of Engineering, UCSD





## Computing and Visualizing the Future of Biomedicine



Chris Johnson Scientific Computing and Imaging Institute University of Utah



## Zooming in On Life

Gene Myers Group Leader HHMI Janelia Farm Research Campus

#### Session 4: Computing Everywhere!

2:30 - 3:50

Sensing Everywhere! Deborah Estrin (University of California, Los Angeles)

Pixels Everywhere! Pat Hanrahan (Stanford University)

Robotics Everywhere! Rodney Brooks (Massachusetts Institute of Technology and Heartland Robotics)

Discussion by the speakers of future challenges and synergies



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## Sensing Everywhere! from ecosystems to human systems

Professor Deborah Estrin

### NSF Science and Technology Center for Embedded Networked Sensing (CENS)

UCLA Computer Science Department

destrin@cens.ucla.edu

#### ... in collaboration with faculty, students and staff at CENS

We gratefully acknowledge the support of our sponsors, including the National Science Foundation, Nokia, Intel Corporation, Cisco Systems Inc., Sun Inc., Google, Microsoft Research, UC Micro, Crossbow Inc., T-mobile, Conservation International, and the participating campuses.

### http://urban.cens.ucla.edu



# **Pixels Everywhere** Media Tech and How it Changed the World

# Pat Hanrahan Department of Computer Science Stanford University







# **Robots Everywhere!**

## **Rodney Brooks**

Massachusetts Institute of Technology iRobot Corporation Heartland Robotics





#### **Evaluation Session: Moving Forward**

4:00 - 5:00

Discussion by the speakers and the audience of what factors made these achievements possible and what factors will accelerate future advances.

Moderators: Susan Graham (University of California, Berkeley) and Peter Lee (Carnegie Mellon University)



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#### Walk to Madison Hall, James Madison Building, Library of Congress 5:00 - 5:30



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## The origins of this symposium

- Built upon a history of attempting to better understand the IT innovation ecosystem
- Discussions with NSF
- Broad input from the computing research community
- Program committee chaired by Dan Reed synthesized this input into a set of recommendations
- Members of the CCC Council assembled the final program



## With thanks to

### Our honorary co-sponsors

- Congressman Bart Gordon (D-TN)
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- Congressman Rush Holt (D-NJ)
- Senator Jay Rockefeller (D-WV)

### The general chairs

- Greg Andrews (University of Arizona)
- David Kaeli (Northeastern University)

- The session chairs and discussion moderators
  - Susan L. Graham (UC Berkeley)
  - Peter Lee (Carnegie Mellon University)
- The Computing Research Association
  - Andrew Bernat
  - Peter Harsha
- The program committee, speakers, and demonstrators

