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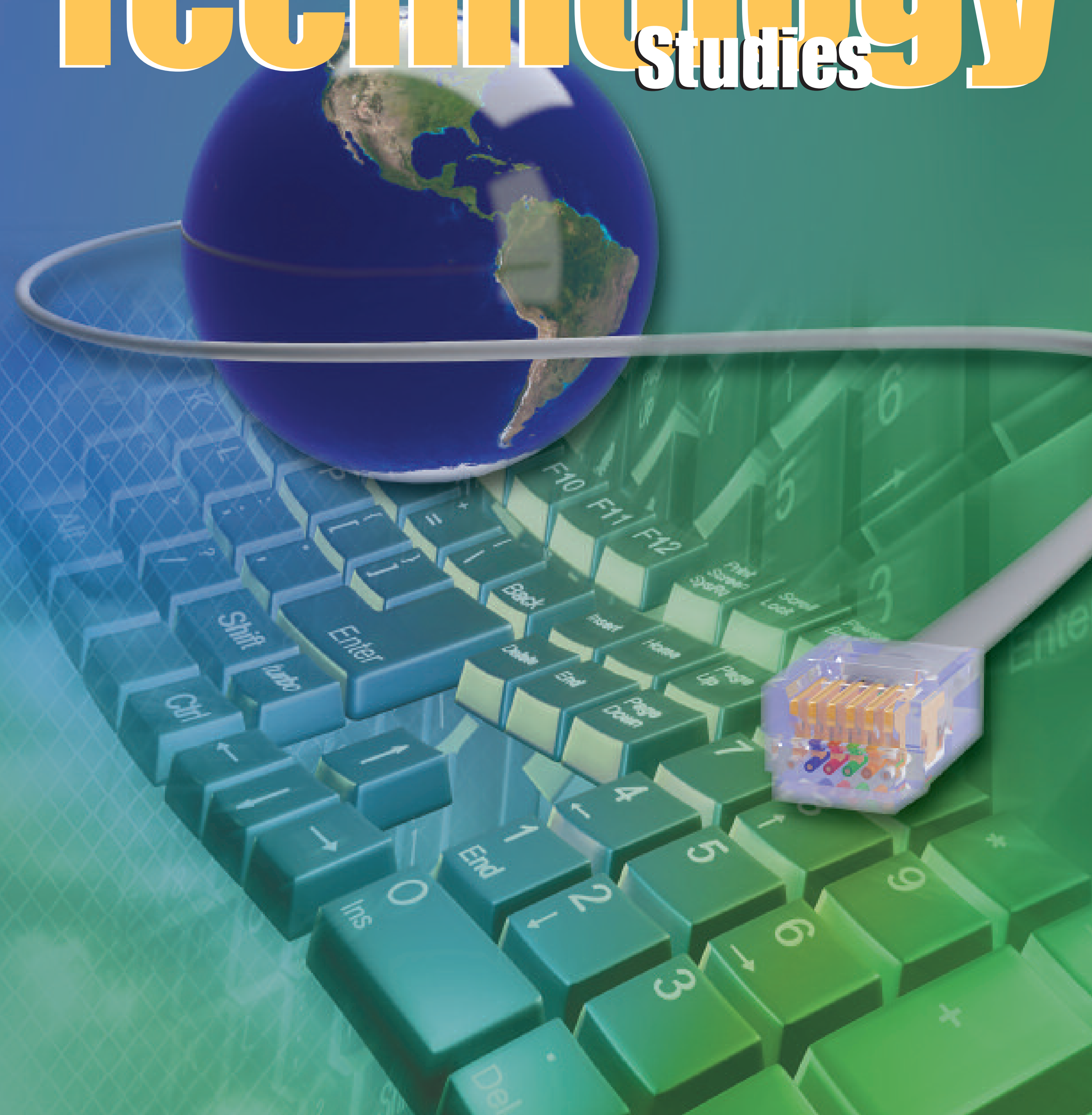

A refereed publication of Epsilon Pi Tau The International Honor Society for Professions in Technology.

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Volume XXXI, Number 1, Winter 2005

The Engineering of Technology Education

Gerhard L. Salinger

This paper is based upon a talk given at the 75th Anniversary Epsilon Pi Tau Breakfast at the ITEA Conference in Kansas City on April 5, 2005. The opinions, findings, conclusions and recommendations are Gerhard Salinger's alone and do not necessarily reflect the views of the NSF.

Engineering technology education (as distinguished from Engineering Technology education) is a design problem. In engineering, an important consideration is to determine the goal of the design. What is the desired result? For whom is it desirable? What are the unintended consequences? I continue to raise the question of what should the goal be for technology education. What are the design issues?

In the last few years I have become enamored with the monograph, *Understanding by Design*, by Grant Wiggins and Jay McTighe (Wiggins & McTighe, 2005). Their use of design is probably more synonymous with purpose. In this book the initial chapters are six facets of understanding - explanation, interpretation, application, other people's perspectives, empathy and self-knowledge. Then they describe a "backward design" process. The first question is "what is the goal?" The second question is "what is the evidence you will accept that the goal is achieved?" This does not mean how you obtain the evidence - but what success looks like. What will you know and be able to do if you reach the goal? Then, and only then, the third step is to develop the activities to reach the goal.

Wiggins and McTighe ask educators to determine the essential questions and keep them as goals. So what is an essential question for technology education? What I detect is that the goal technology education has set is that there should be a strand - a set of courses - in K-12 education called technology education taught by technology educators. We would know it happened when there was curriculum in technology education taught mainly by qualified technology educators. (Very few of the science and mathematics curricula have yet achieved similar quality control.) The standards, curricula and teacher professional development programs with all sorts of requirements may be thought of as activities.

Suppose I change the goal to be that students should be technologically literate - maybe fluent.

