Swanson Engineering Simulation Program

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Swanson Program: Goals

- Original:
  - To facilitate the introduction and routine use of computer simulation in the undergraduate and graduate MAE curriculum at Cornell
- Added with input from Advisory Committee:
  - To provide support and leadership to the community on the integration of simulation into engineering curricula

Swanson Program Activities

1. Support for use of computation in the curriculum
   - Six MAE courses at Cornell
   - Various projects
2. Administrative support
   - *Swanson Lab*
   - Engineering software use: Licensing, installation and technical support

Software and Labs

- Ten engineering packages:
  - ANSYS+FLUENT, COMSOL, MATLAB, Pro/E, SolidWorks, etc
- Enabled broad availability of software across College

Computer Lab	Overseen by
Swanson Lab	Swanson Program
Design Studio	M&AE
471 Rhodes Classroom	M&AE, ORIE
ACCEL Lab	College
CIT Upson Lab	University
CIT Phillips Lab	University

Swanson Lab

- 16 high-end workstations
  - Extensive software suite
  - Specifications chosen in consultation with major software vendors
  - Augments other teaching labs
- SGI f1200 Linux server
  - 24 cores total
  - 96GB RAM (Shared memory architecture)

Three Levels of Simulation

1. Simulation use in courses: Students solve pre-defined problems
   - Industry analog: Engineers doing design modifications
2. Simulation use in projects and research: Students solve new problems
   - Industry analog: Analysis specialists
3. Software development
   - Basic applications in courses
   - Advanced applications in graduate research

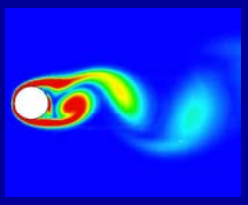
Simulation Use in Courses

Swanson program has helped incorporate simulation into six M&AE courses

	Course	Type	Enroll-ment	Software
1.	M&AE 2120 Mechanical properties & materials selection	Req.	120	MATLAB, CES
2.	M&AE 3250 Analysis of mechanical structures	Req.	100	MATLAB
3.	M&AE 3272 Mechanical property & performance lab	Req.	120	ANSYS
4.	M&AE 4272 Fluids/heat transfer lab	Req.	120	FLUENT, MATLAB
5.	M&AE 4700/5700 Finite element analysis	Elec.	40	MATLAB, ANSYS
6.	M&AE 4230/5230 Intermediate fluid dynamics	Elec.	50	FLUENT

Simulation Use in Courses

- Pedagogical strategies used:
  - Case studies
  - Just-in-time learning
  - Web-based tutorials
    - SimCafe wiki
  - Strong connections with existing curriculum
  - Emphasis on concepts rather than skills



SimCafe Wiki

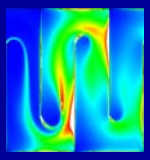
- Wiki-based online resource for teaching and learning simulation
- Open-source
- Enables community collaboration
- Users can
  - Use content as is
  - Adapt content
  - Create new content using templates

SimCafe Wiki: Tutorial Structure

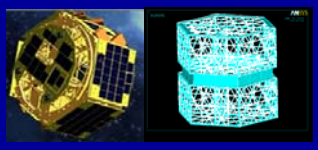
- Each set of tutorials has the same high-level organizational structure
- Required steps:
  - Verification and Validation
  - Pre-Analysis
- Helps students become discerning users

Simulation Use in Projects and Research

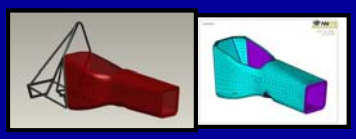
AguaClara Team (CEE)

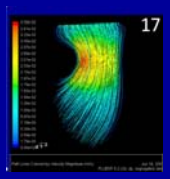
CUSat Team (MAE)



FSAE Race Car Team (MAE)



Blood Flow (Butcher group, BME)



ISTEC 2008 Workshop

- Primary sponsor: College of Engineering
- Other sponsors: ANSYS, Boeing, COMSOL
- 90 attendees, 25 from outside academia
- Brought together major stakeholders
- Next ISTEC workshop: July 2011

ISTEC 2008 Workshop: Summary

- Two learning modes in simulation:
  1. Learning how to use software
  2. Learning fundamental concepts using software
- Broad consensus among attendees
- Important Corollary: Simulation can augment rather than detract from teaching fundamental concepts

ISTEC 2008 Workshop: Summary

- Dr. Graham Holmes (GE) posed the question:

The limiting resource –
- *Computers?*
- *Algorithms?*
- *Turbulence models?*
- *People?*

- Swanson Program addresses the people limitation

Conclusion (1/3)

- Developed effective strategies for integrating simulation into curricula
  - Distilled from cross-curriculum efforts
- Scale-up has been the major stumbling block
  - How to go from 1-2 courses to the entire educational experience?
- Developed scale-up mechanisms
  - SimCafe: Wiki-based open platform
  - ISTEC workshops

Conclusion (2/3)

- Technology and approach are applicable to most physics-based engineering disciplines
- Benefits:
  - Prepare students better for their professional careers
  - Improve the teaching of engineering fundamentals
  - Support projects and research
  - Excite students about engineering

Conclusion (3/3)

- Simulation is a key technology that can greatly contribute to the college's teaching and research missions
- We have made important strides relative to peers due to the uniqueness of the Swanson Program
- Exciting opportunity for Cornell to take leadership