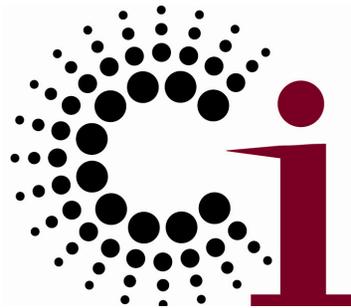


Why do Virtual Environments Matter for Knowledge Production?

Ian Foster



Computation Institute

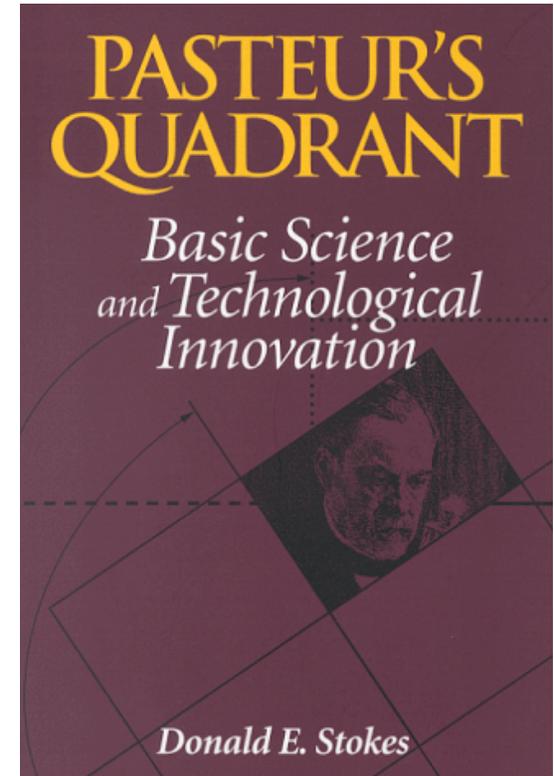
Argonne National Lab & University of Chicago

<http://www.ci.uchicago.edu>



“Knowledge Production” ... or “Problem Solving”?

<i>Focus on Knowledge Creation?</i>	Yes	Bohr	Pasteur
	No		Edison
		No	Yes
		<i>Focus on Application?</i>	



(Thanks,
Dan)

The answer will often be “both”



Examples of Problems We Must Solve in the 21st Century

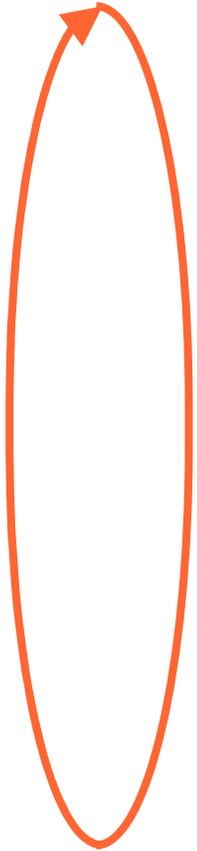
- Increase energy production by 5, while reducing GHG emissions by 2 or more
- Mitigate and adapt to climate change
- Address increasingly drug resistant diseases
- Provide meaningful livelihoods for 9B people

One far-from-exhausted resource
→ Human intelligence ←



For Example

- Facing an avian flu outbreak, we want to understand its biology and epidemiology
- I search for relevant models, data sets, validation methods, past simulation results
- I combine these diverse components, run simulations, apply validation methods
- I perform physical experiments
- I publish my data, methods, codes
- Others evaluate, annotate, criticize, apply, modify, extend, my methods and results





For Example

- Facing an avian flu outbreak, we need to understand its biology and epidemiology
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How do we accelerate this process?



A Human-Centered Approach to Accelerating Innovation

1. Understand how people solve problems
 - ◆ Study problem solving as an end-to-end, human-centered activity
2. Enhance [individual] human intelligence
 - ◆ Tools to enhance how we search, analyze, model, learn (“human-computer symbiosis”)
3. Catalyze knowledge communities
 - ◆ Tools to help communities form, evolve, work, debate, teach, learn



What's the Connection to Virtual Environments?

1. Understand how people solve problems
 - VEs as **experimental platforms** for studies of human behavior
2. Enhance [individual] human intelligence
 - VEs for **problem-solving, data exploration**, etc.; **mirror worlds**
3. Catalyze knowledge communities
 - VEs for **virtual communities**, facilitating formation and operation

