The Computational Engineering and Science (CES) Program at the University of Utah is a unique interdisciplinary program which educates students to be simulation scientists – those individuals that use the simulation science methodology to address problems in science and engineering. Through a carefully constructed program of coursework and research project interactions, students are prepared to make Innovations Through Simulation.

What is the Simulation Scientific Method?

With the advent of modern computing, a new paradigm called simulation science has emerged, in which “experiment” now employed within the scientific method consists of the computational solution of the model. The simulation science scientific method consists of the following stages:

- **Scientific Problem of Interest (“Problem Identification”):** Statement of the scientific or engineering problem of interest. Questions should be developed in such a way that quantifiable metrics for determining the level of success of the simulation science endeavor can be evaluated.

- **Modeling:** The development of a model which abstracts the salient features of the problem of interest in such a way that exploration and evaluation of the model allows an answer to the questions specified concerning the problem of interest. Modeling techniques include, but are not limited to, deterministic or probabilistic, discrete or continuous mathematical models. Means of validating the model (determining the error introduced due to the model abstraction of the real phenomenon) should be established.

- **Computation:** The generation of algorithms and implementations which accurately and efficiently evaluate the model over the range of data needed to answer the questions of interest. This simulation of the physical phenomenon by computational expression of the model provides the experiment upon which the simulation scientific method hinges.

- **Evaluation:** The distillation and evaluation of the data produced through computational simulation to answer the questions of interest and to provide quantifiable determination of the success of the experiment. Methods such as, but not limited to, scientific visualization provide a means of tying the simulation results back to the problem of interest.

Mission Statement of the CES Program:

Our mission is to expose future scientists and engineers to the simulation scientific method of problem identification, modeling, simulation and evaluation. Exposure will be gained through a combination of graduate course work, which spans the simulation science pipeline and individual student involvement in computational engineering and science research efforts.

Vision Statement of the CES Program:

The Computational Engineering and Science Program at the University of Utah trains students to perform cutting edge research, which spans the simulation science pipeline. Students will be able to identify and advance the simulation science pipeline within computational engineering and science endeavors, and thus will spearhead a new generation of simulation scientists prepared as interdisciplinary “bridge-builders” that facilitate interconnections between disciplines that typically do not interact.

Our Purpose:

The primary purpose of the Computational Engineering and Science program is to train students in the use of advanced computing hardware and modern computational, graphical, and mathematical techniques for the solution of problems in science and engineering that are inaccessible without such integrated expertise. Based upon this purpose, the goal of the CES program is to provide a mechanism by which a graduate can obtain integrated expertise and skills in all areas that are required for the solution of a particular problem: the realization of the problem in its engineering or scientific context, the translation of the problem into a precise mathematical statement through mathematical modeling, the formulation of the numerical methodology for solving the problem, the selection of the appropriate computer architecture and algorithms, and the effective interpretation of the results through visualization and/or statistical reduction. The M.S. degree in Computational Engineering and Science can serve as a stepping stone for students who want to pursue professional careers or continue in Ph.D. programs in computational chemistry, physics, computational medicine, bioinformatics, engineering, and many computer science disciplines including graphics, robotics, and visualization.
Admissions
Currently MS degrees and Certificates in CES are offered in our program. Undergraduate degrees in engineering, science, applied mathematics and computer science are all excellent backgrounds from which to approach computational engineering and science and apply to the program.

Curriculum
The CES MS curriculum consists of 31 semester hours of training, 18 of which are required classroom hours which expose the student to the simulation science pipeline. For the remaining credits, three options exist: coursework only option, project option and thesis option, each of which requires a different balance of elective courses and research (project or thesis) courses.

Living in Utah
The University of Utah is located in Salt Lake City, situated at the foot of the Wasatch Front. Salt Lake City is the hub of a large metropolitan area, with a population of approximately one million people. Utah is a diverse state with, among other things, a rapidly expanding high tech base, as well as a major international airport.

Salt Lake City offers a wide variety of athletics, cultural events and popular entertainment. Fine dining is abundant, along with many affordable eating and drinking establishments frequented by students. Excellent cultural facilities are available in the city and throughout the rest of the state, including the Utah Symphony, Ballet West, and a large number of theater companies. The Sundance Film Festival takes place annually in Park City, one half hour’s drive from campus.

The canyon country of southern Utah is unique. The area includes five National Parks and the largest contiguous area of wilderness in the U.S. outside of Alaska. National forests and wilderness areas are scattered throughout the state. The state of Utah has unsurpassed opportunities for outdoor recreation, many only a few minutes from campus. It has the world’s best skiing so close to a major city, along with excellent biking, camping, and mountain and desert hiking.

Participating Departments
- Bioengineering
- Chemistry
- Chemical Engineering
- Electrical & Computer Engineering
- Geography
- Geology & Geophysics
- Mathematics
- Mechanical Engineering
- Medical Informatics
- Meteorology
- Physics
- School of Computing

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