What would that mean? In a recent report by David Barlex, on developing what is being called Engineering Colleges in England - High School Academies, he states:

> "In England perception of engineering stretches from oily rag to mainframe. Much of the activity requires a sound understanding of science and mathematics but this is insufficient. Major engineering activity will not be successful unless those involved have an equally sound grasp of design, managing finance, appreciating local political and social conditions and meeting the requirements of sustainability and minimizing environmental impacts." (Barlex, 2005)

Thus, the study of engineering is not vocational; it is a way of thinking.

There is an international concern that students are not pursuing careers in science and engineering. (OECD, 2005) Engineers in the U.S. are concerned that enrollments have been dropping in engineering schools for some time and the number of new engineers is below that needed. How do students learn about engineering in our present system of schooling? For a long time engineers recruited among high school students proficient in mathematics and science because the engineering taught in good engineering schools was engineering science and not engineering practice. Engineering schools continue to recruit the science and mathematics proficient students. But in the last ten years industry has complained that the engineering students were smart and knew a lot of techniques, but they took too long to train to be useful in industry. They "lack design capability or creativity, lack understanding of manufacturing or quality processes, [have] a narrow view of engineering, weak communications skills, and little skill or experience in teamwork." (Prados, 2005) Engineers require strong technical capability, but also skills in communication and persuasion, ability to lead and work effectively as part of a team, an understanding of non-technical forces that profoundly affect engineering decisions, and a commitment to life-long learning.

For a variety of reasons the Accrediting Board for Engineering and Technology (ABET) changed the accrediting procedures for engineering programs. The new criteria (see Table 1) place strong emphasis on defining program objectives consistent with the mission of the institution and learning outcomes, i.e., the intellectual skills of the graduates. (Prados, 2005) A few years ago Douglas Gorham (Gorham, 2003) compared the new ABET criteria with the Standards for Technological Literacy and found that the standards matched very well to them. This may be due to the influence that a group of engineers appointed by the National Academy of Engineering to review the Standards had on them. However, a review of the fourteen ABET criteria also demonstrates that engineering is a way of thinking. From what we know about engaging women and minorities in learning, the broader goals are helpful. Women particularly respond to learning in meaningful contexts. It is still true that women are underrepresented in engineering schools, but there are reports that at earlier grades there is no gap between learning of boys and girls in technology education classes.

Table 1: ABET Criteria

The Accrediting Board for Engineering and Technology (ABET) criteria include abilities to:
• apply the knowledge of mathematics, science, and engineering; • design and conduct experiments as well as analyze and interpret data; • design a system, component, or process to meet desired needs; • function on multidisciplinary teams; • identify, formulate, and solve engineering problems; • understand professional and ethical responsibility; • communicate effectively; • understand impact of engineering solutions in global and societal contexts; • engage in life long learning; • be aware of contemporary issues; • use the techniques, skills, and modern engineering tools necessary for engineering practice; and • manage a project.

The criteria demonstrate that engineers must be broadly educated and that linking with engineering does not narrow the choices for technology education but broadens them. The liaison strengthens technology education because now it would be connected to a discipline that has stature in both the academic and business communities. Engineering provides an intellectual base for technology education. However, the base is not without cost, since one of the major differences between technology and engineering is the use of analysis - scientific and mathematical. When ninth grade science courses become too mathematical, students complain. This may cause major issues in technology courses; but it should not. The complaint may be because students have not learned the mathematics by methods so that they can apply it in new situations. Very little attention is paid to the question of what mathematics is needed in this problem. With the emphases in Career and Technical Education on increased competency in science and mathematics, the move toward engineering in technology education also provides opportunity to gain support from this community.

One of my two major responsibilities at NSF is the Advanced Technological Education Program - technician education - not training - at the two-year college level and preparation for that in the secondary schools. The goal of the program is to increase the quality and quantity of technicians for the high performance workplace. The object is to develop technicians who have adaptive expertise. Technology education should provide the base. In fact the teacher education part of the ATE program explicitly mentions the education of technology educators. In the interest of full disclosure the most direct four-year degree route for students in this program - if that is what they want to do - is to engineering technology. So a well engineered K-12 program in technology education can lead to engineering technology education as well.

The technology education profession has worked hard on the issue of the content of its discipline and on how to be educated to teach it (ITEA, 2000); but perhaps needs to think more strategically about other dimensions like where can it get support? The present situation in schools is constrained by the accountability movement. The high stakes tests seem to drive administrators and teachers to uneducational behavior, despite the results from cognitive and learning scientists as summarized in some excellent studies by committees of the National Academies (Bransford, 1999; Pellegrino, 2001; NRC, 2002, Donovan, 2005). Some of these studies agree that authentic contexts help students learn in ways so that they can transfer the knowledge to new situations. The context helps to provide a scaffold that makes the knowledge accessible when it is useful in other situations.

Technology educators can increase the opportunities for students to become more technologically literate by collaborating with teachers in other disciplines. What is to be learned in technology or engineering laboratories has been studied by engineering educators (Feisel, 2005). They too have a long list of objectives. The NRC (NRC, 2005) is studying learning in high school science laboratories. The issues are much the same. I have conjectured that although the respective goals are inquiry and design, the methodologies are very similar (Salinger, 2003).

Working with science educators is the greatest lever for increasing instruction for technological literacy in schools. Design and technology are part of the science standards (AAAS, 1993; NRC, 1996). Applications are tolerated in the mathematics standards (NCTM, 2000). The Program for International Student Assessment (PISA) measures 15 year olds' capability in reading, mathematics and science literacy by examining one of the areas in depth every three years. The examination focuses on the ability of students to apply knowledge. As you might expect, US students did not do well in the emphasis on problem solving in mathematics in 2003 (Bybee, 2005). Yet it measures an important strength. The examination for National Assessment of Educational Progress (NAEP) is being revised and the ideas of design and technology as related to science are being discussed. Thus there is a national push for understanding design.