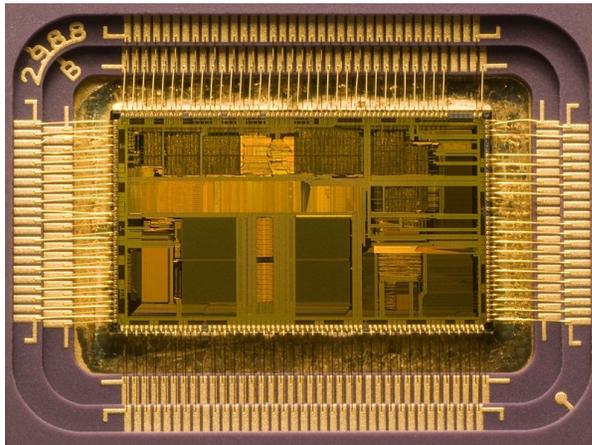
In any and all combinations

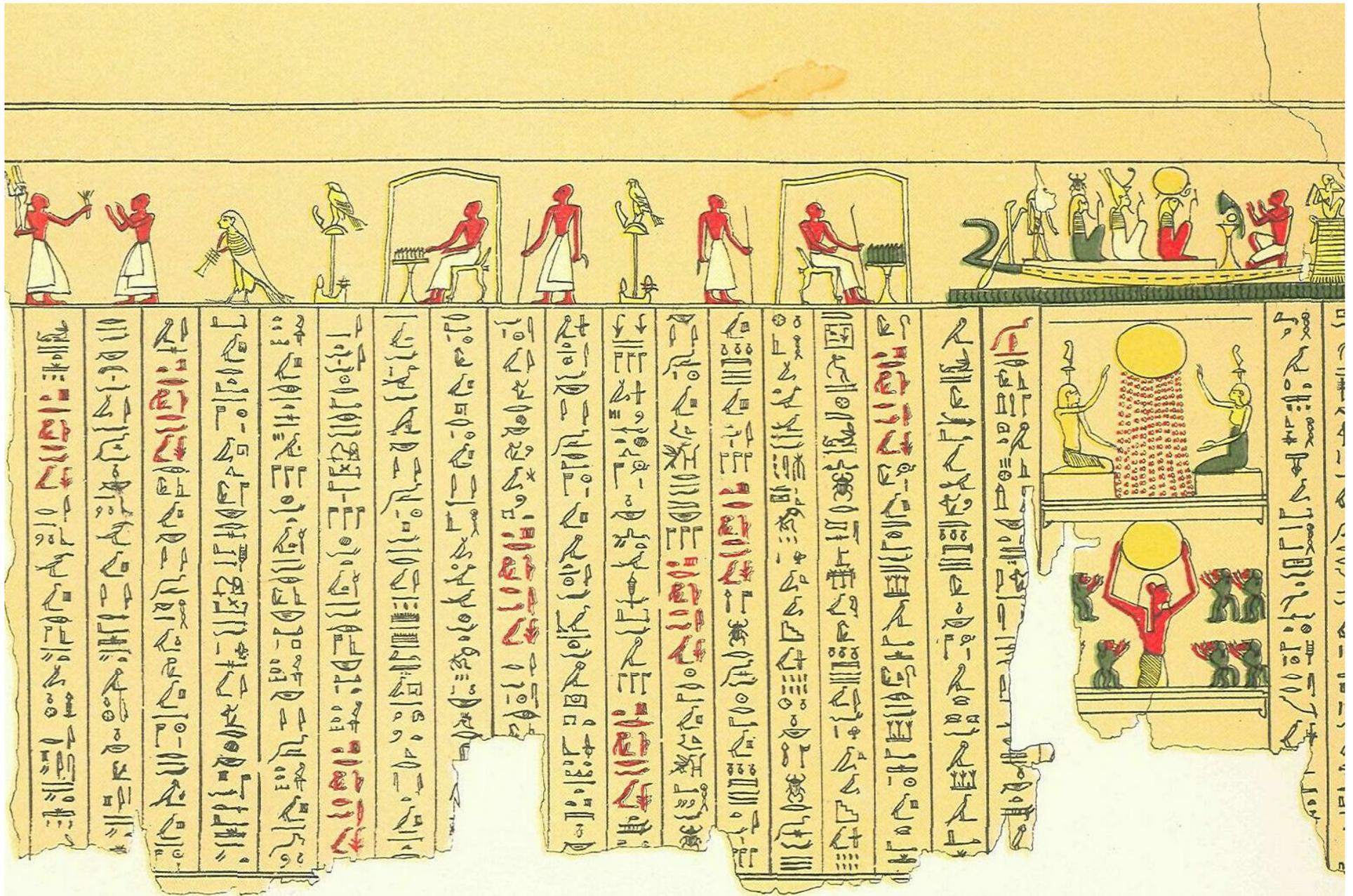


Just What is a “Virtual Environment”?

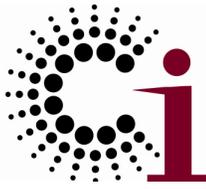
“A computer-simulated environment (real or virtual) with which human(s) can interact”

That is, a combination of two powerful
information processing tools





This is Not a Virtual Environment ...



The Power of Imagination (MUDS as VEs: 1970s [& today])

You are standing in a sunny, grassy park-like area, under the sprawling limbs of a weeping willow tree, growing on the banks of a small stream. To the south you see a university campus. A trail winds north into a forest. Erik is here.

Woj [to Remy]: I looked in Tom's office, and found that we don't have the right kind of scsi cable.

> **say Hmm.**

You say, "Hmm."

Ivan says, "We've got to have one somewhere."

Woj says, "Well, we do have one, but it's only a half-foot long."

> **emote tries to think of the type of cable you need.**

Remy tries to think of the type of cable you need.

Woj says, "Or, I could turn off alewife and steal that one..."

> **say "Check my office, if there's not one there, bounce alewife."**

You say, "Check my office, if there's not one there, bounce alewife."





Enhancing Human Intellect, Revisited

1. Understand how people solve problems
 - VEs as **experimental platforms** yielding understanding of social networks
2. Enhance [individual] human intelligence
 - VEs for **problem-solving, data exploration**, etc.; **mirror worlds**
3. Catalyze knowledge communities
 - VEs for **virtual communities**, facilitating formation and operation

In any and all combinations



Virtual Environments as Social Science Laboratories

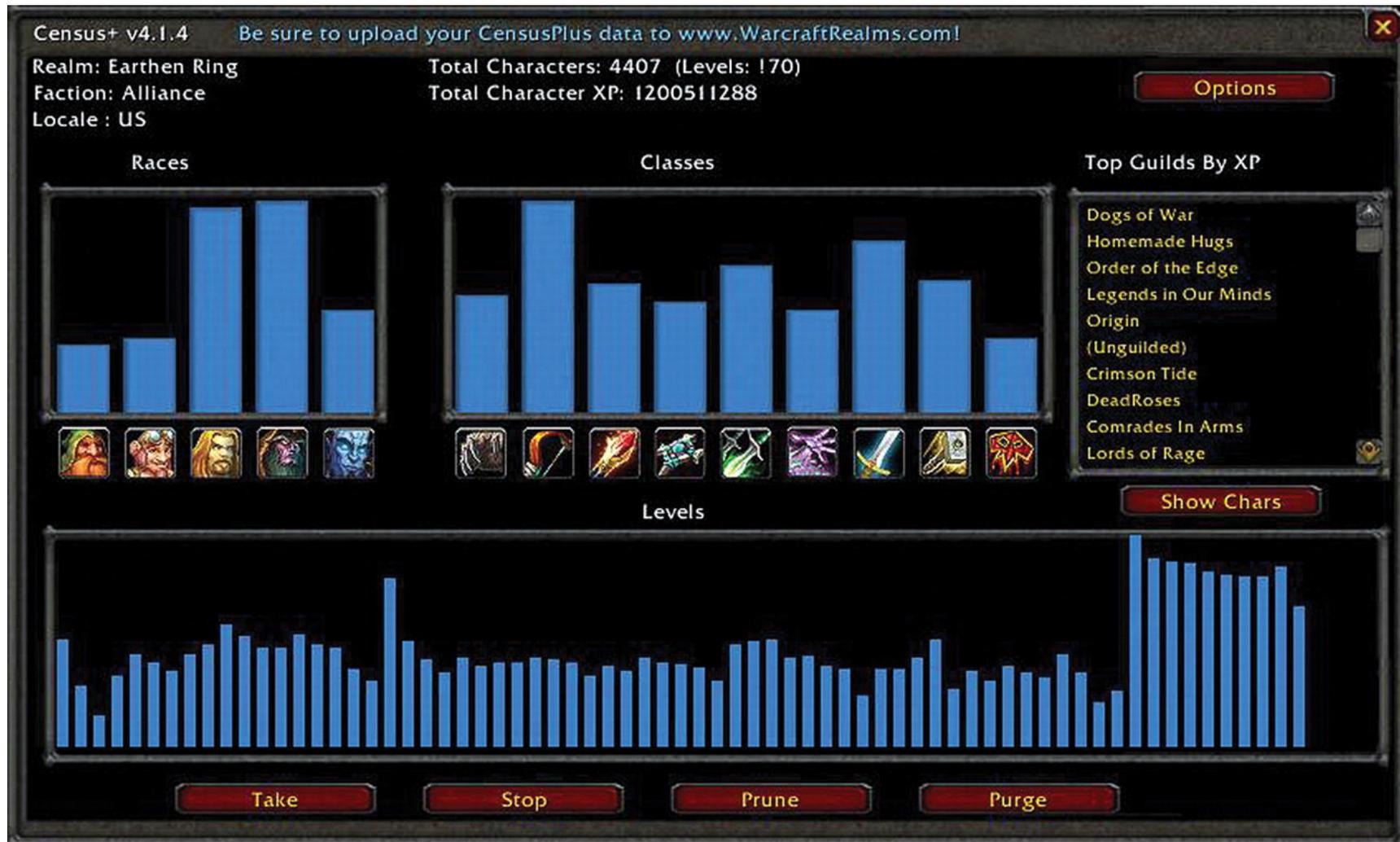
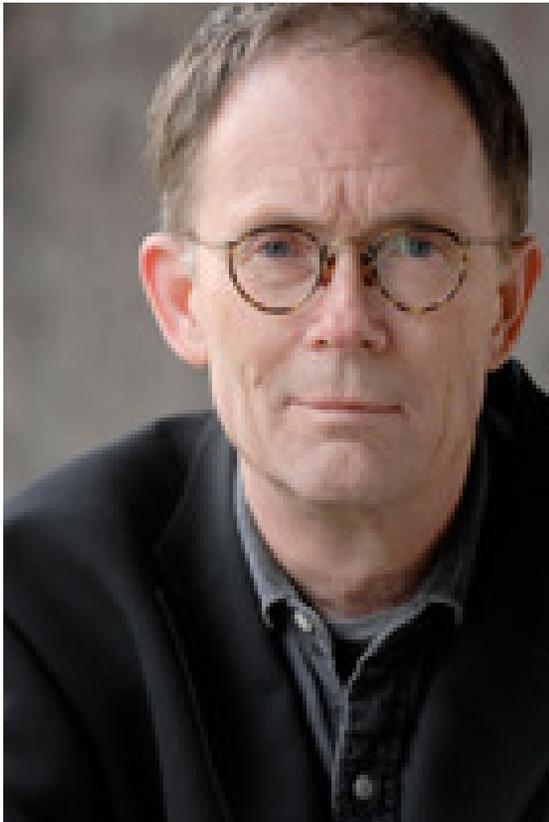


