TECHNOLOGY:

AN ESSENTIAL COMPONENT OF TODAY'S COLLEGE EDUCATION

by

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The Curriculum The Delivery System

ABSTRACT

The growing educational failures of the colleges and universities of the United States are a major concern of the 1990's and are not showing a great deal of promise for the 21st century. The overabundance of committee reports that describe and prescribe for our schools, the evidence presented in those reports, and the analyses that are offered combine to form a persuasive argument that there is a profound crisis (AACC, 1995).

Technological developments have so outpaced the understanding of it provided by almost all college programs that we have become a people who are unable to comprehend the technology we invent and the impact it has on our ethical and moral fiber--our very way of life. We are unable to measure, much less control, the capacity of our technology to violate the natural laws of our world.

Technology has become a permanent, pervasive, and significant part of our culture. Yet it is a rare event to find a curriculum that exposes one to some appropriate combination of technology, innovation, the humanities, and the social sciences.

An engineering curriculum without a cultural component is not an education that will serve the graduate well in our society. Standards established by the Accreditation Board for Engineering and Technology (ABET) have done much to vindicate engineering faculty of the perceived lack of broadening within their curriculum. We must continue to strengthen the cultural component of the engineering curriculum. If we accept science and technology as essential to solving some of the world's most significant problems, applied science, computer science and applied mathematics courses must, of necessity, be included in traditionally non-technical curricula. We must create an expectation that nonengineers/nonscientists will understand the technical facets of problems not just the 'issues.' Bringing the wisdom of the ages to modern problems is essential but it can no longer be done very easily without an understanding of some of the technical details of the modern age.

Faculty must realize that just as they must include philosophy and literature as the cultural component for the engineering or science student they must also include applied mathematics

and computer science for the non-technical student. The only decision for faculty members developing such courses will be to look at their disciplines and subject matter from outside their fields and determine how to best fit the new courses into the curriculum and what delivery method will best present the material to their students.

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INTRODUCTION

"Technology in the classroom is not to transplant a textbook to a computer and hype it up with fancy graphics and sound"

Wm Francis Herlehy III
HCI International '93

Technology has become both a pervasive and permanent part of our society. Science has become an indispensable part of our modern culture. Educated men and women of today, no matter their discipline, must not only speak the language of their field but that of technology also; or, the humanities and social science, if engineering or science is their field. Technology holds a secure claim to being a discrete part of our culture. However, technological issues also have ethical, philosophical, and/or moral dimensions, which must be recognized and addressed (Marx, 1995). Today's college faculty, whether they realize it or not, have a 'real job' of preparation on their hands and will need a great deal of help if they are going to perform that job well.

Traditionally, it has been the engineer and the scientist who was perceived as needing broadening, probably because they were seen as being primary and essential to the emergence of technology. But, traditional, non-technical education also needs to be put under close scrutiny. The purpose of many of these fields of study has been to bring the wisdom of the ages to modern issues.

Those who cannot remember the past are condemned to fulfill it.

George Santayana
The Life of Reason

This simply can no longer be done without understanding some of the technical details of the modern age. The idea that technical subjects such as scientific research, computer science, and applied mathematics need not, or cannot, be taught to non-technical students is every bit as erroneous as suggesting that engineering, science, or flight students cannot, or need not, be taught philosophy or literature. In fact, the only prerequisite in both cases is a desire to know and clearly understand what a subject is all about, to include its implications and ramifications in our technological society.

Now that it is clear that technology is a permanent and significant part of our culture, educators must come under close scrutiny. The ubiquitous computer, the overwhelming technical components of political issues, and the rising awareness of questions of risk and benefit have made technology the focus of new interest to educators--or it should be.

TECHNOLOGY IN THE CURRICULUM

There is so much confusion as to the mission of the college and university that it is no longer possible to be sure why a student should take any particular program of courses. Is the curriculum an invitation to broad intellectual and philosophical growth or exposure to the specific skills of a particular trade (AACC, 1995)? Or, is it some combination of both? Any degree of certainty that might have existed on such questions has all but disappeared during the last twenty-five to thirty years. The apparent void has invited programs fraught with transitory knowledge developed without any concern for the criteria of self-discovery, critical thinking, and the exploration of technology as it relates to the sought-after discipline. The curriculum structured to prepare students for the society and culture they are about to become an active part of has given way to a marketplace philosophy: it is the shelf in the grocery store where the student is the shopper and the faculty are the merchants. The demands of popularity and the success of enrollments become the driving force to the detriment of wisdom and experience. It is as if no one cared, as long as the store stays open.