We are seeing more and more cooperation between developers of science instructional materials and technology educators. I would mention the development of Active Chemistry and the revision of Active Physics (http://www.its-about-time.com/htmls/ap.html) as examples; the Materials World Modules (www.materialsworldmodules.org) are another example. In each, the design of something is the assessment that the content is learned and attention is paid to the issue of design (See also the theme issue of the *Journal of Industrial Teacher Education, Vol. 39*(3), 2002). I have had conversations with a leading science educator (Krajcik, 2005) who uses as the example of an inquiry question: Can I drink the water in Honey Creek? I suggested that the question could also be: What do I have to do to the water in Honey Creek so that I can drink it? He is very intrigued. The science is the same, but my question asks for action. (Notice that there are several answers depending upon the pollutant; but also one can do something to the water at hand or one can also investigate the source of the pollution.)

As the funding for the Directorate for Education and Human Resources at NSF is being redirected, we are discussing possible new directions. We are asking how science and technology education would look if there were coherent learning progressions of content and process throughout the educational experience. For the first year, we are limiting the progressions to modeling, engineering design and inquiry in the context of content emphasized in

Table 2: Goals of Engineering Laboratory Experiences

Students should be able to:
• apply appropriate instrumentation including software tools to make measurements; • identify strengths and limitations of theoretical models; • devise an experimental approach, specifying and implementing equipment and procedures to take and interpret data to characterize engineering materials, components, or systems; • analyze and interpret data; • design, build, or assemble a part, a product, or a system; • identify and learn from unsuccessful outcomes; • demonstrate levels of independent thought, creativity, and capability in solving real world problems; and • understand impact of engineering solutions in global and societal contexts; • select, modify, and operate appropriate engineering tools.

Table 3: Laboratory Goals

Students should be able to:
• identify and deal with health, safety, and environmental issues related to technological processes; • communicate effectively about the laboratory experience in writing and orally; • work effectively in teams; • behave with highest ethical standards; and • use the human senses to gather information and to make sound judgments in formulating conclusions about real-world problems.

the standards. If the goal were to have students reach a competency with the use of design by the time they leave high school, how would instruction look in grades 2, 4, 6, 8, and 10? How are teachers successfully educated - both preservice and inservice - to deliver this kind of education?

At the elementary school, the emphasis is on reading and mathematics. I recently met with a group of people who have had success in increasing the literacy of students with science materials. They had worked on the literacy, but the science was "read about." In the discussion, I brought up the possibility of using design problems. They became enormously excited, because they had already experienced success with these kinds of problems. It then occurred to me that students are frustrated if they cannot know something because they cannot read it. But think of how annoyed they are when they cannot do something because they cannot read it. Being able to do is far more motivating. The question is can we improve reading scores through technological experiences and still be true to the technology? We had rejected an earlier proposal from this group, because the doing of science had been neglected.

Another area is after school programs. Learning through the ideas of design provides a context to learn that is very different from that in schools. The same subject matter may look very different and the students learn about design at the same time. This can be simultaneously coupled to improving reading ability. In the world of informal education, there are many opportunities for technological exhibits that provide insights into engineering experiences.

The publication of the National Academy of Engineering, Technically Speaking, provides many other excellent suggestions (Pearson, 2002). I look forward to seeing the increase in emphasis on both scientific and technological literacy with science and technology educators working together.

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The Ingenuity Imperative

John W. Hansen

This paper is based on a Keynote Address given at the Texas Technology Education Professional Development Conference July 24 -27, 2005 in Corpus Christi, Texas.

When I looked carefully at the attendance list for this conference, I realized that a number of you have been at this conference every year, for the past ten years, as I have. For the last decade I have had the pleasure of working with many of you as we attempted to create a better, technologically-savvy Texan. But I think few of us really understood the future importance of our work as rapidly evolving technologies created an increasingly complex tomorrow. The future really is the result of the choices we make today. What we decide and do, today, actually matters to history and will determine the landscape for decades and centuries to come. I have something important to share with you today about the future of technology education in Texas.

Ten years doesn't seem like a long time, but let's quickly look at what has developed since 1995:

Cell phones

Wireless internet

Hybrid cars

PDAs

MP3 players

The Genome Project

Viagra

Lipitor

Stem Cell Research

Nanotechnology

Genomics, proteomics, bioinformatics

The presence of water was discovered on the moon

The presence of life on Mars

DVDs

The Hubble space telescope

Smart weaponry

The Boeing 777 was designed

Pixar created the first computer generated full length feature film "Toy Story"

Intel released the 200 MHz Pentium processor

Internet fraud and viruses

Biological imaging

Did you prepare any of your students for these changes and new technologies?

Our world has changed more in the last 100 years than in all the preceding years of humanity. We are healthier, safer, and more productive. We live in a world dominated by a single species' technology and not nature. We have longer, healthier lives, improved work and living conditions, global communications and travel, and unparalleled access to art and culture. This is true for most of us in the developed world, not just a privileged few. Of course, most of the people of the world do not benefit from these advantages and it will be the challenge of future generations to spread the positive aspects of our innovations throughout the world.

We all want to know the future; we try to predict what the world will be like.

As educators, we try to prepare students for a world that is unknown. To be frank, we provide to the students knowledge, skills, and dispositions that were valuable during our time, decades ago. I ask you, is this strategy in our best interest, to prepare kids for our past? Or should we try to envision our students' world and revise our curriculum to prepare them for this future?

What do you think the future, 2020 will look like?

Let me show you one of my favorite movie clips from the original H.G. Wells movie, The Time Machine. This scene captures the essence of what I am talking about.

Hold on to the following thought, "Which three books would you take into the future to build a new civilization?" What enduring knowledge would you carry into the future to build a new world? Is it what you are currently teaching in your class? I hope you capture the importance of what I am saying. Our world will be dramatically different in the next decade. How are we preparing the kids of today for the decisions of tomorrow?

What will the future look like? What do you think the next decade will bring? Let me share a few things we know are on the horizon.