Fig. 3. Example of CensusPlus output from WoW
W. S. Bainbridge Science 317, 472-476 (2007)





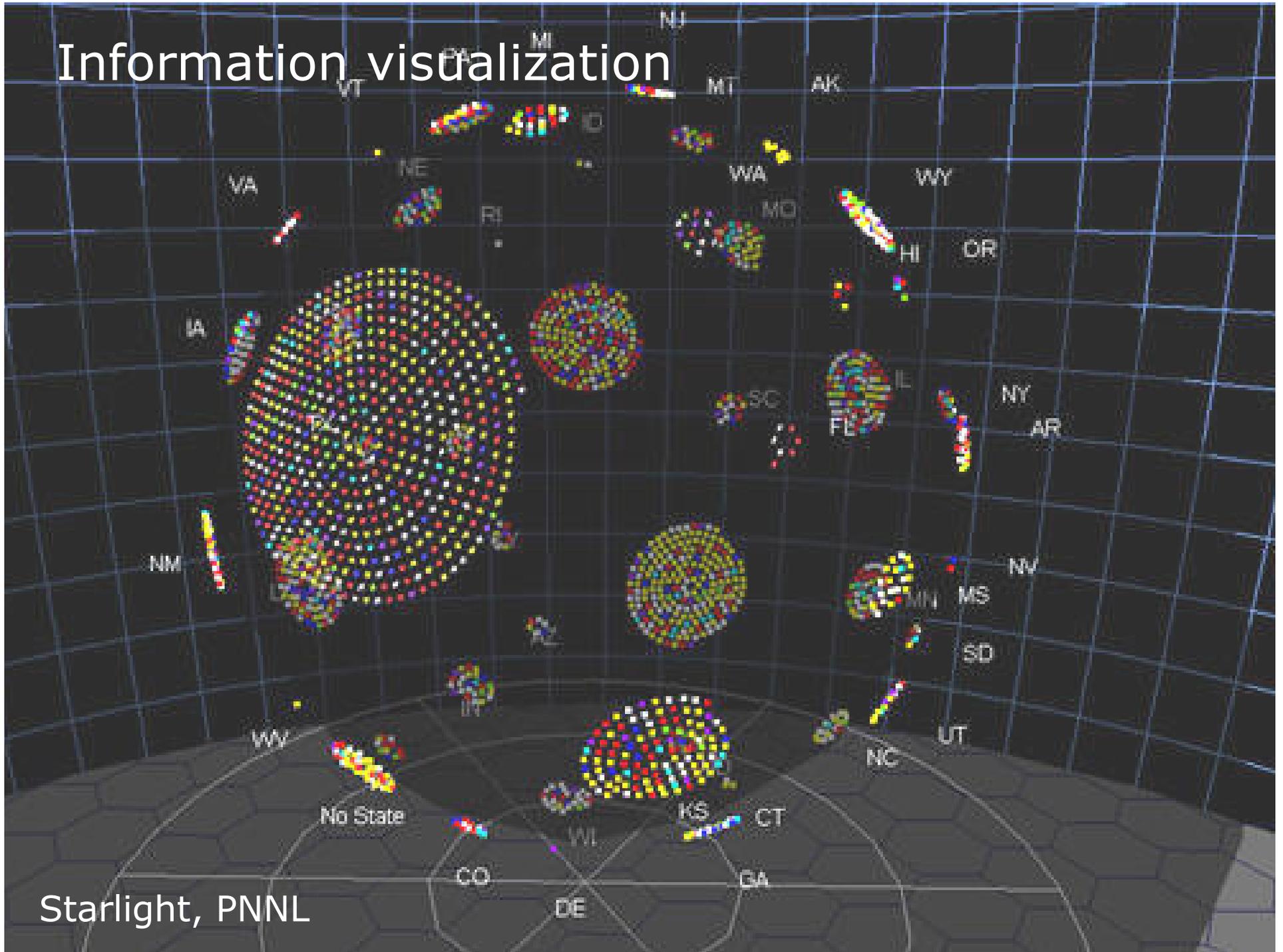
Virtual Environments as Consensual Hallucination



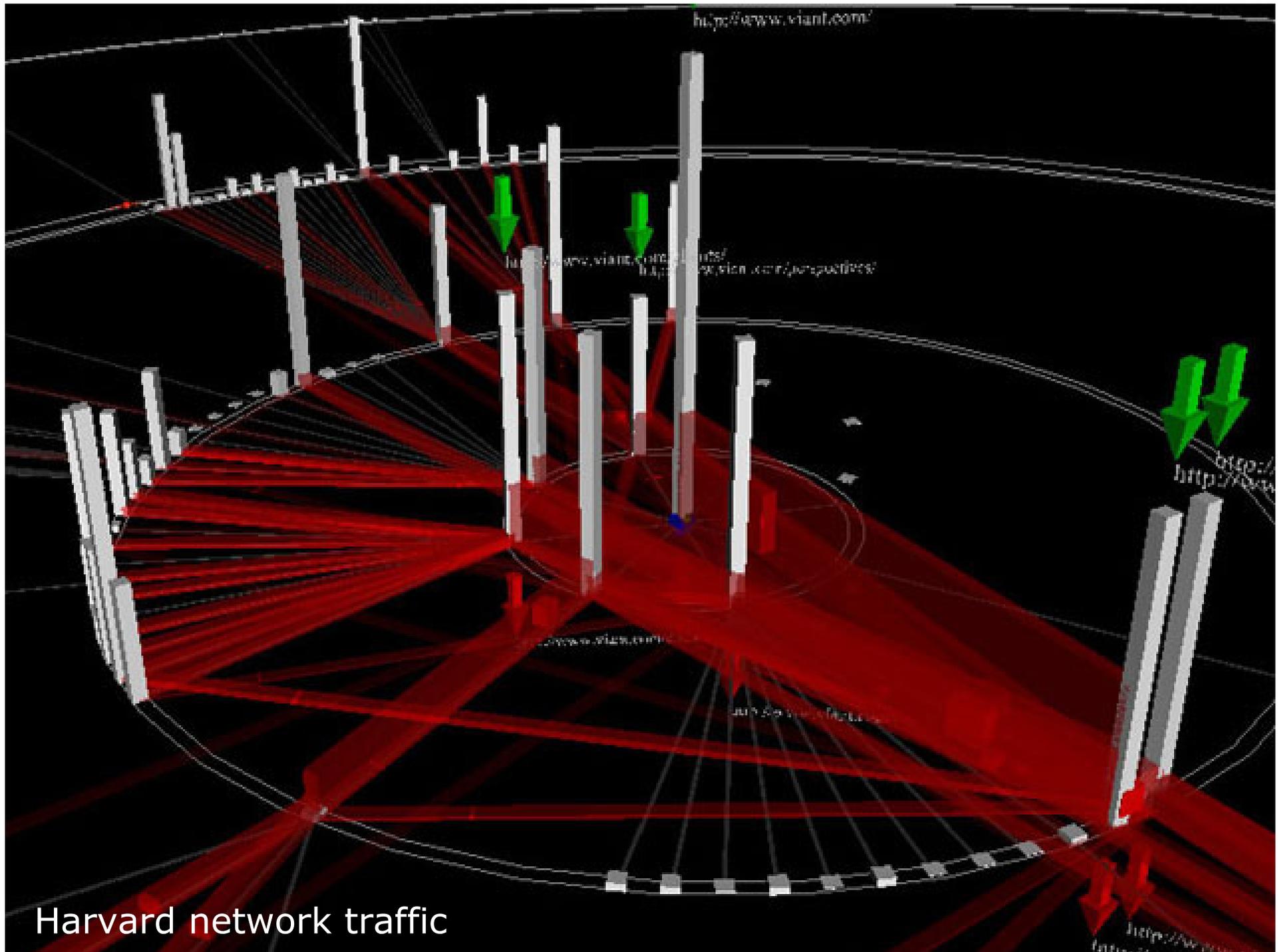
“Cyberspace ... A consensual hallucination experienced daily by billions of legitimate operators ... A graphic representation of data abstracted from banks of every computer in the human system. Unthinkable complexity. Lines of light ranged in the nonspace of the mind, clusters and constellations of data.”

