Preparing the Workforce for the Future of Science and Engineering

Steven I. Gordon
sgordon@osc.edu

XSEDE
Extreme Science and Engineering Discovery Environment

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

Making Progress in Science

- A number of studies document the need for computational scientists
  - …" computer modeling and simulation are the key elements for achieving progress in engineering and science." NSF Blue Ribbon Panel on Simulation-Based Engineering Science
  - "Unfortunately, the translation of systems biology into a broader approach is complicated by the innumeracy of many biologists" Cassman et al. Barriers to Progress in Systems Biology, Nature Vol. 438|22/29 December 2005
  - Nearly 100% of the respondents indicated that HPC tools are indispensable, stating that they would not exist as a viable business without them or that they simply could not compete effectively. IDC Study for Council on Competitiveness of Chief Technology Officers of 33 Major Industrial Firms

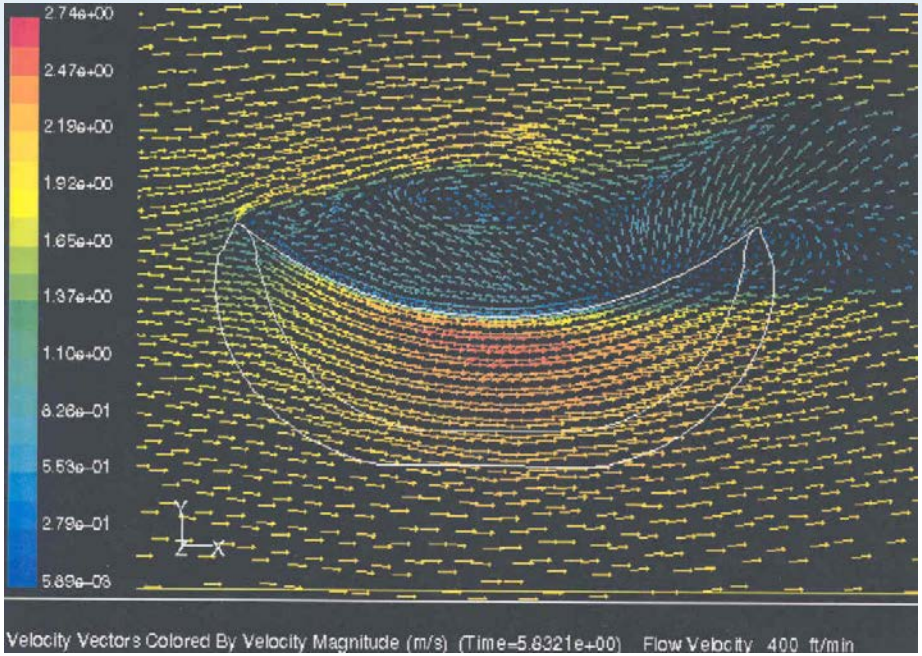
Crucial Tools for Manufacturing

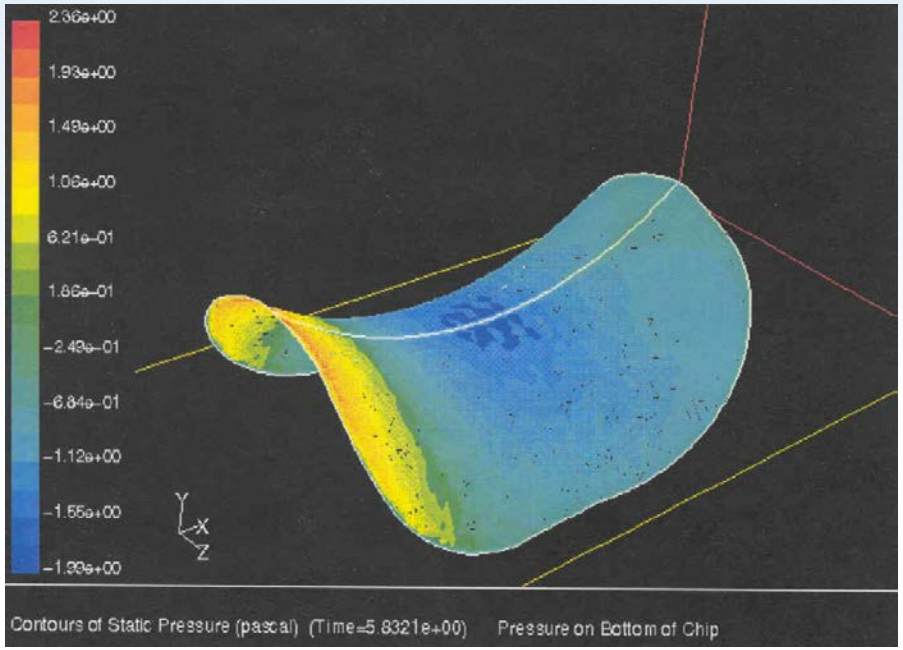
- At Ford, HPC …allows us to build an environment that continuously improves the product development process, speeds up time-to-market and lowers costs.
- The ongoing use of modeling and simulation resulted in new packaging and product design that propelled the brand to a leading market position over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

Ford EcoBoost Technology

Durable coffee package for P&G

Will Pringles Fly?