The future will be filled with exciting breakthroughs in human physiology. Working at the cell level, diseases that we know today will be eradicated. The effects of aging can be reduced. Tissue engineering and regenerative medicine may lead to new technologies that will allow our bodies to replace injured or diseased parts without invasive surgery. Rather than the barbaric equivalent of running a sewer snake through our arteries, nanobots will clean our clogged and blocked arteries. Drugs will be customized for each individual. Embedded devices will aid in communication and monitoring our organ functions.

Nanoengineering will create and manufacture structures at the molecular, even atomic level. Environmental cleaning agents, chemical detections agents, the creation of biological organs, nano electronic systems, and ultra fast, ultra dense electrical and optical circuits will result from nanoengineering.

Our perceptions of connectedness, location, and access will change as the world becomes more connected electronically. Everything will become smart. Every product, service and system will be directed at meeting the needs of the humans it serves and will adapt its behavior to those needs.

In 2019 a $1,000 computer will have the computing capacity of the human brain. In 2029 the same computer will have the computing capacity of 1,000 human brains. In 2039 the computer will claim to be conscious and self-aware. These claims will be largely accepted.

We will struggle with those who attempt to use new chemical and biological discoveries as weapons. We will need a better understanding of the transport characteristics of biological and chemical agents.

The United States has probably the best physical infrastructure in the developed world. But these systems are degrading rapidly. Our water treatment, waste disposal, transportation, and energy systems are in serious need of replacement and redesign.

As we depend more on the information infrastructure it becomes more vulnerable to accidental, terrorist, and malicious attacks. This will impact our national economy, national security, our lifestyles, and our sense of personal security. At the same time issues of privacy and access have to be addressed.

In the next 20 years, every nation in the world will face some type of water supply problem. Currently, 2 billion people live in conditions of water scarcity. Water supplies will affect the world's economy and stability.

Ecological sustainability must be a consideration as we develop new technological solutions to the problems we create if we are to have economic prosperity. Green engineering, the design, commercialization, and use of processes and products must become mandatory if we are to mitigate the risks to human health and the environment that we have created.

What we know about science and technology today will double in 10 years. It will become increasingly difficult for us to understand the total body of knowledge of a field. The notion that a person learns everything he or she needs to know for a life-time in a four-year degree is not true. It really never was. You and your students will need to accept the responsibility for re-educating yourself.

When engineers begin sketching a design they do it not only with a foundation in the sciences, they also use the tacit knowledge gained from their experiences. Tacit knowledge is grounded in objectivity. It is the knowledge that is gained by doing, not imagining. Tacit knowledge and experience prevent us from wasting energy on fanciful ideas that violate known scientific principles. Western society values its deep scientific understandings. In fact, we judge our national prowess by the strength of our scientific discoveries and the rate at which we accumulate knowledge. We also value the discoveries of the humanities, whether by poets, painters, writers, or dancers. In fact, we consider these successes to represent the height of human endeavor. But, for a variety of reasons, we don't value the contributions of the ingenious, the innovators, nor the inventors. While their work is not in the direct pursuit of

> Civilization, as we know it today, owes it existence to the engineers. These are the men who, down the long centuries, have learned to exploit the properties of matter and the sources of power for the benefit of mankind. By an organized, rational effort to use the material world around them, engineers devised the myriad comforts and conveniences that mark the difference between our lives and those of our forefathers thousands of years ago.

The ingenious, the innovative, the inventive are driven by a deep passion to conceive new technology, to build it, and to make it work. Innovations and inventions occur when a need arises or an opportunity presents itself. Science rarely translates into technology directly. Many advances of technology occurred before we knew about the science. But this is a model that is now no longer valid. Human-made artifacts are now principally designed through rules, principles, and predictions rather than trial and error. Today we find that the work of scientists and engineers are growing closer together and are sometimes indistinguishable. The thrill of the scientific discovery and the engineered creation are intellectually challenging and satisfying.

The goal of science is to discover the laws of nature and understand its behavior. The goal of engineering is to create technology that meets the needs and wants of humanity. “Science deals with what is, comprehending nature as it exists; engineering focuses on the future. It creates new material environments, producing products, processes and systems that did not previously exist.” (Lewis, 2004)

I see three overwhelming threats to our American way of life that I believe, we as technology and pre-engineering educators can address through a single strategy: Ingenuity Education.

The first threat is related to human and technological growth. The world population is, as we know, increasing and the problems created because of this growth are complex. Energy themselves, create unanticipated problems which are often more complex than the original problems. So, we have technological growth problems and population growth problems.

Problems require human ingenuity, innovation, and inventive solutions if they are to be sustainable. There is a possibility that we may be approaching an “Ingenuity Gap.” As population and technological growth increases, new complex problems are created and there may be a point at which we will not have the inventive, innovative or ingenuity capabilities for solving them.

This is an interesting concept for us to grapple with because we’ve always believed in “Yankee Ingenuity” and how we would always solve whatever problems were encountered. Looking around the world, we already see many countries where the creative workforce capabilities are not sufficient to solve its current problems. The only solution for these countries is to import the intellectual capabilities.

The “Ingenuity Gap” theory, developed by Thomas Homer-Dixon is an alarming conceptualization and potential call to arms for education. We’ve always been able, as a nation, to develop more solutions than problems. A significant part of the American high quality of life is related to innovation and ingenuity. But, we may be approaching a point, somewhere around year 2020, when we might we are unable to solve our present problems. That is, when our present intellectual capabilities are insufficient for solving the new problems. We would have an “Ingenuity Gap.” The “Ingenuity Gap” is a critical theory that we must consider now if we are to “head off” its devastating consequences.