— William Gibson, 1984

Information visualization

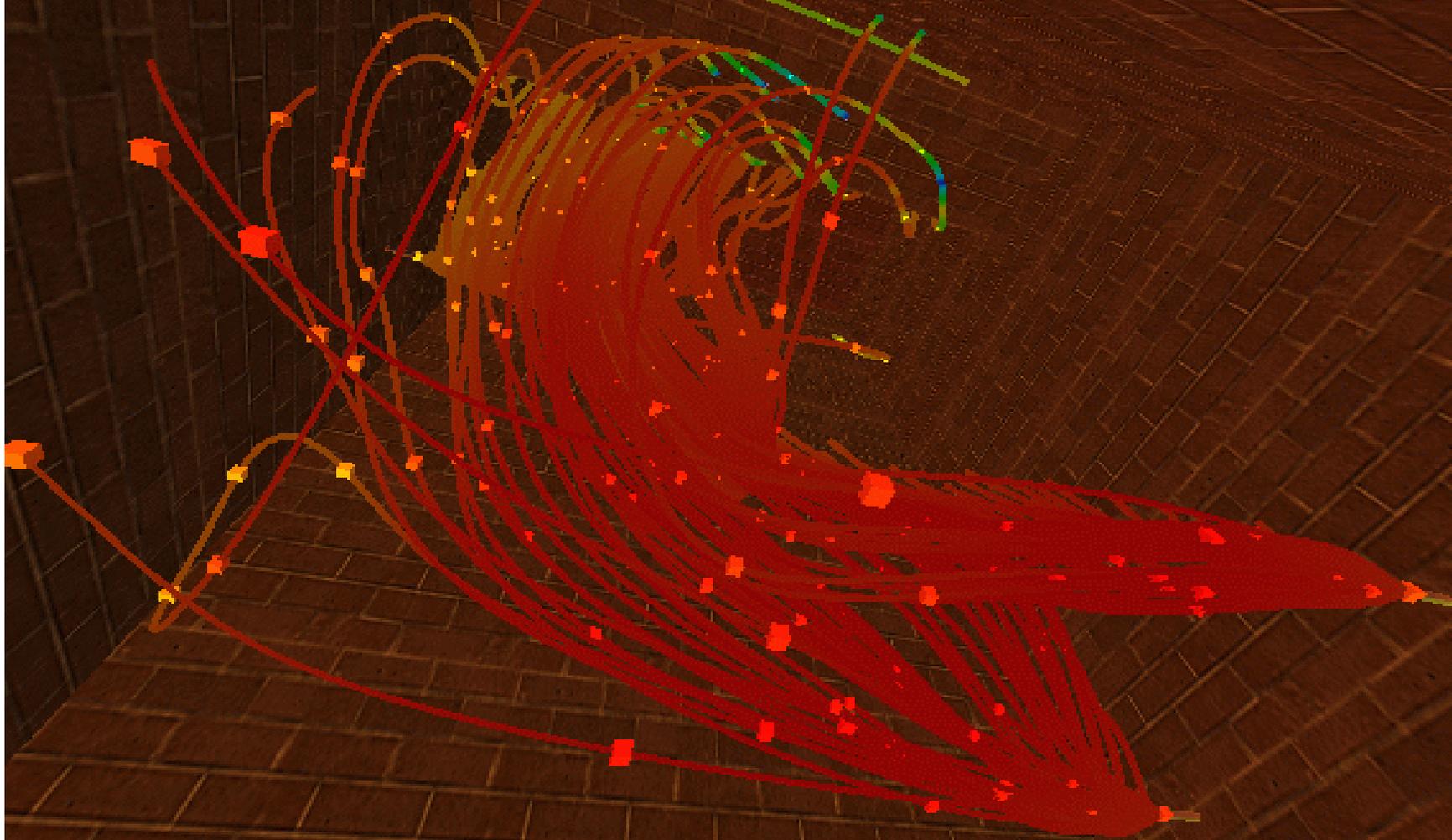


Starlight, PNNL



Harvard network traffic

Interactive Combustion Modeling in the Argonne CAVE



L. Freitag et al, 1997

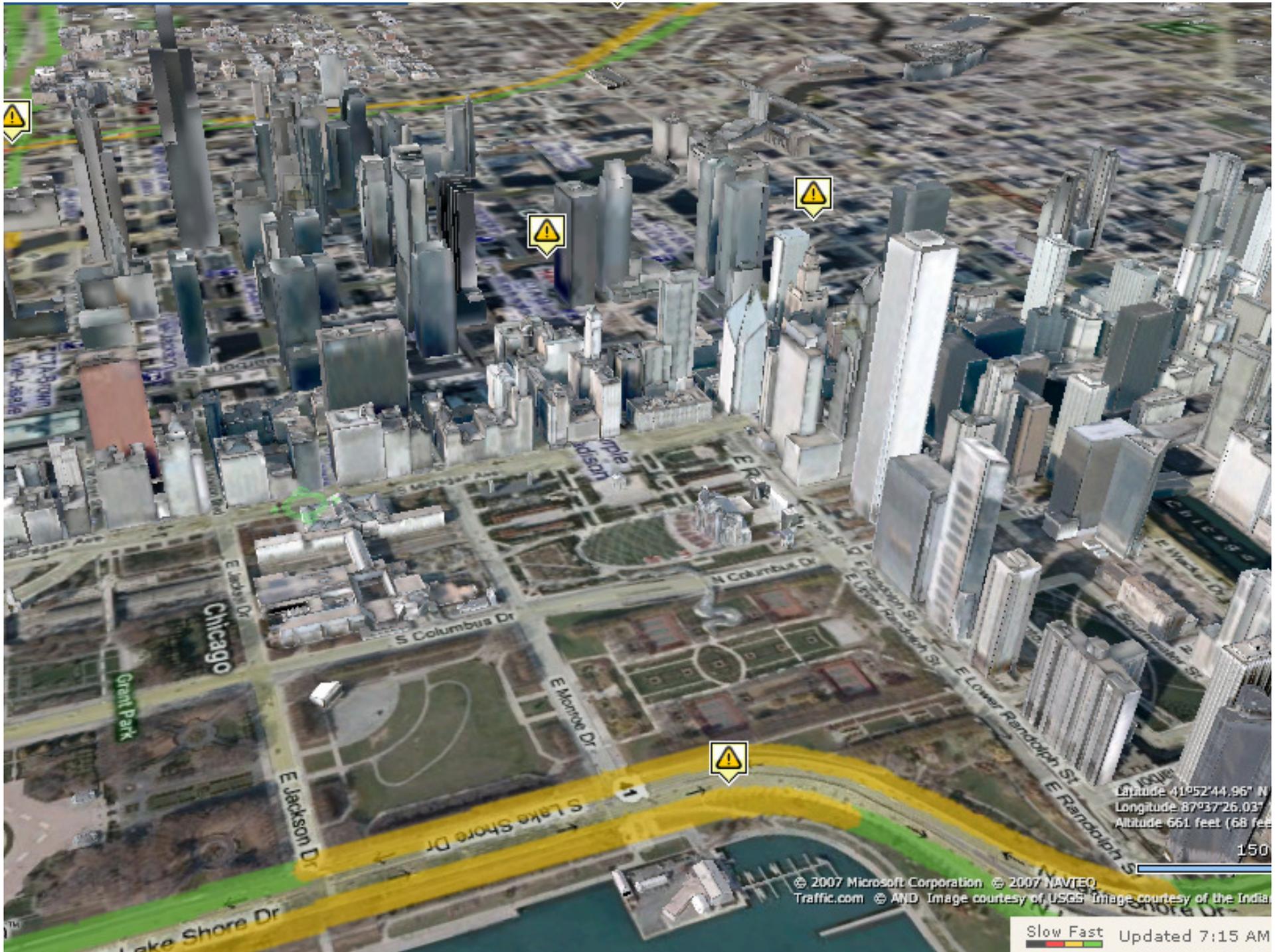


VEs as Mirror Worlds



“A Mirror World is some huge institution's moving, true-to-life mirror image trapped inside a computer—where you can see and grasp it whole”

— David Gelernter, 1992₁₉



Latitude 41°52'44.96" N
Longitude 87°37'26.03" W
Altitude 661 feet (68 feet)

© 2007 Microsoft Corporation © 2007 NAVTEQ
Traffic.com © AND Image courtesy of USGS Image courtesy of the India

Slow Fast Updated 7:15 AM



Mirroring Complex Systems: Hospitals?

Emergency Room

UNIT	PATIENT	DESTINATION