Not all liberal-arts students would agree they need to understand anything about physics or nuclear energy to understand the political implications or ramifications of a 'Chernobyl' and neither would all engineering or flight students agree they need to know how to parse a sentence or where it was that Shakespeare wrote "brevity is the soul of wit.' Few technical problems are without their social, economic, moral, and aesthetic elements. As knowledge of the liberal arts broadens the experiences of the engineer or pilot, an understanding of technology broadens the experiences of a social scientist or philosopher.

Because of the computer, especially the personal computer, courses in technology need to fast become indispensable components of a college-level education. Stephen White wrote, "What the computer has done is provide scope for analytical skills that has never before existed, and in doing so has altered the world in which the student will live as well as the manner in which he (or she) will think about that world" (Marx,1995). Large, and not necessarily so large, computers can do anything from play war to model the universe and a considerable portion of what they can do is unintelligible without the fundamentals of technology and quantitative knowledge.

Decidedly new courses must be developed because courses characterized by a 'soft' approach to science and technology typified by such titles as "Poetry for Physicists" and "Computers for Social Scientists" will simply not suffice in today's world. Faculty members who develop such courses will have to look at their disciplines and subject matter from outside their fields and make decisions as to how these new courses will be integrated into the curriculum. It will not do simply to offer these courses. Faculty and administrators must encourage and, perhaps, ultimately require nonscientists, nonengineers, and liberal arts students to take an appropriate, specified number of courses in the quantitative areas, applied mathematics, and technology. The engineer, scientist, and pilot must likewise be encouraged and, if necessary, required to take those social science and humanities courses that address the social, moral, economic, and aesthetic elements of their respective technical disciplines.

Much of what Jacob Bronowski posited in his article entitled "The Educated Man in 1984" has not withstood the test of time. The 'orwellian' world he warned of has not come to be. However, his belief that most of the unique developments of the 20th century were technological and that they called for more science, applied mathematics, and quantitative studies in the classroom does hold up or, perhaps, even gains strength with the passage of time and through observation of the aftermath of current technological change. He suggested the absolute necessity of 'hard' courses that conveyed the essence of statistics, chemistry, biology, and computer sciences as the evolution of knowledge through the scientific method (Petroski, 1994). I join in his suggestion for this to be the core requirement of today's college curriculum. I also echo his call for every undergraduate to 'do one small piece of scientific research.'

Though I am not inclined to prescribe specific courses, there are certain learning experiences that are essential to the kind of education that will prepare the undergraduate as an individual and as a member of a society abound in technology. I will briefly discuss what I consider to be the most important of these.

We as a people neither understand nor exercise control over the technology we have unleashed. The technology has placed a man on the moon, given us acid rain, and put a computer on every desk in both the office and in the home. The technology continues to accelerate; the understanding and the control get further behind. If there is any validity to the notion that it is not possible to be comfortable in this technological world, educators have to share in some of the blame for this state of mind. Surely this world is less bewildering to someone who understands the nature of technology, its methods, its reliability, and its limitations. Technology is based on scientific truths. These scientific truths are subject to revision. Their revision is based on new knowledge and understandings. A person who understands what technology is recognizes that technical concepts are created by acts of human intelligence and imagination and comprehends the difference between observation and inference and between the occasional accidental discovery in technical investigation and the decisive strategy of scientific investigation: the forming and testing of hypotheses; the understanding of how theories are formed, tested, validated, and given provisional acceptance; and the distinction between conclusions that are based on unverified assertions and those that were developed from the application of empirical reasoning (Horn, 1994).

To be intellectually comfortable with technology is to understand the inherent limitations of scientific inquiry--to know the questions that empirical reasoning neither asks nor answers. A comprehensive understanding of technology REQUIRES an awareness of the ways in which technology has had a direct impact on intellectual history, one's own view of the universe, and one's view of the human condition. It also REQUIRES an awareness of how certain types of technological thought (empirical reasoning) inform and affect other disciplines such as history, economics, sociology, and political science (AACC, 1995). The understanding of technology just described is conspicuous in its absence among holders of a college degree.

Faculty can best assist students in understanding technology and its methods in a course that is not broad and infused with generalities but rather in a course where the subject matter is highly circumscribed. With skillful teaching, any problem or issue can be examined skeptically using the 'scientific method' to show relationships between data and conclusions, to suggest and evaluate hypotheses, and to design methods and procedures for careful examination of the problem or issue (Horn, 1994). Consideration of such methodology can in turn be used to raise philosophical questions about the nature of technology and the influence of political values and/or social setting on that technology. One invariably successful approach to the study of technology is an interdisciplinary perspective. Properly structured and taught interdisciplinary courses would focus on concepts and issues and satisfy the need, indeed requirement, for all college students to have a technical understanding of the world around them.

