Education Strategies

Advancing Education in Computational Science and Engineering

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Assertions about Modeling and Simulation

- **All fields of science and engineering have benefitted or will benefit from computational modeling and simulation**
  - All scientists and engineers must understand computational simulation
- **Fidelity of computational models will continue to improve as computing power increases**
  - Power of computational simulation will continue to grow
- **It's the software!**
  - Computational codes encapsulate current state of knowledge
    - Computational models will continue to be refined
  - Developing computational codes to describe natural or engineered systems requires knowledge of:
    - Scientific foundations
    - Applied mathematics
    - Computer science, including modern software engineering practices
  - As computing technology changes, software challenge increases

Assessment of Current Situation in Education

Based on personal observations

- **Undergraduate Education**
  - Use of simulation in undergraduate courses:
    - Used, but largely limited to simulations that run on laptop
  - Courses in Computational "X" are not widespread
    - Largely driven by faculty interest, not national requirements
    - May not address many basic computational issues – largely focused on teaching how to use existing applications
  - Existing mathematics and computer science courses are not well suited for computational science and engineering
- **Graduate Education**
  - Graduate computational science and engineering programs are growing, but "best practices" have not been established
  - Existing mathematics and computer science courses are not well suited for computational science and engineering

Statement from American Chemical Society

Undergraduate Professional Education in Chemistry

ACS Guidelines and Evaluation Procedures for Bachelor's Degree Programs

Computational Capabilities and Software. The ability to compute chemical properties and phenomena complements experimental work by providing understanding and predictive power. Students should use computing facilities and computational chemistry software in their course work and research.

Spring 2008

ACS Committee on Professional Training

But, there is a huge gap between this statement and the state of practice in universities, even major research universities.

Virtual School of Computational Science and Engineering

- **Goals of Virtual School**
  - Increase and enhance computing-related curricula available to graduate students, especially at the petascale
  - Prepare the current and next generation of scientists and engineers to utilize leading-edge computer systems
- **Organization of Virtual School**
  - Multi-state, multi-institutional virtual organization
  - Pools expertise of faculty/staff in many universities and national laboratories
- **Funding**
  - Start-up funding by Illinois as part of Blue Waters Project

Virtual School's Summer Schools

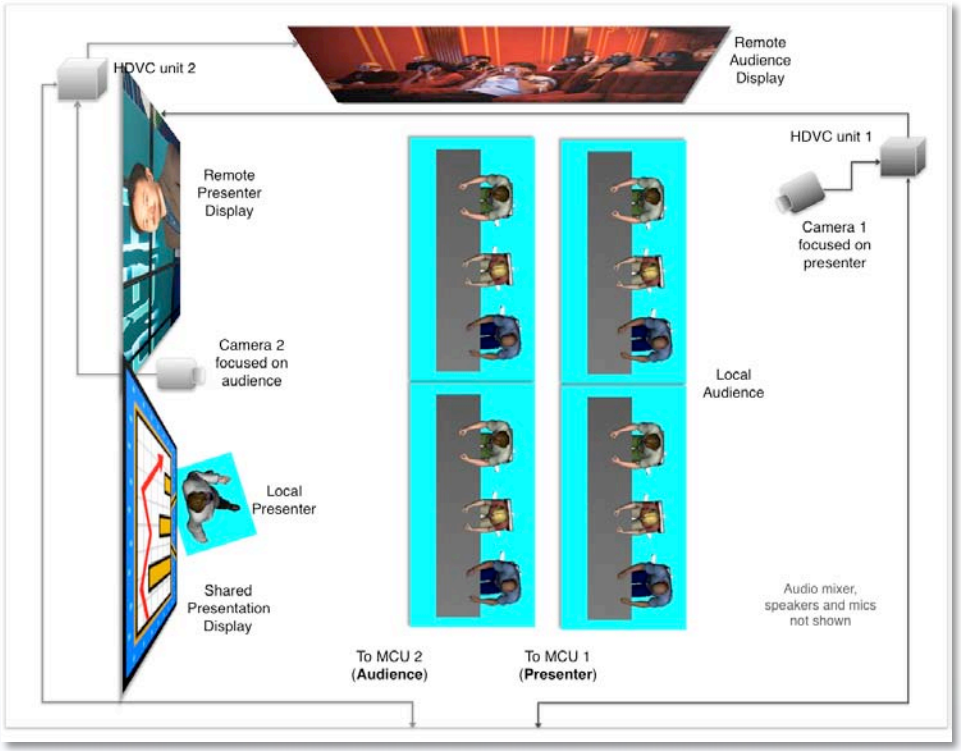
- **Summer 2008**
  - One one-week course: *Many-core Processors*
    - One site, 42 graduate students
- **Summer 2009**
  - Two one-week courses: *Many-core Processors*, *Scaling to Petascale*
    - Four sites, 230 students
- **Summer 2010**
  - Three one-week courses: *Many-core Processors*, *Scaling to Petascale*, *Big Data in Science* plus 3 on-line courses
    - Twenty-one sites (ten for each course), over 1000 students
- **Assessments**
  - External evaluations were conducted each year to assess impact and to help guide improvements for scaling-up the next year

2010 Participating Institutions

	Host Institution	Scaling to Petascale	Big Data for Science	Many-Core Processors	MSI or EPSCoR
1	Louisiana State University	Yes		Yes	X
2	Clemson University	Yes			X
3	University of Illinois at Chicago		Yes		
4	Georgia Institute of Technology			Yes	
5	Indiana University		Yes		
6	Michigan State University		Yes		
7	NCAR	Yes			
8	NCSA	Yes		Yes	
9	NICS/ORNL	Yes			X
10	Northwestern University	Yes		Yes	
11	Ohio State University			Yes	
12	Pennsylvania State University	Yes	Yes		
13	RENCI/UNC	Yes		Yes	
14	University of Arkansas		Yes		X
15	UCLA	Yes	Yes	Yes	
16	University of Iowa		Yes	Yes	
17	University of Michigan			Yes	
18	University of Minnesota	Yes	Yes		
19	University of Notre Dame		Yes		
20	University of Tennessee			Yes	X
21	University of Texas at El Paso		Yes		X

Virtual School Infrastructure

- **Two-way High Definition Video**
  - Near in-classroom experience for remote students
  - Empowers students to interact with presenters and other students in real-time
- **Distributed Education Teams**
  - Teams include faculty and teaching assistants at participating institutions to optimize student experience



Virtual School Classrooms
(designed by Electronic Visualization Laboratory)

Future Opportunities for Virtual School

- **Student Demand**
  - Huge demand for participation in Virtual School's Summer Schools
    - By students (and teachers!)
    - By institutions, including minority-serving institutions
- **Additional Summer Schools**
  - Large number of high priority courses have been identified by computational science and engineering community
- **Scalable Model**
  - Scalable model for reaching thousands students across U.S. (and world)
- **Resources**
  - Dependent upon resources to coordinate activities, support content development, and expand delivery

For more information, contact

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