County Station 4	Smith, John M 72yo Possible AMI	ED Bay 1
City Unit 2	Clark, Karin F 64yo Fall/head trauma	ED Bay 2

StatCom
EMS NOTIFICATION

Patient Journey ED Cath Lab Med/Surg Discharge
Start ○ ○ ● ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ End

11:46
EMTs wheel Mr. Smith into Emergency Department. StatCom tells EMTs to put Mr. Smith in ED room 3.



Virtual Environments for Knowledge Communities?

The world is flat ... expertise is distributed,
diverse, enormous [in aggregate] ...

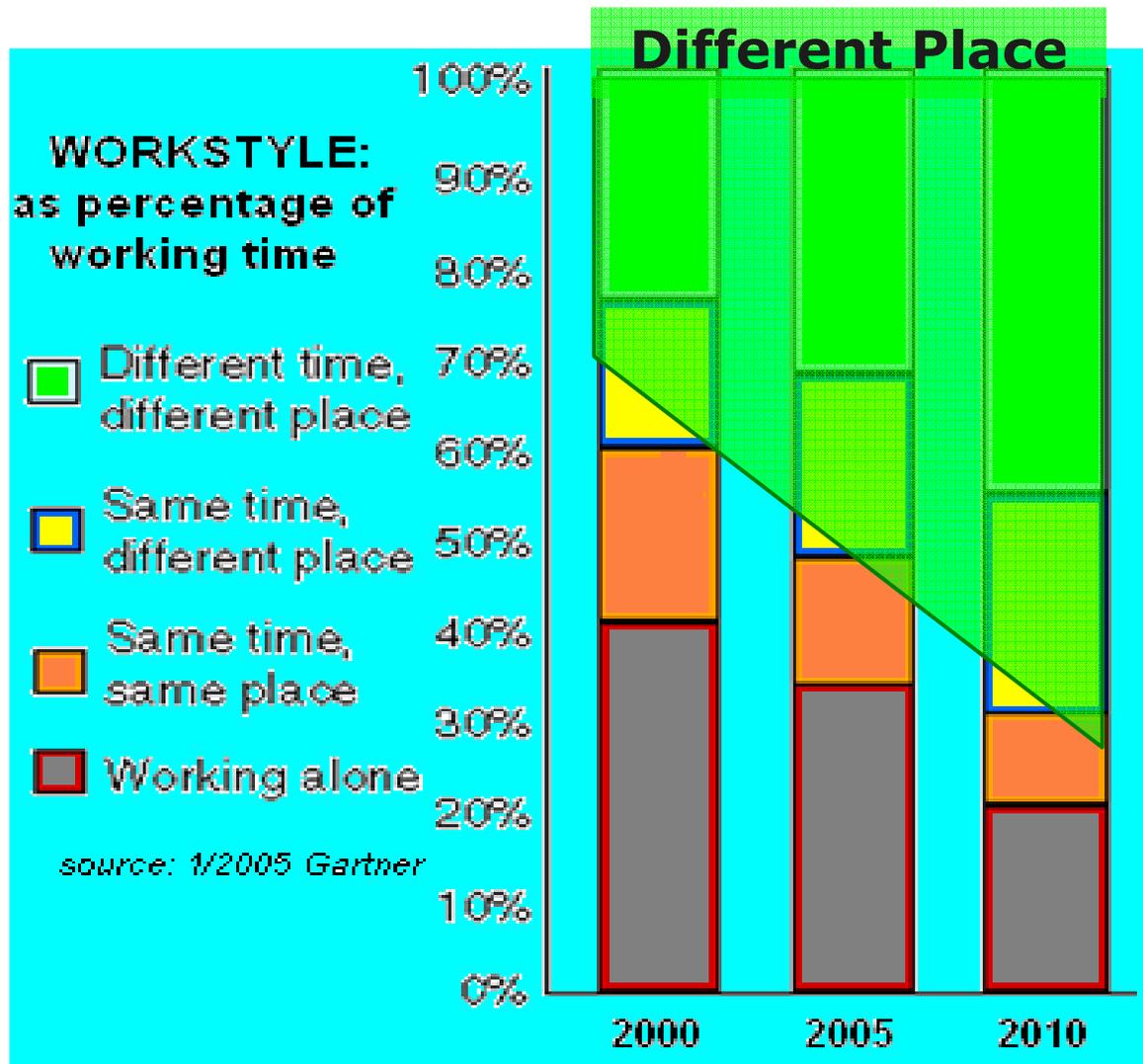
→ Work will increasingly be performed within
emergent and **virtual** organizations

How do we support the formation, operation,
evolution, and scaling of such organizations?

Can virtual environments help?



