COMPUTERS IN ENGINEERING EDUCATION

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Introduction :

In today's global economy, a well-trained, well-educated workforce is needed for creating, developing, producing, and marketing high quality products that meet consumer needs at minimum cost and compete successfully with similar products from other countries. Economic competition is a technical competition, and technical competition has become an educational competition. High intelligence is the only source of competitiveness. Indian education is being confronted by profound technological changes occuring in the society. These changes are generally referred to as the INFORMATION REVOLUTION... a revolution characterized by rapid developments and reduced costs in electronic information technologies and global information network.

The computer is a one-in-several centuries innovation. The computer, in the environment of technology and scientific advances, is changing the nature of business, industry and everyday life. Preparing students for this new world makes strong demands on education, at a time when the cost of engineering education is rising rapidly than other prices. Fortunately, the computer, combined with new knowledge of human thinking and learning, provides new means for meeting these needs and eventually for increasing the productivity of education.

The situation seems to be particularly prevalent ... if not acute ... in our country, where knowledge level among a majority of citizens is insufficient to utilize computers and other elements of modern technology, let alone maintain or design them. There seems to be a shortage of mathematics and science teachers at the pre-college level.

In my pursuit of computer literacy programs for everyday people, I have come across a sizable number of students who fell significantly short of the standard admission requirements but in whom I saw a high potential if subjected to special programs to bring them up to speed. Although the cost of breakthrough in achieving the scholastic proficiency for such students will be appreciably higher, it will be negligible in comparison with the cost of underutilization of resources of our citizens over their lifetime.

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Developing Aptitude for Science and Engineering :

What would you select as the essence of science that you would like to convey to the generation? What characterises science? What makes people want to devote their professional lives to science ? Of course, there would be as many responses as there are scientists; but most of us would agree that the excitement of exploring the unknown, of discovering something new, of adding to the storehouse of knowledge is central to our vision of science and our own motivation. According to George Polya :

"A great discovery solves a great problem but there us a grain of discovery in the solution of any problem. Your problem may be modest; but if it challenges your curiosity and brings into play your inventive faculties, and if you solve it by your own means, you may experience the tension and enjoy the triumph of discovery."

You might conclude that discovery and exploration would play an important part in science education. Unfortunately, exploration and discovery have been effectively squeezed out of science education at all levels prior to graduate school. In the rush to put more science into science education, to prepare students for the ensuing examination, the essence of science has been omitted. Science education has developed into a separate entity divorced from science and scientists. From kindergarten through college, students rarely DO science, they rarely participate in the creative act.

What a strange situation we have in science education; we expect the next generation of practitioners to learn without practicing, the next generation of voters to live in a technological society enriched by the fruits of science without having any appreciation for the creation of new scientific knowledge. Our citizens are aliens in their own homes. It is like teaching lessons in swimming without letting the students near water; it is like preparing artists by teaching these students only the history of art; it is like trying to develop great quarterbacks solely by having trainees watch the replays on the VCRs. Even the audience needs an appreciation that can only be gained through participation as an amateur.

Computers in Science and Engineering Education :

Technology can help bridge this gap between the conduct of science and the teaching of science. Microcomputers can give students the tools they need singly and in groups to begin to experience investigations that are original and important. They provide unique opportunities for students to collaborate and share ideas, techniques and data. They also give scientists a convenient means to contribute to education and to enrich their own work through contact with young minds. Micro-computers are perhaps the only commodity in today's market with its ever appreciating value and ever depreciating cost. They are versatile instruments giving students the functionality of racks of electronics not long ago reserved for advanced research. With these microcomputer-based instruments, students become experimentalists, able to explore first-hand, a broad range of phenomena on which scinece is based. These same micro-computers can be used for computations, allowing students to be theorists, and to move between theory building and experimenting with ease.

Of course, technology alone cannot make the difference; needed are the major changes in the way the science is taught. The tech-

nology creates new opportunities to institute these changes, but the choice to exploit these opportunities always remains. And once that choice is made, there remains the mjor problem of making effective use of the technology in a way that will be accepted by the educational community.

The current pressures to improve science education put us at crossroads. If traditional educational practice prevails and yet more content is squeezed into science education, we will only be aggravating the situation and create a crisis in the next generation. The gap between science as taught and science as practiced has its origin in the gap between science educators and scientists. New technology has the potential of bridging this gap. However, as a society, we rely too heavily on technological fixes to simplify our efforts. The solution to the crisis in science education will take effort, and practicing scientists are needed to participate in this effort, to bridge the gap.

In the field of applications of software for word processing, spreadsheets and database management is not so much user friendly if not user hostile. We need a type of hardware with user interfaces which are, in some measure, intuitive; emulating the way we think, and which gives at least the illusion of total control in the hands of the user. This approach is feasible and much work is being done today in this direction.