The second threat is a new division of labor. Many current jobs are being replaced by automated machines and low-cost labor. We teach about the effects of automation in our robotics classes. The secondary and postsecondary education system was unprepared for the rapid changes in the labor force as a result of the application of information and computer technology. Many of the jobs we are preparing students for are no longer available. If they are, they are low-paying non-family supporting jobs. Information and computer technology have dramatically impacted the way in which we work. Electronic communication technologies have allowed many jobs to be completed in distant, offshore locations. When you call a company for their 24/7 service, it is not that a single location is staffed 24 hours a day. It may be that, in different time zones around the world, there's another shift worker processing your request. I think we are ignoring the profound effects this will have on sustaining a high quality American lifestyle.

Outsourcing. What's your the number one complaint when you go through a fast-food restaurant drive-through? You get the wrong order or you're missing something! You've learned to open the bag and check to make sure you got all your fries and burgers. Did you know in St. Paul, Minnesota that a national fast food restaurant is experimenting with outsourcing the order taking process? When you drive up to the window, to the little box where you speak your order, that the person talking to you is not located in that building – he/she is in North Dakota. You give your order to the person in North Dakota who then transmits it to the food preparers in the building. Why, you might ask: in order to increase reliability and give greater customer satisfaction. It probably won't be too much longer before they find it can be done in some place cheaper than North Dakota.

I think we are experiencing a massive redistribution of labor and probably a redefining of the American way of life that we need to pay attention to. This new division of labor is going to be based on two concepts. One is rule-based, procedure-based jobs that don't require creative solutions, are easily programmed, easily outsourced and easily automated. All that is required is to follow the procedures, follow the flowchart. Notice that when you call technical support for you new appliance that they ask you a series of questions. Once they get to the end of their script, so to speak, they'll transfer you to the next level of technical support, to somebody with new script of questions. Its mass production type work with limited thinking and absolutely no creativity required.

The second division of labor will be the creativity, innovation, imagination and ingenuity-based jobs. These are high-value, economy building jobs. They are high wage jobs that support a high quality of life. The economic function of creative talent is to generate new ideas, technologies, and solutions. I think there is an impending creativity crisis that will lead to a national "Ingenuity Imperative." We really need to look at the issues before us. Creativity-based jobs include scientists, engineers, architects, designers, educators, artists, musicians, technologists, leaders, managers, business people, finance people, lawyers, healthcare professionals, communication specialists, and the entertainment sector. These are the people that use their minds to develop new solutions to current, new, and recurring problems. We should be alarmed at the shrinkage in the American creative talent pool.

The third threat – security and safety – is one which I heard from Congressman Vernon J. Ehlers, and I think it is very important for us to consider. The issue is homeland security. He stated very simply, "Those we educate today will protect us tomorrow." The military requires an increasingly sophisticated soldier. Counterterrorism will require more advanced capabilities if it is to win the war on terrorism. The destructive radical innovator/inventor must be minimized. What are we doing to foster the intellectual capabilities of our youngsters to protect their futures?

What are we to do? The American creative talent pool that feeds the high tech, high margin industries is, in fact, shrinking. New talent, if we're looking at it from that perspective, is not sufficient for the future demands. Innovation education is, tragically, not a part of the American public education system. I had the opportunity to talk with several technology educators from New Zealand who indicated New Zealand had made innovation education a part of its national economic development plan. It's a part of New Zealand's strategy for survival, sustainability, and economic growth.

Let me suggest two solutions for your consideration. First, we need better technological planning and decisions based on technological literacy. Reconsidering the "Ingenuity Gap, we may be creating more problems than we can solve and the adoption of some of the technologies that we create should be reconsidered or even halted. This requires an informed decision maker and the current education system does not provide opportunities for students to become technologically literate. The citizens of the choose to develop or use a plethora of new technologies.

Second, we should also think of creating better technology through increased ingenuity, innovations and inventions. Good decisions about technology I think are important, but it is not enough. Engineers and technologists are those prepared to imagine, design and build a better world. We and our societies change with the diffusion of technology. We don't understand what's happening and we don't even see what's happening until it actually happens. So, we need to understand the place and role of existing and new technologies in their social organizations as well as their future impacts on society as a whole.

I developed the concept Five Pillars of Technological Literacy, which I believe support sustainable technological and economic advancement. These are characteristics that I would like to see evidenced by all kids: (1) I want a kid who walks into a situation and says, "I can solve this. I'm not afraid of this technology." We refer to this as technological self-efficacy. That's the kind of kid I want working for me or preparing for my future. (2) I want kids that can say, "I've made a good decision." They have a rational decision-making process. They've actually thought about not only the process but the decisions they've made. (3) I want kids that say, "You know, I understand the issues of technology. You know, I do understand the science also, and I do understand the social impacts that are related to this." I refer to this as pre-requisite knowledge and skills. (4) I want kids that can say, "This is a good application. We chose the right technology for this problem." So, there's critical application. (5) And certainly we want kids who are able to say, "Let me rethink this. Let me make sure that the solution that I created, that I adopted or adapted or invented is the right one." They reflect on why they did what they did in order to make sure that it was a good decision, and to try and improve their own thinking processes. The Five Pillars of Technological Literacy are dispositions which are important for us to foster in our students. Technological literacy supports these characteristics.

ing. Second, one can adopt what others have done. One does a search of how others have solved the problem. This is a part of our problem-solving methodology. Third, one can adapt a solution. One looks at what others have done and says, "That doesn't quite fit; let's tweak it; let's modify it; let's be innovative; let's change it just a little bit and it will meet our needs." The fourth option is to invent a new solution. The ability to adopt, adapt, invent and evaluate technology to positively influence the community and the environment is what technological decision-making encompasses. The ability to consider these decisions options is a fundamental part of a technologically literate society.

