HAS COMPUTING CHANGED PHYSICS COURSES?

By Norman Chonacky

AS SOMEONE WHO BEGAN USING COMPUTERS IN PHYSICS INSTRUCTION STARTING WAY BACK IN 1970, I MUST CONFESS THAT THE EXCITEMENT OF THAT ODD BAND OF PHYSICS PROFESSORS WHO WERE MY FELLOW ENTHUSIASTS WAS SOMEWHAT MISPLACED. WHAT THEN APPEARED TO BE WILD DREAMS has become mundane practice, and the cutting edge of computer use, especially for numerical computations, has moved beyond the bounds that even our eager eyes had conceived as extreme.

A great deal of this is due to the hardware evolution, unfolding in accordance with Moore's law. Software evolution followed, albeit understandably delayed and also somewhat more slowly, but the computing tools and power that have emerged and their accessibility today to scientists and engineers are still breathtaking compared with those to which we had access in the early days.

Accordingly, science and engineering perspectives and practices have changed as well. Modeling and simulation are now the telescopes we commonly use to look at problems, and large-scale, complex numerical computations are becoming more or less commonplace in many research labs and development workplaces. But just as there is an understandable delay between computing hardware and software evolutionary phases, there is a lamentable but seemingly fated delay between science and engineering practice and science and engineering education.

A strong case for documenting this phase lag can be made inferentially by contrasting the results of a study—"The Early Careers of Physics Bachelors"[1]—conducted by the Research Statistics Center at the American Institute of Physics with the results of a survey—"Computing in Physics Courses"—conducted by Robert Fuller for *CiSE* and reported in this issue (p. 16). The 2002 AIP study reported that a plurality—fully 24 percent—of physics graduates with bachelor degrees, five years after graduation, were doing software-related work. In second place—close behind at 19 percent—were those working in engineering. Forty to fifty percent of these same groups rated modeling and simulation, scientific software use, and computer programming as important skills in their work repertoire. Yet only 25 percent of those in software jobs reported that their computer programming preparation was very good, and barely 20 percent of those doing science and engineering work reported that their education for using scientific software was very good. This judgment flies in the face of the fact that most of their time (and a large majority in the case of those working in software jobs) was spent on these tasks. An issue not explored in the AIP survey was numerical modeling, but it doesn't take a great deal of imagination to assume that physics undergraduates aren't adequately prepared for this activity, now in its ascendancy in all the sciences and engineering.

That the situation in most college and university physics departments hasn't substantially changed since these bachelors graduated in 1997 is the case that Fuller makes in his report. I would summarize this finding by the (slightly twisted) aphorism that "the spirit is willing, but the practice is weak." In fact, one person's testimony during a grassroots discussion we conducted before I decided to commission Fuller's study was that "we in physics have first-class 19th century physics programs in our introductory courses, and not very much beyond that in our physics major curricula." Contemporary sciences and engineering practices are cross-disciplinary; these people not only compute but also use computation as a common interface between their respective contributions to cross-disciplinary projects. It's especially discouraging to me that the bulk of engineers—and computer scientists, inasmuch as they opt to take physics—get their physics education in those introductory physics courses and thus suffer from this common lack of computational connections.

What to do then? And is it *CiSE*'s job to do anything anyhow? Addressing the latter first, I hope you will read a quote

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by *CiSE*'s first editor in chief, George Cybenko, which appears in David Winch's Guest Editor's Introduction to this special theme issue (p. 11). From its very conception as the child of the AIP's *Computers in Physics* and *IEEE Computational Science & Engineering* eight years ago, *CiSE* has been committed to bridging science and engineering and inviting computer scientists, software engineers, and applied mathematicians into the discussion as well. As a cross-cultural force, *CiSE* should be a leader in facilitating a meaningful integration of one discipline with another and of education with practice.

The details of what preceded the study and what we discovered are subjects for the subsequent articles in this issue, but our rationale for the study and this theme issue should be clear. We're committed to support, by every invention at our disposal, the development of a community consisting of educators and practitioners in science and engineering bound by the common thread of computing. To guide us in our foray into the physics enterprise, we needed some hard data and some illustrative examples on the current situation in physics education. We hope to use the study and issue as an impetus for community building. Enjoy the issue, keep it on hand as a primer, and stay tuned to *CiSE* for further developments.

Reference

1. R. Ivie and K. Stowe, "The Early Careers of Physics Bachelors," Am. Inst. of Physics publication no. R-433, Aug. 2002.

New Editorial Board Member

Rachel Kuske holds a Canadian Research Chair in Applied Mathematics at the University of British Columbia, Canada. Her mathematical interests vary over several areas of applied mathematics, including modeling in stochastic dynamics, mathematical finance, and mathematical biology. Kuske has a PhD in engineering sciences and applied mathematics from Northwestern University. She is on the editorial boards for *SIAP* and *SIAM Review* and founded and served as director for the Association for Women in Mathematics' Mentor Network, coordinating projects that support women in science at various levels. Her full CV is online at www.math.ubc.ca/~rachel.