By demystifying technology with an emphasis on the social, political, and human implications of empirical reasoning, faculty empower their students with an understanding, a resiliency, and a sense of their own capacity to play a role in how the results of technology are used and will affect them. They will learn to observe, question, think of alternatives, and infer. They will catch on to the importance of paying attention with some appropriate combination of imagination and concentration.

Undoubtedly, suspension of judgment is an appropriate element of empirical reasoning. It allows researchers to proceed and postpone decisions until empirical evidence mandates it. But we do not live our 'real lives' in suspension of decisions. We must make real choices, assume responsibility for those choices, and be comfortable with our own behavior in responses to those choices. They must embody the values of a democratic society and fulfill the responsibilities of citizenship in that society. We must be equipped to be perceptive and informed critics of our society and become repositories of the values that make a civilized and humane society achievable.

Capstone courses in moral philosophy and theology as the source and definition of values have all but disappeared from college curricula. They have been replaced, in many cases, by so-called 'value-free' social science courses and 'objective' scientific/technical courses. Investigation into the sources of moral behavior and the nature of virtue were intended to lead one into the reasoning of human nature, the pursuit of goodness, and individual and social ethics. They instilled a reassuring sense of one's own fitness to play a role in the 'moral order.' While many of us subscribe to ethical concern and social responsibility they seem to have been shunted aside from the college curriculum. It appears that the only certain place in the curriculum where human values and character receive any attention are in the required ethics or philosophy course. There appears to be no other place where we develop and nurture the capacity to make informed choice and accept responsibility for that choice. This learning experience must be available to all students. We cannot avoid the necessity of preparing students for inquiry, choice, and judgment in the technological society we have created. The curricular opportunities are there. Unfortunately they are seldom seized by faculty who are so taken up with specialization and empirical reasoning that they miss the challenge, the difficult challenge, of bringing their students the humanistic aspect of their discipline, the values, choices, and judgments of their subject, and the perspectives that are beyond their parochial interests and capacity. Faculty with a personal and professional commitment to teaching is one way to focus course material on life, its qualities, its demands, its choices and their relationship to the technological society for which we are preparing them.

TECHNOLOGY IN THE DELIVERY SYSTEM

Put away those chalk boards and flip charts. Technology, as a training tool, is becoming cheaper and more accessible.

Management Review
February, 1995

The technological content needed in the curriculum that should be presented in today's college classroom calls for a compatible delivery system. And colleges and universities should be at the forefront of technology in that delivery system.

New employees hired fresh out of college are going to get their first taste of the 'real world' by *logging on*, *surfing the net*, and *interacting*. A recent report published by Andersen Consulting suggests they are not adequately prepared to do so. Business and Industry is not going to get into a philosophical debate with academia over where the responsibility for this shortcoming, and whether it is a shortcoming or not, lies. They know they are faced with a burgeoning technology, not the least of which is the computer, and they are not going to be, or remain, competitive with a workforce that has not been educated and/or trained in the ways of technology. The theories of technology are not enough. They need people in the workplace who have experienced technology. And technology is advancing so quickly that even those who have experienced it in the academic classroom are just 'less behind' than others when they enter the workplace.

Business and Industry and the U.S.military have shown their conviction and commitment to technology in the delivery system with collective budgets exceeding hundreds of millions of dollars. The United States Air Force's Air Education and Training Command educated/trained more than 260,000 people last year. They recently issued a press release, which included a statement that without the efficiency and quality in the classroom made possible by technology, their training accomplishments would have been impossible (Conti, 1995).

To the Air Education and Training Command, technology applied to delivery systems means video teletraining, video teleseminars, computer based instruction, computer aided instruction, full motion video, and full duplex speech with compressed digital video service. Telecommunication systems have been established to provide the capability for one-way video with two-way audio interactive links via satellite (Conti, 1995).

To Business and Industry, as indicated by eighty percent of the *Fortune 500* companies, technology applied to delivery systems means interactive multimedia training. IMT generally refers to computer-based learning that includes sound, video, graphics, animation, and text. Typically, it is delivered on a CD-ROM because of its huge storage capacity. Video and audio use up so much more storage space than text alone that the CD-ROMs become an ideal choice for multimedia (Marx, 1995).

Education and training are areas where the payback can be quite large. Interactive multimedia training is getting rave reviews from business, which are reporting improved learning and savings of millions of dollars. That once-elusive rate of return for training has become quite clear and definitive.

An appropriate question at this time and for this report is, 'What is academe doing?' It is my intention in concluding this report to address some of the key areas to consider when answering the suggested question.

Training without people?