The ingenuity component of my solution is something new. As you know, there's tremendous effort – millions and possibly billions of dollars are spent for science and mathematics education. We need new solutions and better solutions, and increased math and science capabilities are important. But, I ask you, if we have already spent millions and billions of dollars in trying to increase math and science education as a solution to this problem, why are we in a creativity crisis? Why are we in a situation where America is no longer the world's innovation powerhouse? I believe we find ourselves in this situation because mathematics and science education are directionless. Without coupling these capabilities to the creative abilities of our students we will continue to lose dominance as an innovation nation. Ignoring the ability to be innovative, ingenious and inventive is a tragic and potentially catastrophic mistake of our public education policy. Science and mathematics education is only one aspect of this sustainable economic future. Innovation, ingenuity, and inventiveness must be a part of every child's education. It is something we can contribute to as technology educators.

I think we are at a critical moment in American economic history. A tremendous amount of money is being spent once again for mathematics and science education, which is critical to the development of new technologies. The old trial and error method that we used (what I affectionately refer to as successive approximation which sounds much better than trial and error), has left us with a creativity crisis. We have no nationwide plan for K-16 innovation, ingenuity and invention education. I think we need to act now on this issue. We as informed and concerned technologists and pre-engineering educators must embrace this opportunity to build a better world.

An interesting book *The Engineer of 2020 – Visions of Engineering in the New Century*, released by the National Academy of Engineering (2004), confirms my supposition on these items. The NAE wanted to see how they could foster change in engineering education and suggested several attributes of a 2020 engineer. Look at the first three attributes they identified – (1) strong analytical skills, (2) practical ingenuity, and (3) creativity (i.e., innovation, invention, thinking outside the box and art.) How's that! Gee whiz, isn't that something that we do in our laboratories and classrooms? We teach kids how to plan, how to combine, how to adapt things to solve problems. These are the attributes the NAE thinks are important for engineers in 2020. I think these attributes are important for every citizen in the United States.

This is Technology Education's decade. This is the decade when we will make a difference in public education, and I wonder, will we seize the problem and solve it by what we know, by even using our own innovation and ingenuity? Will we, instead, protect our past, or will we do nothing? This is our decade to lead the nation to a better tomorrow. So, I ask you to join us in unleashing your own ingenuity, your own innovative and inventive capabilities as you instruct future generations for a better world.

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Speculations on the Insights and Perceptions of Professor William E. Warner Regarding the Status of Technology Education and Its Future

James J. Buffer, Jr.

> We trained hard, but it seemed every time we were beginning to form up into teams we would be reorganized. I was to learn later in life that we tend to meet any new situation by reorganizing; and what a wonderful method it can be for creating the illusion of progress while producing confusion, inefficiency, and demoralization. (Petronius Arbiter, ca 60 A.D.)

Prologue, Warner the Scholar!

I feel honored to make this presentation on the 75th anniversary of the founding of Epsilon Pi Tau (EPT). My own initiation was conducted in Chicago at Chi Chapter in 1957. There are persons in this room who knew Dr. Warner very well, including my good friend and colleague, Professor Donald G. Lux, who recommended that I give this presentation. Lux was one of Warner's doctoral advisees, a good friend and professional colleague of his at Ohio State, and is an excellent Warner advocate and analyst. Don learned his leadership skills from Warner including delegation, and that is why I am here today. Thank you Don and rest assured that I will do my best to represent Professor Warner with dignity and distinction.

As I pondered how to begin my presentation on this momentous occasion, I reflected on the historical work and scholarly contributions of Professor William E. Warner. Without a doubt, the man was an intellectual genius whose personal and professional energies were devoted to the development and cultivation of industrial arts education.

Warner's Professional Mission

Warner was a tall, distinguished looking man who was always impeccably dressed and whose demeanor attracted the attention and respect of others. I recall an incident at Ohio University when Dr. Warner walked into a meeting during another professor's presentation and the speaker stopped talking. And, all eyes seemed to be on Warner as he strolled quietly down the aisle, and after taking a seat in the front row, instructed the speaker that he could now proceed.

Clearly, Warner was a man who "walked the walk and talked the talk," so to speak. He taught by example as indicated by his involvement of graduate students when undertaking creative and scholarly projects. Many of his master and doctoral students worked collaboratively to create historically monumental documents including "A Curriculum to Reflect Technology," "Plans for the Exemplary 'Laboratories of Industries,'" and "The Three Degrees—Assumptions and Patterns," which were guidelines for the development of baccalaureate, master, and doctoral programs in industrial arts education. Nothing was left to chance with Dr. Warner.

In addition, Warner is acknowledged as *the* person who promoted the creation of the American Industrial Arts Association and Epsilon Pi Tau. Both initiatives were important to elevate the level of professional and scholarly recognition of industrial arts education as a curriculum specialty and to support the professional integrity of industrial arts educators.

To gain such acceptance, he worked diligently negotiating with the leadership of the U.S. Office of Education and the National Education Association, particularly with the president and past presidents of its Art Division. As previously said, nothing was left to chance. He was a master at "networking," and I'll address this process and its political implications as we get into the heart of this presentation.

The EPT Challenge

Jerry Striechler challenged me to "get into Warner's head" and speculate how Warner, who contributed so much to the conceptualization of technology education, would view the profession's recent accomplishments and what the future holds for it. To expand on my analysis, I solicited feedback from two groups: one comprised of associates who worked or studied with Dr. Warner and the second composed of teacher educators or leaders who were aware of Warner's work and have leadership responsibilities in technology education today including participation in ITEA, EPT, CTTE, AERA, or related organizations.

Respondents were asked to be frank and were assured that no one would be identified to ensure anonymity. My role was to provide a composite analysis and synthesis of their responses. I also reflected at length on my knowledge of Warner and built that into my analysis. As part of this process, I reviewed a historical collection of Dr. Warner's personal correspondence given to me by Mrs. Ellen Warner after her husband's death, watched a video interview of Warner conducted by Dr. David Mohan, and read numerous publications written by or about W. E. Warner including Latimer's doctoral dissertation on Warner completed at North Carolina State University in 1972 under the direction of Delmar Olson, another one of Warner's doctoral advisees.