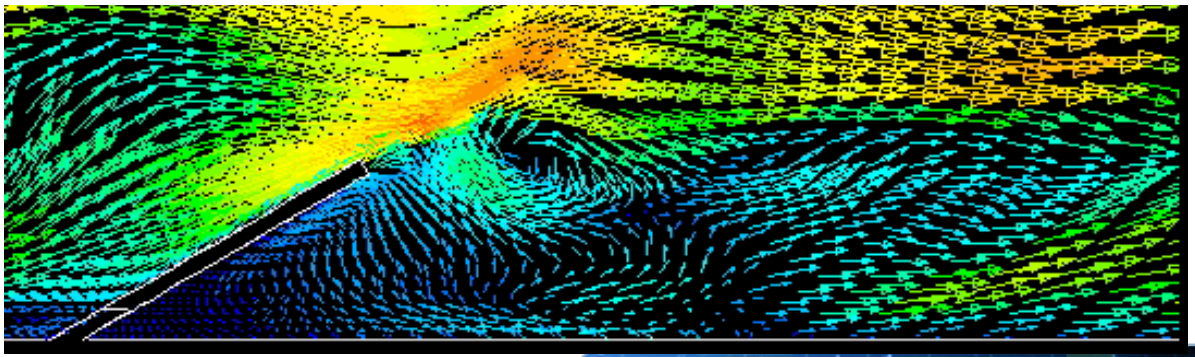




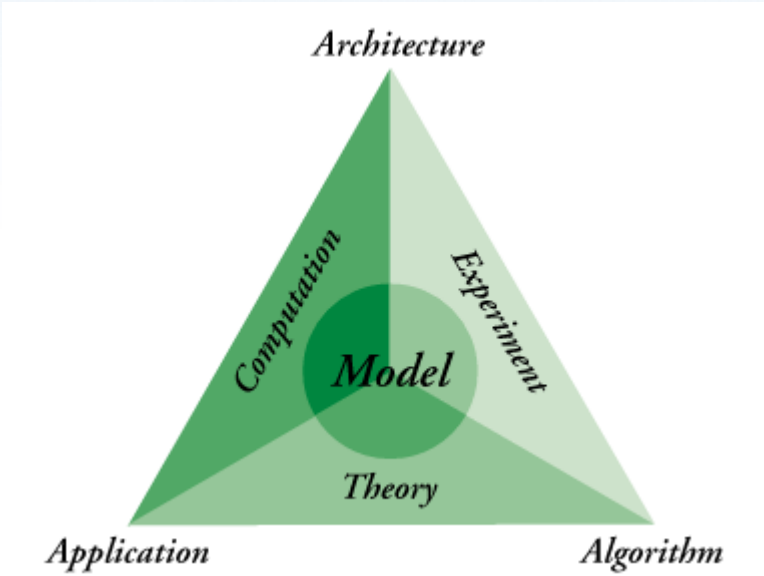
High Speed Conveying Create Vortices Shedding…

…'Rocking Chips'

NOT GOOD!



Computation is Central to How Science is Done



- Computation lets us explore phenomena that are too big or complex to experiment, too small, or changes too fast or too slowly.
- Computation allows us to explore more options more quickly.

Expertise Required

- Need skills in several areas to effectively use computation at these scales
  - Modeling and simulation
    - How to create a model and know whether it is “right”
  - Mathematics
    - Representing system behavior with the appropriate mathematical representation
  - Computer science
    - Technical skills in programming and data management
  - Domain knowledge
    - Expertise in the subject area being studied

Data Science Competencies

- Developed by multi-disciplinary group of researchers and practitioners
- Provided as guidance in the development of new programs
- Basic competencies
- Advanced competencies

Example Minor Program

Data Analytics Minor - University of Mary Washington		
Total credits: 23		
Required Courses	MATH 220	Introduction to Statistics
	MATH 200	Linear algebra
	CPSC220 Computer Science 1	Programming and Algorithms
	CPSC419	Data mining
	CPSC420	Modeling and Simulation
One of these electives	CPSC230 Computer Science II	Data structures
	BUAD 400	Analytics Application Development
One of these electives	BUAD 403	Foundations and Applications of Data Analytics
	CPSC 425	Parallel Processing

New Chapter of the ACM

- SIGHPC Education Chapter
  - http://sighpceducation.acm.org/
  - Inexpensive to join - $10 professional, $5 students
  - Webinars on education opportunities and programs
  - Reviewing training and education materials to create a list of high quality materials

Summary

- Market for computational science skills is expected to grow rapidly
- Opportunity for careers across a wide range of science and engineering applications