Preparing the Future Workforce for Careers in Science and Engineering

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XSEDE
Extreme Science and Engineering Discovery Environment
Agenda for the Morning

• 9:00 – 10:00 AM
  – Opportunities and Challenges for Curriculum Change
  – Review of Competencies
• 10:00 – 10:30 Break
• 10:30 – 11:30 Industry Panel
• 11:30 – Noon
  – Worksheet to create a program
  – Program examples
Opportunities and Challenges

• Workforce needs in computational science
  – How science and engineering (and social science and humanities) research is done
  – Prepare students for work in private sector, in research, and for graduate school

• Changing how we teach

• Barriers to program implementation
Preparing Students

• Need for a workforce which understands both modeling and simulation principles and applications of models and data analysis at large scale
  – Requirements for high fidelity models of complex systems
  – Managing and understand large datasets – data science
  – Applications across a wide range of science, social science, and increasingly humanities
Crucial Tools for Manufacturing

- At Ford, HPC ...allows us to build an environment that continuously improves the product development process, speeds up time-to-market and lowers costs.
- The ongoing use of modeling and simulation resulted in new packaging and product design that propelled the brand to a leading market position over a several-year period.
Myriad of Examples

- Behavior of new and existing materials at multiple scales
- Climate change and its potential social and economic impacts
- Concentration of environmental contaminants and their impacts on ecosystems and human health
- Genetic markers and disease
- Analysis of huge datasets
  - Market and customer behavior
  - Genomic data
  - Social media
Changing How We Teach

• Getting students actively involved in learning
  – Reducing traditional lectures
  – Increasing inquiry-based learning

• Ideally suited to instruction in computational science
  – Students need technical and analytical skills to create and test models and analyze data
  – Students enhance “soft” skills in teamwork and written and oral communication
Benefits to Students

• Inquiry-based learning is more effective than traditional lecture oriented instruction
  – Students are actively engaged in the learning process
  – Students gain deeper insights and have higher retention rates for the information
  – Facilitates the integration of information across academic disciplines – math, science, engineering, computer science
Challenges to Changing the Curriculum

• We tend to teach in the way we were taught
• Computational science is interdisciplinary
  – Faculty workloads fixed on disciplinary responsibilities
  – Coordination across departments is superficial
  – Expertise at universities is spotty
• Major time commitments are required to negotiate new programs and develop materials
• Curriculum requirements for related fields leave little room for new electives
• Change is hard
Barriers to Program Implementation

• Limited resources and strained workloads
• All of our colleagues don’t see the light
• Access to example materials and datasets
• Access to appropriate infrastructure and technology
• Limits to faculty expertise
Overcoming the Barriers

- Availability of external resources and materials
- Making incremental changes
- Involving potential employers
- Marketing to administrators, faculty, and students
- Inter-institutional collaboration
Sources of Information

• Course syllabi from existing courses
  – Some available through XSEDE
  – Sharing of syllabi with collaborating institutions

• Digital resources on variety of fields
  – NSF digital libraries
  – Collaboratories
  – Consortia
  – Examples: See
    https://www.osc.edu/~sgordon/workshop/materials
Collaborative Online Materials

• Collaborative courses at XSEDE and Blue Waters
  – Online lectures by central instructor
  – Computer exercises, quizzes
  – Local instructor to advise and grade

• XSEDE Examples
  – Engineering parallel software
  – Applications of Parallel Computers

• Blue Waters Examples
  – High Performance Visualization for Large-Scale Scientific Data Analytics
  – Designing and Building Applications for Extreme-Scale Systems
Other Resources

• Technical training materials on XSEDE and other sites
• HPCUniversity Resources
• Journals
  – Journal of Computational Science Education
  – Computers in Education
  – Other domain educational journals
Other Materials and Certificates

- XSEDE training materials
  - Online and webcast workshops
  - Future addition of certificates
- Software carpentry
- HPC University
- Links to a variety of sources
Opportunities for Students

• Blue Waters Graduate Fellowship
• XSEDE Scholars
• XSEDE Summer Internships
• Internships with national labs
• See
  http://hpcuniversity.org/students/opportunities/
Starting a Program

• What do students need to know?
  – Competencies for undergraduate and graduate programs developed as part of several NSF grants and the XSEDE project
  – Review of competencies
Questions and Discussion