Collaboration and Workstyles



Intel employees in 2005:

- 64% on 3+ teams
- 70% on teams with different tracking methods
- 80% on multi-cultural teams
- 73% work across time zones

Data: Chuck House, Intel



Upper Atmosphere Research Collaboratory

Real-time instruments

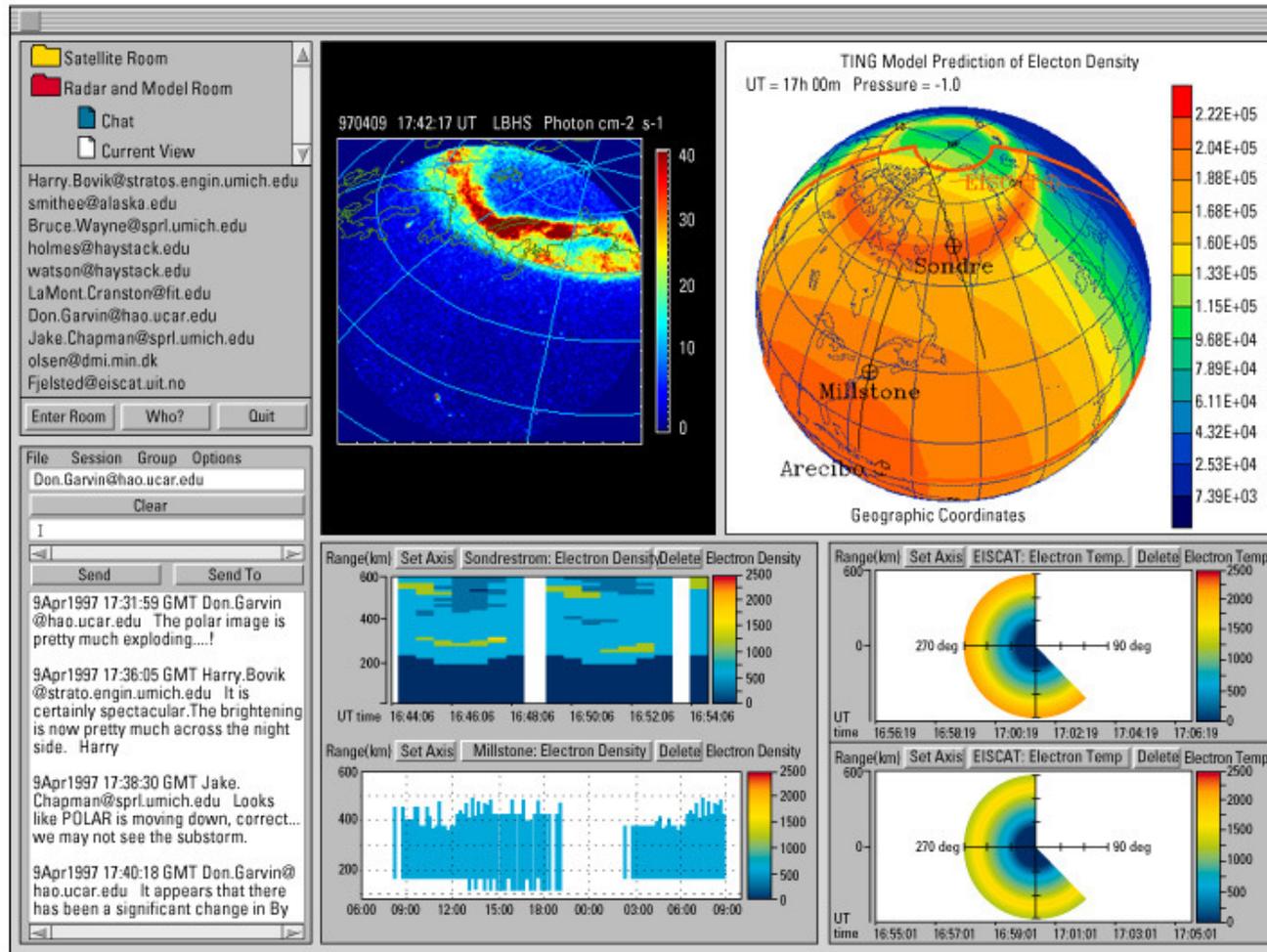
Computational models

Dynamic work rooms

Annotation

Team chat

Session replay



Archival data

Journals



Access Grid



AG Venue Client
_ □ ×

Venue Tools Navigation Help

https://vv3.mcs.anl.gov:8000/Venues/000000ff6f312bfe008c00dd00: Go

Argonne National Laboratory

My Venues

- [-] Argonne Lobby
 - [+] Big Horn
 - [+] Bridgeport
 - [+] Dantooine
 - [+] Full Sail
 - [+] Institution Lobby
 - [+] Jack Frost
 - [+] Kamar
 - [+] Lucky Labrador
 - [+] Talus
 - [+] Test Room
 - [+] Windmer

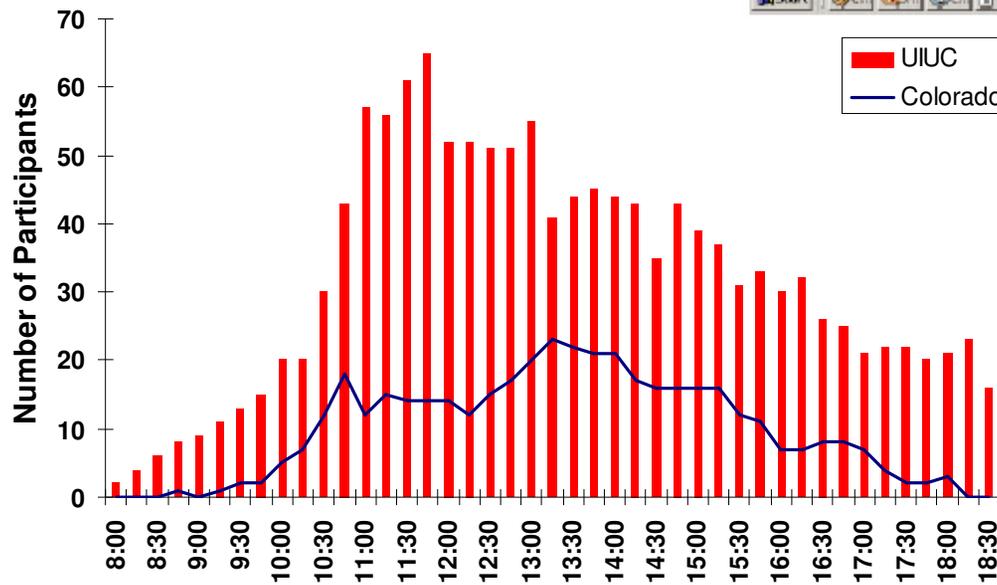
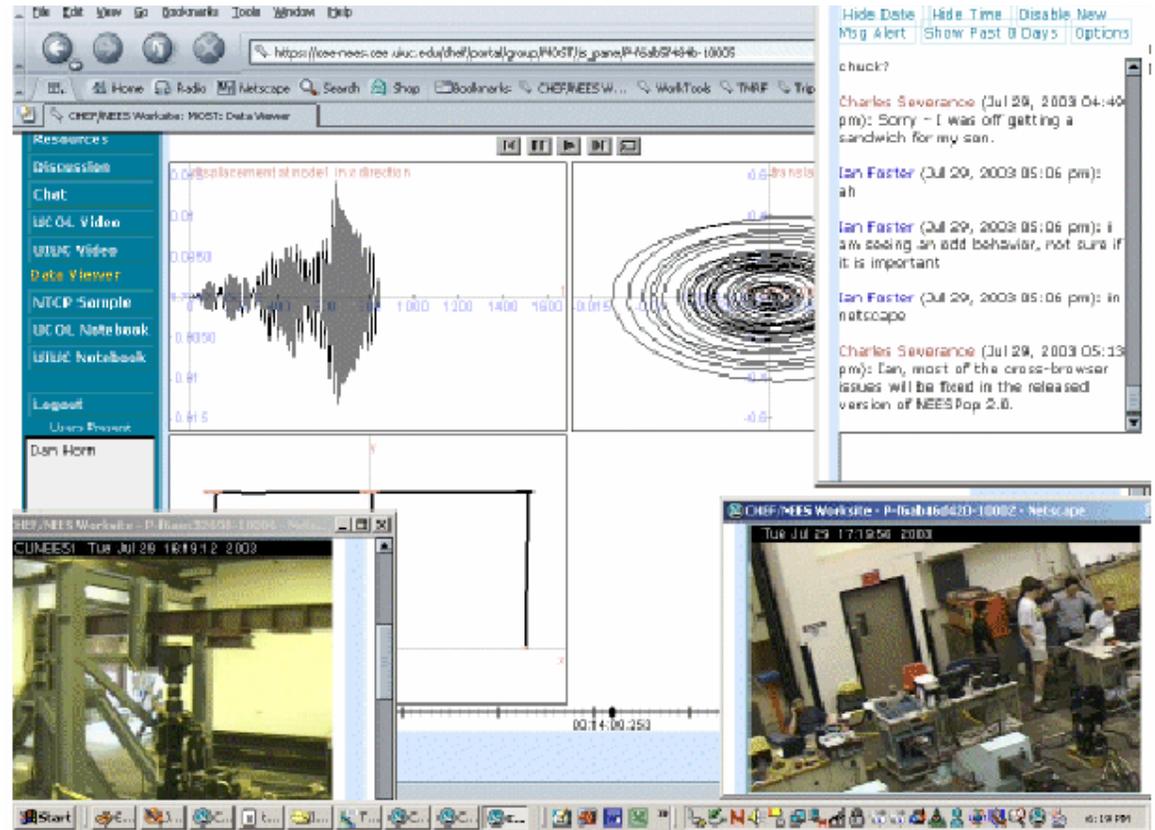
- [+] Participants
 - Eric Olson
 - Joe Insley
 - Mark Hereld
 - Michael E. Papka
 - Susanne Lefvert
 - Thomas D. Uram
 - Ti Leggett
- [+] Data
 - DataSnapshot01.jpg
 - DataSnapshot02.jpg
 - MeetingSlides.ppt
 - Proposal.pdf
- [+] Services
- [+] Application Sessions
 - Shared Movie Viewer - 12:01:04 PM Jun
 - Shared Presentation - 10:15:59 AM Jun

