Integrated, First-Year Curriculum in Science, Engineering, and Mathematics

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The Integrated, First-Year Curriculum in Science, Engineering, and Mathematics evolved from faculty discussions in 1986 to address two problems with traditional curricula: (1) overemphasis on rote manipulation; and (2) failures to make connections between the various disciplines taught in the first year.

The new curriculum (now in its third year) is a three-quarter, twelve-credit-per-quarter course sequence for first-year students who plan to major in mathematics, engineering, or the physical sciences. The curriculum is now offered to 120 students in the 1991-92 academic year. To support instruction, 5 classrooms are equipped with 145 NeXT computers. Software includes *Mathematica*, FrameMaker, as well as custom applications developed by students and faculty at Rose-Hulman Institute of Technology.

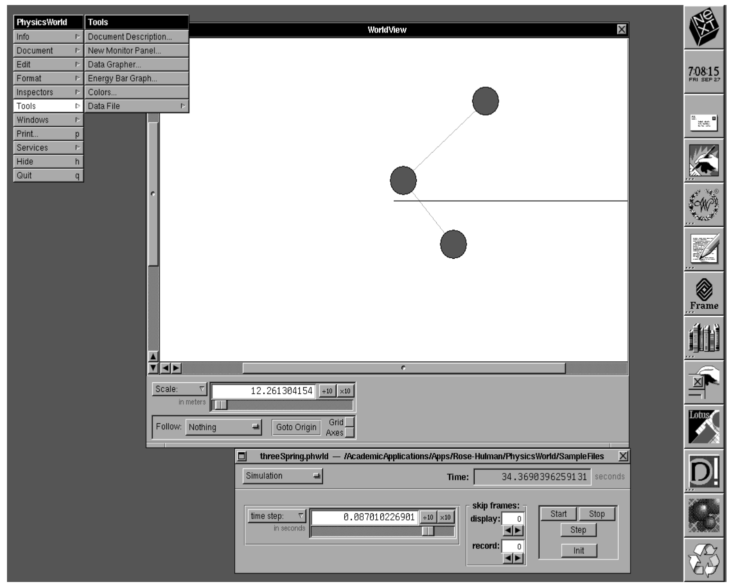

Figure 1 *PhysicsWorld, a student-developed application, allows students to put particles in gravitational fields, electrostatic fileds, and magnetic fields, and analyze their motion.*

In addition to the integrated curriculum, the remaining first-year students take calculus using *Mathematica* and Pascal programming in the NeXT classrooms. For upper-class students, there are two sections of differential equations, one section of circuits, one section on image processing, and one section of introduction to communication systems.

Presentation focuses on the applications that have been developed by undergraduate student developers during the summers of 1990 and 1991 to support the integrated curriculum. The applications were developed to help students visualize and explore fundamental concepts in science, engineering, and mathematics.

Applications include:

- Exercises such as *Curves*, *TrigGigI*, and *TrigGigII* in which students explore sinusoidal functions
- *SlopeGame* and *AreaGame*, in which students explore the relationships between a function and its derivative
- *PositionGame* and *VelocityGame*, in which students explore relationships between position and velocity
- *PhysicsWorld*, is a simulation in which students investigate and visualize the motion of particles in gravitational, electrostatic, and magnetic fields, the motion of a pendulum (see Figure 1)
- *RateLaw*, which allows students to simulate the kinetics of a variety of chemical reactions.
- *FieldSimuator*, helps students visualize field line and equipotential contours for both electrostatic and gravitational fields
- An application called *DataAnalyzer* that allows students to plot and fit functions to data

These applications are a sample of more than 50 applications that have been developed to support visualization and exploration of fundamental concepts in science, engineering, and mathematics.

Benefits of NeXT Technology for Teaching Engineering

At Rose-Hulman, the single most important feature of NeXT technology is the NeXTstep development environment. Object-oriented programming and Interface Builder allow us to develop applications such as *PhysicsWorld, TrussMaker,* and *FieldSimulator* that we could not develop on another platform with our limited resources. Current plans call for further refinement of existing applications and creation of more engaging applications that will allow students to explore further concepts in science, engineering, and mathematics.

Also, Rose-Hulman hopes to expand and include applications that will support exploration and communication in the humanities and social science. These software development plans are feasible within the NeXTstep development environment.

The network and communication technology built-in into every NeXT workstation is the second most important technology. UNIX, Ethernet, NFS, multimedia electronic mail (NeXTmail), Mach interprocess communication, and Speaker/Listener objects provide a rich environment in which new modes of interaction between faculty and students can be explored. UNIX, AFS (Transarc), and Ethernet provide an Institute-wide file system so faculty can share instructional materials with students. NeXTmail enables rapid communication among the faculty who participate in the integrated curriculum and between the faculty and students. Speaker/Listener objects provide a productive interface to the Mach interprocess communication facilities with which a new class of interpersonal applications can be developed.

Finally, NeXTstep provides an engaging, productive graphical user interface to a powerful computing environment. NeXT offers multitasking, virtual memory, and 68040 computing power combined with an easy-to-use user interface. Students have no limits with the computing resources upon which they draw.

For more information about the Integrated, First-Year Curriculum in Science, Engineering, and Mathematics, please contact:

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