The area that stands to gain particularly from more computers is TEACHING. It is in teaching that the most promising market for future expansion lies. Using computers in teaching does not mean teaching about computers, but rather exploiting it to represent and communicate ideas within substantive academic disciplines. It has been quite inconvenient to bring much of the world into our schools. Many schools teach years of science without a single experiment. Almost no schools use REAL experiments in whcih the result is not foreordined and RIGGED. The central promise that computers hold for education, all of education, is the provision of a domain in which students don't have to take someone's word as to what happens. The first message in meta-learning is : you can do this stuff AS WELL AND BEAUTIFULLY as anyone else. The teachers must try to continually provide students with visually striking results, to reinforce this sense of well-being and control as the curriculum progresses.

The standards of admission to these courses have been fixed by the department of education for the State. However, the faculty must be intimately involved in the setting of standards for retention and transfers of students from other institutions.

It is equally important to maintain quality of students throughout the degree program. It is the responsibility of the faculty to monitor the progress of the students. Appropriate measures; consistent with the institutional mission, must be devised to guide students towards completion of the program in a reasonable amount of time.

To facilitate the evaluation of the students, it is necessary to maintain a database of sample measures of students performance. Such measures may include examinations, tutorials, home assignments, and project reports.

Specialised Courses and the Teacher :

In spite of beating of drums about use of computers in education, we do not see educational institutions taking initiative in the use of computers in the environment. Apart from the large investment in computers, the educationists hesitate in adopting computers as part of their campus because they

continually apologize for their lack of expertise; they are continually made to feel inadequate.

As far as the teachers are concerned, majority of subject in the curriculum are not less than 50 years old, and most of the content in the subjects is hundreds of years old. On the contrary, for computers, almost everything is less than 50 years old and much of it is less than a couple of years old. Computers are both a relevant aid to problem solving and a source of problems in every academic discipline at every academic level.

What is a middle-aged, retreaded teacher in science and engineering to do? Certainly, he can continue to learn by learning to say, "I don't know - let's learn together", WITHOUT FOLLOWING IT WITH AN APOLOGY. AS Dave Morsund puts it : "There is nothing worng with not knowing about the latest piece of hardware and software. There is nothing wrong in not carrying in one's head all of the fine details of a particular machine that some bright 14 year olds seem to memorize so easily. I am still a competent person even if a 14-year-old knows many things about computers that I don't know. For me, what is especially important is learning to take advantage of my strengths, such as wisdom and experience gained through the past 46 years. I have a greater breadth and depth of knowledge than most of my students. I have had a greater range of experiences, and I have had more practice in learning to learn. If I keep this fact firmly in mind, I can more easily say, I DON'T KNOW - LET'S LEARN TOGETHER. For me, that is an important goal."

The average age of engineering teachers is between 45 and 50. While some have managed to stay current in the specialized courses they teach, those who are overloaded have taught the same introductory courses without change for 20 years. Such introductory courses do not necessarily provide the best foundation for specialized course. For example, in many of the electronic circuit analyses and modelling courses, we are still teaching bipolar junction transistors in excruciating detail, whereas the graduate classes include a considerable amount of MOS technology and VLSI design .

Also, the technology for delivery of education is amiss. We rely on the traditional lecture process. In many cases ... and I am thinking of myself in particular ... it is easier to just go in and lecture, rather than do the adequate preparation to deliver a high-quality course.

Conclusion :

The role of the computer is changing, It can be your depository, your library, your shoebox full of card files, with an all-encompassing framework in which to organise the information. It used to be that the computer would dictate how information could go in and how it could come out. Today, ways for people to harness th power of the computer rather than letting the computer harness them are available through Object Oriented Programming Systems like Ted Nelson's HYPERTEXT and HYPERMEDIA. However, effective use of computers in learning will not occur automatically. A reasonable chance exists that it will not occur at all unless we readjust our current directions. Just because computers and other modern technology are widely present in our engineering colleges is no guarantee that this equipment will be wisely employed. It is only through the teacher's heightened awareness of the need for an integration of teaching and learning experiences this could be made possible. What we teachers plan and implement in our classrooms as educators, facilitators, and direc-

tors of learning today, shall ultimately affect not only the kind and quality of thinking that our engineers and scientists do on a particular project, but also mental habits that they shall form for life.

References :

1. The gap between Science and Education : - Robert F. Tinker, Hands On, Spring 88
2. Research Aptitude ... what it is and How to Develop it. Workshop held at SNDT College of Education. Feb. 7 to Feb. 9, 1990.
3. Microcomputers in Education, - Doris Carey and Regan Carey, International Council for Computers in Education.