Questionnaire—Review and Analysis

A formal questionnaire was developed to collect the data and anecdotal information from the two groups identified. Copies were distributed to respondents via mail or e-mail, and upon 100% return, their responses were then compiled to be shared with the profession. Respondents were asked to place themselves in the "mind" of Dr. William E. Warner and critically review each of the statements that relate to the current status and future of technology education. Using a scale of 1 = not satisfactory progress or status, 3 = average progress or status, and 5 = outstanding progress or status, respondents selected the value that best described their perceptions (see Table 1). Respondents could also include a written response to "qualify" or expand on their perceptions, speculating on what Dr. Warner would probably say. And yes, I realized that this task would be quite a challenge because Warner was and remains an enigma today!

Table 1: Results of Questionnaire

GROUP I: PROGRAM STATUS AND VITALITY (2.40 Near Average)	
ITEM 1. Current status of *technology education* in 2004 based on the number of active programs and student enrollment in:	
a. Middle and secondary schools.	2.35
b. Accredited teacher education programs at the baccalaureate level.	1.69
c. Master's degree programs designed to enhance professional practice and development.	2.69
d. Doctoral programs to ensure and sustain teacher education/leadership pool.	2.50
ITEM 3. Recognition of technology education as a subject area valued as part of general education for all learners.	2.23
ITEM 5. The vitality of technology education as a subject area in K–14 and its mission to enhance the general education goals and objectives for all learners.	2.54
ITEM 10. The status and prominence of international technology education K–12 programs and collegiate programs that focus on technology teacher preparation.	2.80

GROUP II: CURRICULUM AND INSTRUCTION (2.97 Average)	
ITEM 2. Curriculum, terminology, and instructional activities inherent in middle and secondary schools that have evolved from what was known as industrial arts education.	3.15
ITEM 6. Implementation of the ITEA *Standards for Technological Literacy* in the United States.	3.08
ITEM 7. The extent to which current curricula, instructional programs, and activities are reflective of technology.	2.69

GROUP III: TRANSISTIONS TO ENGINEERING TECHNOLOGY (2.87 Average)	
ITEM 8. Appropriateness of instructional practices that link engineering and information technology activities compared to past efforts that focused on problem solving and activity-based learning and skills with tools, materials, and processes.	3.31
ITEM 9. The evolution of collegiate level industrial or engineering technology and human resource development programs and resulting demise of institutions and programs that focus on technology education teacher preparation and teacher education.	2.42

GROUP IV: LEADERSHIP AND DEVELOPMENT (3.41 Average +)	
ITEM 4. Leadership activities that help to improve the status and vitality of technology education across the K–12 curriculum and Higher Education.	3.31
ITEM 11. The mission, goals, and outcomes of professional organizations Warner helped to establish (ITEA & EPT); and their influence on enhancing the status, vitality, and growth of technology education programs (K–12 and Higher Education).	3.50

GROUP V: OTHER OBSERVATIONS	
ITEM 12. Please provide comments regarding other issues, topics, or concerns that you feel Professor Warner would offer on the 75th anniversary of the founding of EPT. For example:	
a. How would Warner, who contributed so much to the conceptualization of technology education, view the profession's accomplishments? b. What would Warner have to say about what the future holds for the profession? c. How would technology education be different if William E. Warner had not existed? d. How would technology education be different if Warner and most of his opponents had worked together to improve the program and its goals?	

Note: Questionnaire used scale of 1 = not satisfactory progress or status, 3 = average progress or status, and 5 = outstanding progress or status.

To help quantify and analyze the results, I combined the 12 statements into five groups. A brief synthesis of the results for each group follows. Those seeking a more comprehensive analysis and discussion of the study along with copies of the instruments may request them by contacting the author at bufferj@vt.edu.

Group I: Program Status and Vitality

The general consensus was that Warner would *not* be pleased with the current status or vitality of technology education programs, primarily because of the dramatic reduction of programs (K–12, teacher preparation, and teacher education) over the past three decades. He might even be "confused" if he made some site visits to various technology education programs across the country. He would see programs that are familiar to him (e.g., hands-on problem solving using a variety of tools, materials, and equipment). But, he would also see many programs made up of nothing but computers and/or a few technical modules and might wonder what was going on.

Furthermore, he would not be pleased to learn that:

1. Many teacher education programs have been replaced with majors in human resource development, training & development, and management or engineering technology.
2. Master degrees are no longer required for licensure or certification and many practicing teachers are now selecting other specializations for graduate study as security for alternative career placement.
3. The number of doctoral programs in technology education has declined dramatically, and the future professorial pool has dwindled. In 2003 about a dozen doctoral graduates matriculated in technology education, and career opportunities in higher education appear to be minimal.

On the bright side, there are approximately 40 technology education programs nationwide that are accredited through ITEA/CTTE/NCATE guidelines. This is a fairly constant number and, hopefully, in the future this number will increase.

Also, given Warner's involvement in international education, he would be pleased with the international activities of technology educators across the globe as evidenced by collaborative curricular efforts in Japan, the Netherlands, Taiwan, Australia, New Zealand, England, Finland, South Korea, and Hong Kong.

Group II: Curriculum and Instruction

The ITEA standards have clearly influenced the evolution of curriculum, terminology, and instructional activities from industrial arts to technology education. Many states and localities have upgraded their content for these programs based on the *Standards for Technological Literacy*. Hopefully, the instructional programs will focus on what we do best, namely, "hands on teaching and learning" about how industrial technologies shape our human-made world. And, we need to impress upon our state and national leaders that the study of technology (not narrowly defined as computers) is essential to the health of our nation.

Associates felt that Warner might approve of the "technological problem-solving method" that has been transforming our practice in the past two decades and that he would understand the need to include new technological tools and processes. Tools have changed and are increasingly digital, which appear to be appropriate for a curriculum designed to reflect technology. However, Warner might find this explanation too simplistic. One must also consider the variety of "tools" and processes that humans use to change the form of materials to meet their consumer needs. For example, one cannot troubleshoot and replace a thermostat on a water heater or install a grab bar in a shower solely by studying computer programming.