-- Entered venue Argonne National Laboratory (Mon, 18 Sep 2006, 12:21:38)
 Venue for Argonne National Laboratory, information at <http://www.anl.gov>.
Thomas D. Uram: Compare the snapshots in the venue with the latest snapshots here:
<http://www.mcs.anl.gov/fl/research/snapshots>
Mark Hereld: There's an interesting change in the third set of time values
Susanne Lefvert: That's likely due to a build-up of nickel as the front expands

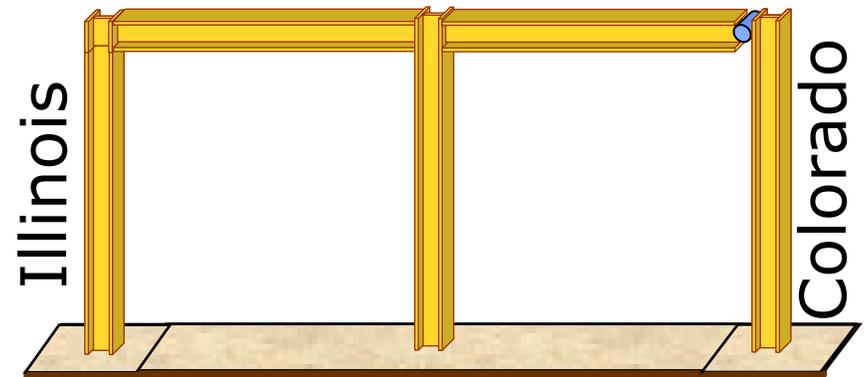
Display

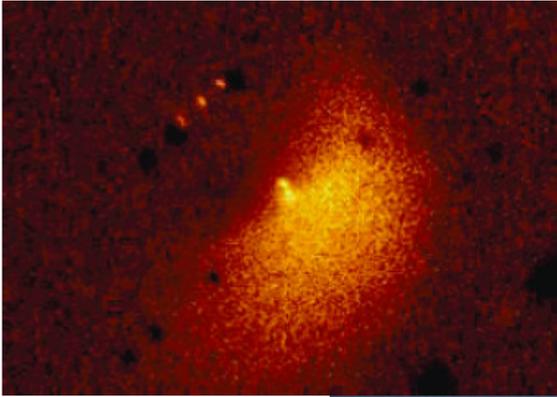


Remote participation in earthquake engineering experiments

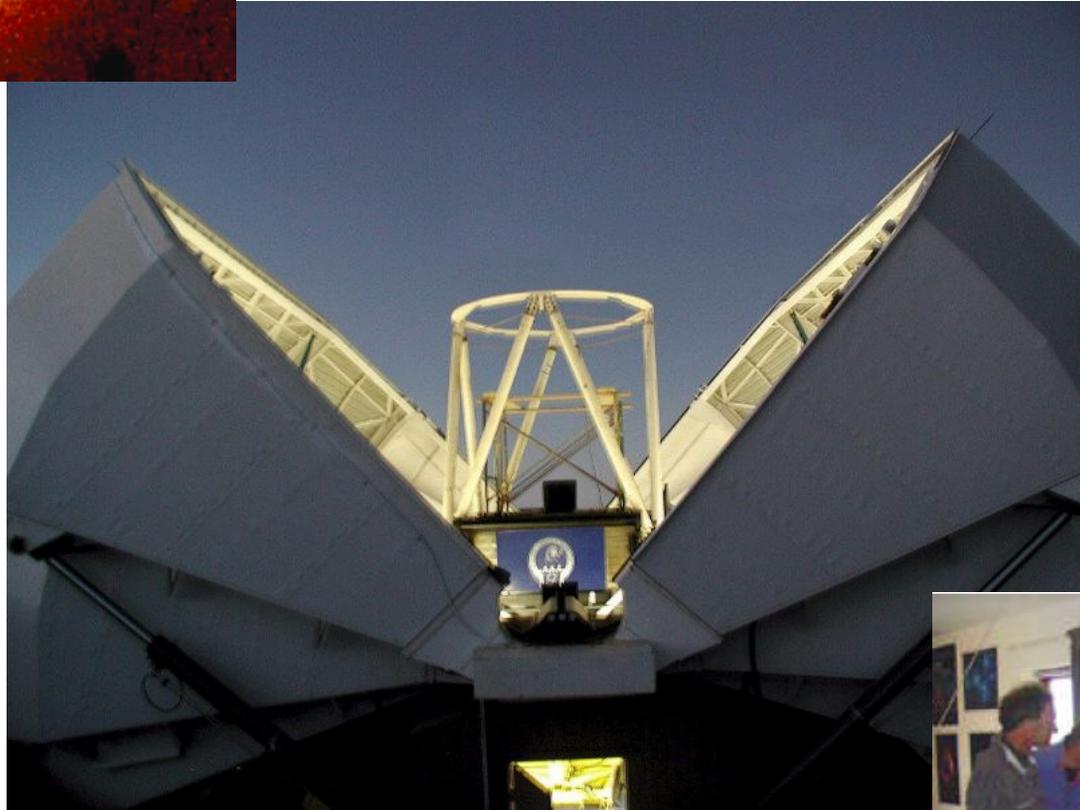


Illinois (simulation)