Education and training have come to mean a classroom with an instructor. I am not going to suggest nor does anyone I know expect technology to wipe out the need for face-to-face classroom instruction. However, there are many teaching and learning tasks that are more effectively and more efficiently handled by technological tools. I am ready to suggest that for any needed learning experience that was previously dealt with, in whole or part, outside of the classroom, or not at all, because of a limiting resource, we reconsider the learning experience for the classroom using telecommunications and/or simulation to bring the resource, or a reasonable facsimile, to the student. There are customized simulations and made-to-order telecommunications programs along with new off-the-shelf simulations and programs that can tremendously increase the size and enhance the scope of almost any education or training program (Horn, 1994). Faculty and facilitators need only be limited by their imagination and creativity.

Example is the school of mankind,
and they will learn at no other.
Edmund Burke
On a Regicide Peace

Resources available?

No standards for quality or content currently exist for defining technological delivery systems so caution is of the essence in selecting or developing systems for any particular use. Transplanting a text to a computer and hyping it up with fancy graphics and sound is not putting technology in the delivery system. A key behind putting technology in the delivery system is to liberate learning from the 'linear tyranny' of a textbook where each chapter moves lockstep into the next. Technology in the delivery system is to have access to a 'huge encyclopedic wall full of textbooks'(Marx, 1995) and to be able to go right to the information that is needed and present it to the student in multiple ways, with sound, with video, and with graphics or animation. This on-line collection of learning resource materials is not only to be available to faculty but also to students. Technology in the delivery system is not only access to the library of learning resources but is also a system of providing instant feedback to a persons responses to instruction.

Taking advantage of computer technology allows students to zig zag through a course, taking a little bit from one section of a course outline and more from another in a fashion that allows them to customize a course, indeed a program, to accommodate their learning needs. It will let the faculty member, or the student, have either a cursory view or in-depth knowledge of a subject, depending on what the need is. A good example of this is simulation in the delivery system (Horn, 1994). The fundamental justification for including a simulation game in the delivery system is to allow faculty and students to continue using in the learning environment the very method they have used all of their lives to gain knowledge of themselves and others. Simulations can present a carefully designed framework of selected topics around which students will engage in activities that closely approximate the realities of what would otherwise be an inaccessible life situation.

With some planning, innovation, and strategic execution it is fairly easy to incorporate simulation into the college course. The point to be made is that simulation can offer a great deal to college faculty. Simulations offer an inexpensive and intriguing means for bringing issues alive in the learning environment. They allow for the examination of theoretical paradigms and their applicability to everyday situations. They offer a means of actively involving students in 'failure-proof decision making' and in analyzing the consequences of the process (Horn, 1994). Faculty will not have to rely on special-order materials or 'nerds' once a basic understanding of the simulation process is developed.

Flexible? Adaptable?

The best feature of technology in the delivery system is that it creates methods that easily adjust to students responses and reactions. Because the student tends to respond independently, they can be given feedback independently. However, technology in the delivery system is not the panacea for all teaching and learning concerns. Certain courses, requiring complicated judgments or those that benefit from peer interaction, are better left to the classroom and face-to-face interaction. A computer cannot duplicate the level of sophisticated interactions between a faculty member and a student where you find a question is followed by an answer which is immediately followed by another question and another answer. Where technology in the delivery system excels is in teaching fundamental aspects of a subject such as negotiation techniques, accounting analysis, process/results analysis, as well as procedures. What makes the technology especially appealing in the learning environment is that it makes teaching and learning relevant from the perspective that we are using technology to teach and learn about technology (Herlehy, 1993).

Example is always more
efficacious than precept.
Samuel Johnson
Rasselas

We can do things with technology driving the delivery system that we simply could not do before. We can simulate situation-specific environments so well that students will feel they are actually working the issue or problem. The net result is that students have deeper competencies, more skill, and more knowledge.

Perhaps the most valuable result of all
education is the ability to make
yourself do the thing you have to do,
when it ought to be done,
whether you like it or not.
Thomas Henry Huxley
Technical Education

In The Forefront?

Putting technology in the delivery system is a natural decision for the college and university. They already have some portion of the hardware that is needed. Many also have at least some of the multimedia capability to support it. Academia is equipped to take advantage of emerging technologies for the learning environment. They might get better equipped. They need to be willing to do it. Computers, interactive programs, simulations, etc. are the answers to providing a technically-oriented curriculum to prepare students for the technological explosion they are to face when they leave the university and to do it in the most effective and efficient fashion. It is the efficiency and effectiveness of technology in the delivery system that mandates it be used to keep up with the explosive growth of technology in our society.

Learning is for the future;
that is, the object of instruction
is to facilitate some form of behavior
after the instruction has been completed.
Robert F. Mager
Developing Attitude Toward Learning

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