



## Wanted System Thinkers

---

## For Exciting Science Opportunities

**Linda Grisham**   **Raquell Holmes**  
Lesley College   Boston University

## Science in the Information Age

---

- Humans are Computers (1800's)
  - Machines as number crunching devices (1940's)
    - programmable computers
  - Tools for complexity (1980's)
    - Parallel Computing, Thinking Machines
  - A Supercomputer on your desktop (1990's)
    - workstation, gigaflop PC, Nintendo!!!!
-

## Exponential Cascade: From Leading Edge to Consumer Electronics



**1985 Cray X-MP**  
**Cost: \$8,000,000**  
**60,000 watts of power**  
**No Built in Graphics**  
**56 kbps NSFnet Backbone**

“CPT”: Computer People’s Time

**1997 Nintendo 64**  
**Cost: \$149**  
**5 watts of power**  
**Interactive 3D Graphics**  
**64 kbps ISDN-to-Home**



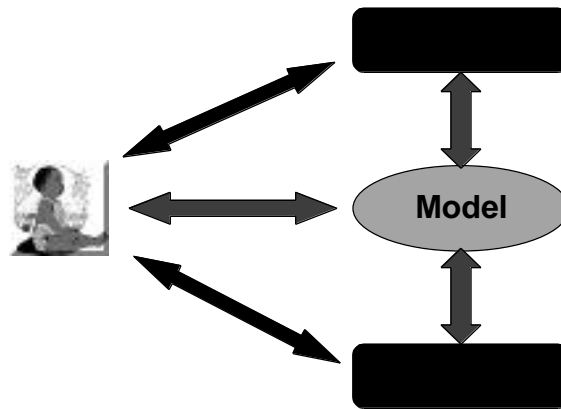
Source: Larry Smarr, NCSA

## From the Few to the Many

- Increased computer power and memory
- Opens door to non-programmers
  - scientists, K-12 teachers and students, visual and musical artists, architects, engineers, managers....
- What is everyone doing?
  - Modeling, Simulation and Visualization

## Modeling Process

---



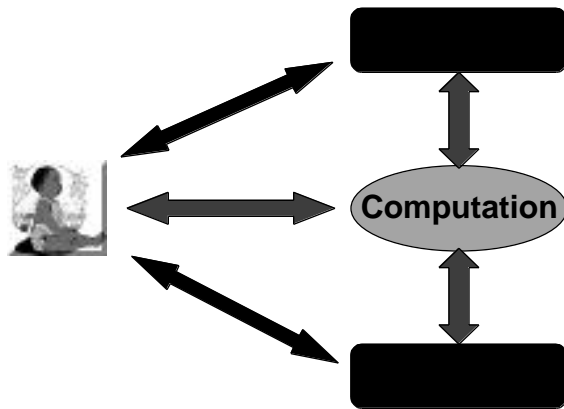
## Real world impact of modeling?

---

- Planes, Trains and Automobiles
  - Boeing 777
  - Portable cardiac defibrillators
  - Train scheduling
  - Anti-locking brakes (abs)
- Knowledge devices

## A New Way of Doing Science

---



## Science *Past* and Present

---

- Problem Solving Strategies
  - Historically
    - Investigative Tools
      - Observation and experimentation
    - Knowledge experts
    - Simple problems -tractable
    - Reductionism

## Science Past and *Present*

---

- Problem Solving Strategies
    - Currently
      - Computational Tools
        - Modeling
        - Simulation
        - Visualization
      - Knowledge (information) explosion
      - Complex problems -tractable
      - Systems thinking and dynamics
- 

## Systems Thinking is Fundamental to Science

---

- Confronting Complexity
    - Composed of many elements
    - Elements are interdependent
    - Structured relationship of elements need to be determined
    - Time dimensions are involved
-

## Goals of Scientists and Teachers

---

- Using modeling and systems thinking to
    - build understandings
    - generate insight
    - allow for further analysis
    - communicate ideas explicitly
- 

## The Process of Inquiry

---



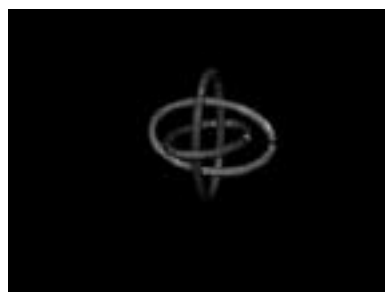
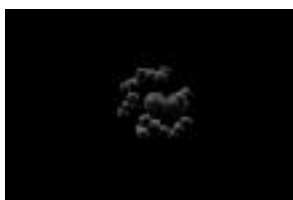
## What are Scientists doing?

---

- Modeling molecules and energies
    - chemistry and physics
  - Collaborating with large models
  - Using 3D immersive environments
- 

## VizGal

---



---

<http://scv.bu.edu/SCV/vizgal>

## Life on the Grid

---



- An example of collaboration across the grid.
- 

## BU's Art World

---

ArtWorld, is a collaborative, networked, multi-user, virtual reality environment filled with animated models, artwork and audio created by New England artists collaborating with SCV at Boston University. It supports localized telephony and audio for each entity, participant avatars and user-defined "robots".



## *TelePresence Microscopy*

*Middle/High School Collaboratories*



**Netscape Client on Mac's & PC's in Classroom provides simple and inexpensive interface where students and remote instructors can interact with Microscopes.**



**Live Video Conferencing using "CuSeeMe" provides low cost interactions between Instructor and Students**

## *Collaboration and Access to Scientific Resources*



## Scientists and Teachers: Natural Allies

---

- Teachers who promote systems thinking
    - Develop people
      - With multi-faceted set of problem solving skills
      - Who consider “the big picture”
      - who visualize problems
    - Face Challenges
      - Validation & Acceptance
      - Policy makers and Administration
      - Teaching to tests
- 

## Scientists and Teachers: Natural Allies

---

- Scientists
    - Want to increase knowledge in their domain
    - Need talented graduate students
  - How scientists can support teachers
    - Scientists as
      - advocates for teachers.
      - definers of standards
      - mentors for teachers and students
      - collaborators in curriculum development/validation
-

## Moving to the next level

---

- Working Together

- Activities:

- Teacher training, Workshops, Pre-service programs, Curriculum development, Community networks

- Examples of Funding Opportunities

- G-k12, NSF
      - Informal Science Education, NSF
      - Education Human Resources
      - National and State Departments of Education
- 

## Moving to the next level

---

- Working together continued

- K12 interfaces to research tools

- Chickscope (<http://chickscope.beckman.uiuc.edu>)
      - BiologyWorkbench (<http://glycine.ncsa.uiuc.edu/educwb>)
      - ChemViz (<http://www.ncsa.uiuc.edu/chemviz>)
      - Riverweb Consortium- (<http://riverweb.ncsa.uiuc.edu>)
-

## Education, Outreach and Training

---

### EOT-PACI [www.eot.org](http://www.eot.org)

- GirlTECH  
(<http://www.crpc.rice.edu/CRPC/Women/GirlTECH/>)
- Maryland Virtual High School  
([www.mvhs1.mbhs.edu](http://www.mvhs1.mbhs.edu))
- ASPIRE ([www.aspire.org](http://www.aspire.org))
- Ohio Supercomputer Center  
([www.osc.edu/edweb](http://www.osc.edu/edweb))
- Shodor Education Foundation ([www.shodor.org](http://www.shodor.org))