

CP6

CSE Education, Visualization and Image Analysis I

Chair: Robert E. White, NCSU

4:30-4:45 Establishing a Center for CSE in an Undergraduate Institution

Peter R. Turner, US Naval Academy

**4:50-5:05 Understanding Results from Large-Scale 3D Transient Simulations
Through Visualization**

**Robert Haimes , MIT and Kirk E. Jordan, IBM T. J. Watson
Research Center**

5:10-5:25 Transition from Calculus to Computational Scientist

Robert E. White, NCSU

*What is the role of visualization
in computational science education?*

OR

*What is the role of computational science education in
visualization?*

Transition from Calculus to Computational Scientist

By

**Robert E. White
Department of Math
North Carolina State University**

white@math.ncsu.edu

<http://www4.ncsu.edu/eos/users/w/white/www/white/bob.html>

Outline

- **Traditional Approaches to CSE Education**
- **Some Courses at NCSU with CSE Mode of Investigation**
- **Concluding Remarks**

Traditional Approach to CSE Education

Create a PROGRAM and make it look like US:

- **Numerical analysis**
- **Matrix algebra**
- **Differential equations**
- **High performance computing**
- **Grand challenge applications**
- **.....**

We HOPE that by association with US the student will become skilled in the computational science/engineering (CSE) mode of investigation.

Some observations:

- **Most scientific/engineering disciplines are using more computer simulations.**
- **A larger proportion of members of these disciplines are doing this.**
- **Most undergraduate programs do not have room for the traditional courses and the courses required to effectively use the CSE mode of investigation.**

Therefore, there is a need to integrate the CSE mode of investigation into more of the undergraduate programs for science/engineering.

Some Courses at NCSU with CSE Mode of Investigation

- **Two one credit computational math courses associated with calculus**
Uses computation to examine simple models via
“what if” and “vary a parameter” scenarios.
- **Introduction to applied mathematics for second year undergraduates**
Five modules survey applied math and
create a “plan of study” for the third and fourth years.
- **Computational math or “numerical modeling”**
Introduces simple PDEs via discrete models and
uses high performance computing.

Computational Math for the Life and Management Sciences

- **Students have one semester of calculus.**
- **Uses the Excel spreadsheet (graphs, trendlines, solver, macros).**
- **Models of data, optimization, information and population.**
- **Examine the models via “what if” scenarios such as incorrect or variable price data.**
- **Meets one day a week with about 7 written reports.**

Numerical Solution and Application of ODEs

- **Students have at least two semesters of calculus.**
- **Uses Matlab (plot, given m-files, ode45 and stiff solvers).**
- **Models of mechanics, circuits, populations and chemical reactions.**
- **Examine the models via “vary the parameter” scenarios such as variable damping in the resonance of a mass-spring.**
- **Meets one day a week with about 5 written reports.**

Introduction to Applied Math (A new course in Spring 2001)

- **Students have three semesters of calculus (second year undergraduates).**
- **Some Matlab and Maple will be used.**
- **Five three-week modules, and this spring they will be**
Heat and pollutant transfer,
Cryptographic schemes,
Acoustic waves,
Biological applications and
Modeling random phenomena.
- **Examine the models with the hope motivating the students**
for a more detailed study, and develop math “as is needed”.
- **Meets three days a week with some traditional homework and**
a five or six page written report on
“A Plan of Study for the Third and Fourth Years”.

Computational Mathematics: Models, Methods and Analysis

- **Students have at least ODEs and some matrix algebra.**
- **Uses the Matlab (80%), Fortran and MPI for multiprocessing.**
- **Model evolution of heat diffusion and pollutant transfer.**
- **Numerical methods include matrix products, Schur complement with domain decomposition order, SOR with red-black order, conjugate gradient, Picard and Newton algorithms.**
- **Meets three days a week with about 10 traditional home works and two projects.**

Concluding Remarks

- **The wide spread use of the CSE mode of investigation is driving computation science education to a much larger portion of the undergraduates.**
- **The CSE mode of investigation needs to be at least illustrated to first and second year undergraduates.**
- **Students should have an overall appreciation of the this process, and be able to give an analysis of possible errors.**