Comet
9P/Tempel 1



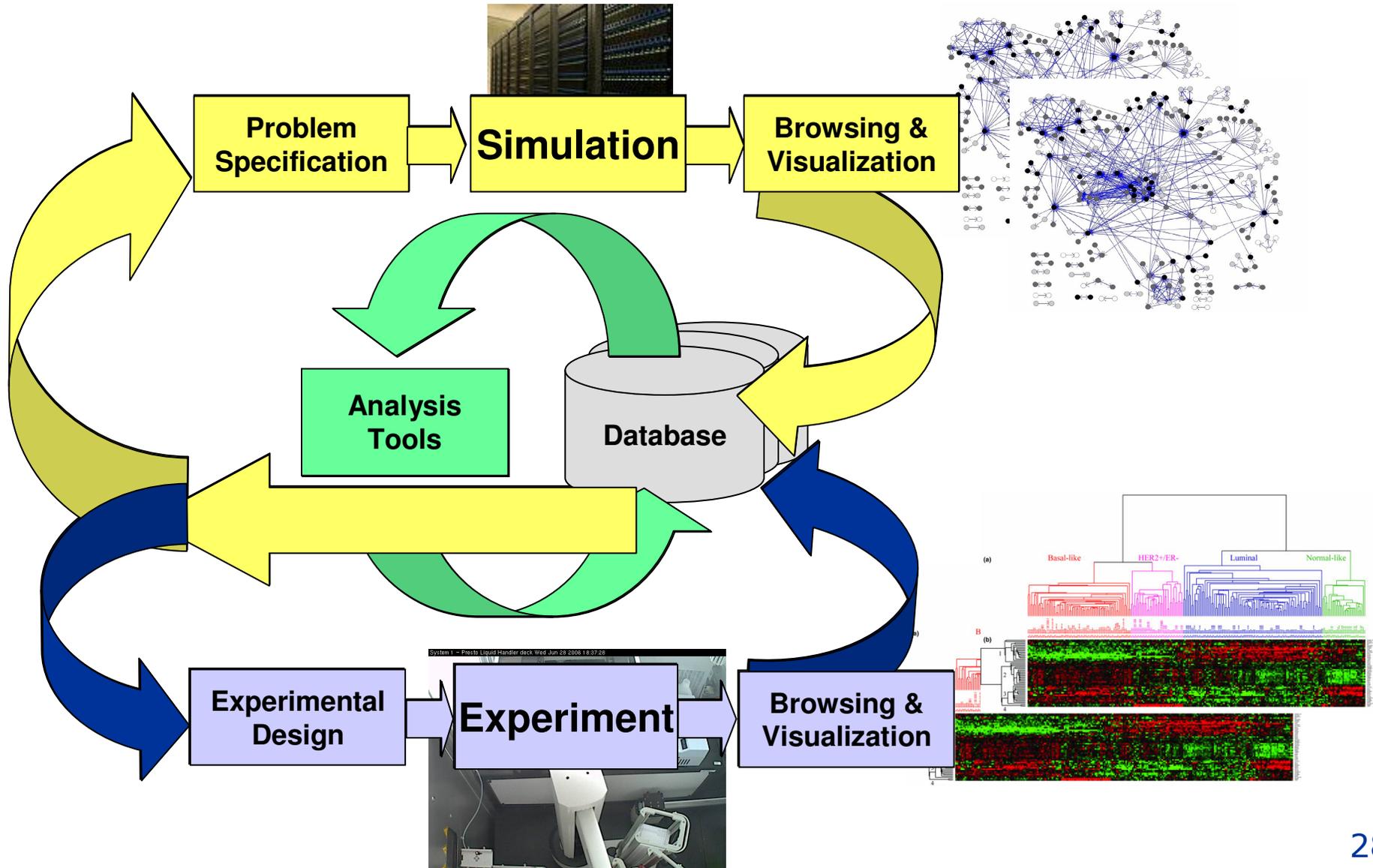
Faulkes Telescope North
(Hawaii)

Students
in Wales





Problem Solving can be a Complex Business ...







Can Virtual Worlds Help?

- A tentative **yes**
 - ◆ **Complex & sensitive** tasks demand all six human senses
 - ◆ Place is powerful
 - ◆ Commodity economics are powerful too!
- **But**
 - ◆ There is work to do before we can routinely use virtual worlds for this purpose

“Better than being there”?



Issues Include

- Integration with the physical world, e.g., sensors and instrumentation
- Integration with the rest of the cyberworld
- Integration with simulation
- Security and trust, in their many forms
- Abstractions, metaphors, interfaces
- Scale (data volumes, simulation fidelity)

1. What are the right interaction modalities?
2. What can we develop now?
3. How do we prepare for the future?

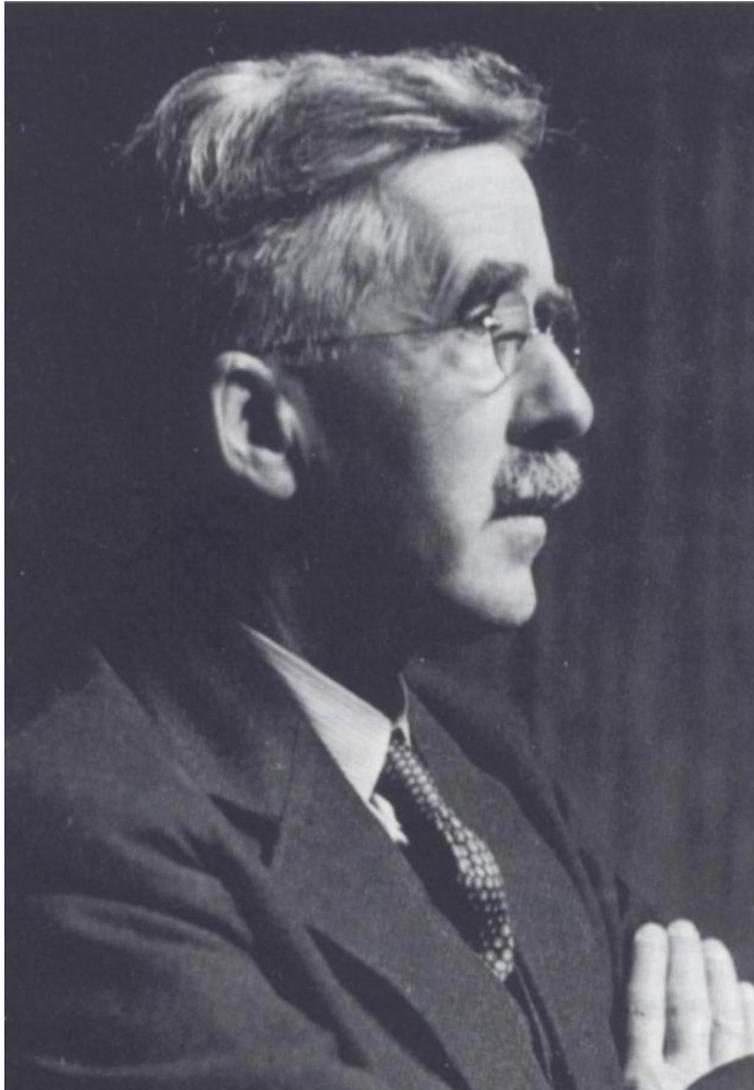


Concluding Thoughts

- We must not lose sight of the real issue: **enhancing human capabilities**
- People solve problems by **interacting**—not just with people, but also with data, computations, physical devices
- The grand challenge: support such interactions in “**better than being there**” environments



Earth to be Paradise; Distance to Lose Enchantment



“If, as it is said to be not unlikely in the near future, the principle of sight is applied to the telephone as well as that of sound, earth will be in truth a paradise, and distance will lose its enchantment by being abolished altogether.”

— Arthur Mee, 1898