

**Integrative Computing Education & Research (ICER):
Preparing IT Graduates for 2010 and Beyond**

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1. *Preparing undergraduates for computing careers:* What are the biggest challenges that you face in your role (i.e., as an educator, employer, administrator, leader, other)?

The biggest challenges are: 1) Keeping up with the field, 2) keeping courses and curriculum current, 3) trying to fit even a fraction of the ACM curriculum in an undergraduate program that only allows students to take 10 courses in computer science, 3) making courses fun and relevant for students, 4) falling enrollments - attracting good students, female and minority students, any students, 5) trying to find time for the ever increasing research, committee, and teaching demands, 6) defending the role of computer science in a liberal arts environment.

2. *Transforming the educational experience:* What might the community do to address the challenges you identified above?

More discussion and experimentation is needed to better define what should be taught at the undergraduate level. The ACM Computing Curricula 2001/2005 is an excellent starting point and has outlined many worthwhile issues such as generating separate degree programs and rethinking the introductory curricula away from strict programming. These ideas need to be explored much more and expanded upon further.

Publishers, faculty, and professionals need to develop better cs resources. Textbooks are expensive and unsatisfactory especially given the rapid changes in the field and given the variability of topics that might be taught in any given course. Recent developments for creating "textbooks" by pulling materials from different resources (e.g. safari U) are very promising but much work still needs to be done to make these systems workable. In fact, books in the traditional sense may become obsolete and be replaced by smaller, self-contained "units" around a topic or theme and be available online. These "units" could be used by faculty as well as students to learn new topics.

Universities need to acknowledge the tremendous effort and time that is required to keep up with the field and to keep curricula current. Computer science faculty spend much more time learning new material and developing new courses as compared to many other departments yet we are not given any credit for this additional extra work when it comes to promotion and tenure. In fact, these efforts can penalize us because they take time away from research and publishing. How can we be rewarded and recognized for our work?

In general, universities need to provide more funding and time for faculty retraining, and curriculum development, e.g. through course releases, workshops, conferences, research funding for summer students. But where will this money come from? Increasing endowments and tuition, government support, industry grants?

There is tremendous variability in computer science education at the high school level. As a nation, we need to recognize the importance of K-12 education in computer science as well as the more traditional subjects.

3. *Models for transforming computing education:* What might an ideal undergraduate model for computing education look like in five years?

Whatever cs education looks like in five years, it will be different from what it is now given the rapid changes in the field. To succeed we must stay nimble. In the future, both faculty and students will ideally have many more resources available, particularly online, in which to learn new topics and to stay current in old ones. We have the growing ability to communicate and share information through email, web pages, electronic classrooms, e-portfolios, and who knows what else. We should continue to explore how best to take advantage of these. We should continue to build repositories of teaching examples, syllabi, lab problems. These materials can be generated by faculty or other professionals in the field, however, they must be refereed to maintain quality and consistency, and should count as "published" work.

Electronic communication will also encourage more teaching and research collaboration at across schools and across disciplines.

The continuing expansion of the field will force undergraduate programs to continue to separate into different sub-majors. In addition to the 5 separate degrees listed by the ACM, the computer science degree will specialize even further perhaps even focusing on very specific areas such as computer graphics or machine learning.

Computer science has tremendous potential for interdisciplinary work. We may attract many new bright students by providing programs that work hand in glove with other departments on campus, such as mathematics, the sciences, economics, art. Homework and research projects could draw directly from other disciplines.

4. *Inhibitors and strategies*: Can you identify inhibitors that might prevent the nation from achieving goals it sets for computing education? Can you identify strategies that may enable the transformation of undergraduate computing education in the USA?

There are many false perceptions among students and the general public regarding what computer scientists do. The computer science community needs to better educate the public about the breadth and richness of the field. These false perceptions can be partly attributed to the fact that most students' (majors and non-majors alike) first and often only exposure to computer science is through the first year introductory programming courses which many students dislike and which expose students to a very narrow view of the field. We need to rethink what this first course looks like. This narrow view also contributes to the perception that all jobs are being outsourced. While many programming jobs are being outsourced, programming is not all we do. This all leads to dropping enrollments, which in turn, weaken departments and reduce the number of computer science graduates at a time when the need for such skills will only increase.

There are many topics that could easily be learned at the high school level yet there is huge variability on what is covered in the high schools. In Oregon, for example, I am told that schools are not allowed to hire teachers with just a computer science degree because cs is not one of the approved subject areas. Because not all students go to college, good high school programs would reach many more students. For those that do go on to college, more could be done at the college level if students came into college with at least a minimal foundation in cs.

Industry needs to step in more to expose student to the practical side of computer science. Academia can't teach it all. Industry should provide more summer internship opportunities for high school and college students so that students can learn practical skills and make connections with industry workers. Summer internships for faculty to retrain would also be very beneficial both to the faculty and to the industry in the long run. This will cost industry more initially but could have huge benefits in the long term.

NSF or other organizations, rather than providing a few very large grants for large projects, could provide many small research grants for faculty and students to work together in the summer. A few dollars can go a long way to motivating and providing seed money.

5. *Who might participate*: What stakeholders should be involved in designing strategies to catalyze the transformation of university computing education throughout the nation? What is the role of government in this process? Professional societies? Universities and faculty? Others?

Professional organizations, faculty and students (graduate and undergraduate), and industry all need to be involved because we are both participants and beneficiaries. We provide the knowledge and guidance that is needed. Government and the public need to be involved as well because 1) participation will help educate them about the value and role of computer science, 2) the entire nation has a great deal to gain by having an educated workforce, and 3) the public provides enormous support through tax dollars for research as well as education at all levels (K-12 through graduate).