Warner would not be concerned that the new programs are not consistent with the mission and goals he professed as part of the *Prospectus* and *Curriculum to Reflect Technology*. Rather, he would be more concerned about the assertion that the name *technology education* has little or no identity today. Furthermore, he would say that there is not much uniqueness to the field anymore to a point that almost any teacher could teach technology education without a laboratory.

Group III: Transitions to Engineering Technology

As mentioned earlier, vital signs are bad primarily because we are not producing enough teachers and we are closing too many teacher education programs. Warner would be very disappointed with the almost nationwide abandonment of teacher education in favor of industrial technology, engineering technology, or human resource programs that have been built on an industrial arts platform and that then have allowed the teacher education programs to dwindle and die.

A few respondents expressed positive outcomes coming from formal collaboration with engineering departments, especially in the delivery of preservice preparation of technology education teachers. And from my perspective, this can become a mutually beneficial outcome for both disciplines, engineering and education alike.

While Warner would embrace some of the new innovations as being important to keep up with our technological and cultural shifts in society, he would also remind us that we ought not leave behind what we have so long known and practiced about activity and activity learning, especially as one begins to link with engineering and information technology. One cannot forget his many pronouncements of teaching the value of "doers versus talkers" and his recommendation that general studies in technology education should continue to focus on our "industrial" heritage within the social-cultural context.

Results of the earlier Gallup poll sponsored by the Standards Project support the "integration" of technology with other subjects in the schools. However, one must be cautious when considering the significance of those results because respondents did *not* know what *technology education* really was. Most thought it had something to do with computer instruction or instructional technology. I am aware that the Standards Project's leadership staff has taken steps to resolve this issue as part of their recent project updates.

Group IV: Leadership and Development

The creation of EPT and ITEA was clearly a stroke of genius and was due almost solely to the work and commitment of William E. Warner. Clearly, both organizations have done much good for providing professional and scholarly recognition to technology educators and the profession.

National leaders report that EPT and ITEA have remained supportive of each other while each has moved forward with the times. Both have had to deal with globalization for example and have adapted well to this influence. For the most part, respondents felt that EPT and ITEA have stimulated and contributed to major change in our profession over the past few years. A few persons did comment that Warner's heart and soul were devoted to teacher education, and questioned EPT's decision to extend its membership and services to nonteaching "industrial technology" fields.

Our profession has created and maintained relationships with accreditation groups such as NCATE, placing our field in the position of having superior accreditation standards along with the other core subjects in our schools. The Standards' initiatives were also a great addition. However, teachers struggle knowing how to make good use of them as far as the curriculum is concerned. ITEA has responded with a written innovative, standards-based technology education curriculum. Through their Bright Ideas and ICON (Innovative Curriculum Online Network) there is a "central source for information dealing with technology and innovation about the human built and innovated world" and it is correlated to the Standards of Technological Literacy. These appear to be excellent curriculum initiatives and their adoption/adaptation by the profession will be indicators of their long-term value in restructuring the technology education curriculum. ITEA is to be congratulated for involving local and state educational agencies, teachers, and supervisors in these developmental efforts.

Warner was an activist and clearly worked in harmony with other educational and political organizations to promote the causes of technology education. As mentioned earlier, he was a master at networking and getting others to support his mission and goals. As such, he would applaud ITEA's demonstrated efforts to collaborate with other professional organizations to promote the study of technology education. However, several associates felt that Warner would have been ambivalent—praising ITEA for its work (e.g., funding successes with NSF and NASA, and consequent standards and curriculum development) but disappointed in its ability to capitalize on these successes in the local and national grassroots political arenas. Warner would probably have liked to see aggressive assistance from ITEA particularly to those local educational agencies and state technology organizations where programs are under siege.

It was also suggested that Warner would most likely have included different representatives as part of his educational and political counsel rather than math, engineering, or science. Some concerns focused on loyalty and creating political support for the continuation or vitality of technology education in K–12. For example, if a state education department recommends the elimination of technology education programs as it announces the continuation of the delivery of technology education experiences as part of science and social science classes, one must ask if there is reason to believe that NSF would intervene to prevent that from happening. And, would independent technology education programs continue to be offered as part of the common school curriculum?

Group V: Other Observations—Accomplishments & Future Expectations

First, we should feel good about our professional accomplishments and progress over the past century as a new academic subject matter has evolved over the past century with roots emerging from the study of manual training, to manual arts, to industrial arts, and now technology education. Instructional programs seemed to be focused and integral to the teaching of "industrial technological" concepts.

Warner would have been open-minded enough (and somewhat self-congratulatory) to see that much of what has been conceptualized since the publication of *A Curriculum to Reflect Technology* in 1947 has been built on the philosophical principles and foundations described in that document. Some notable examples include the curriculum development efforts at Ohio State University, University of Wisconsin—Stout, and University of Maryland in the 60s and 70s and, to some extent, the work reflected in the ITEA-sponsored *Technology for All Americans* project.

But the profession was not "unified" like math or science; and as a result, there was no single voice or agreement as to what industrial arts education or technology education should have been or was to become. Related to this issue is the fact that as a profession, we have not satisfactorily defined technology education or successfully implemented it as part of the school curriculum, thus causing much confusion and a lack of national support for the field.

As such, the profession must coalesce and strive to focus on a core set of subject titles that can be recognized by the general public such as what science has done with its subjects: biology, chemistry, physics, and life sciences. Math has been successful in its own way like science.

The other subject areas have 100 years on us. The public probably only knows us as shop or woods, metals, and drafting. Colleagues must come together to accept the challenge and opportunities to engage in curriculum development based on the 2000 content standards, and perhaps in a few years the public will be able to recognize the difference between technology education and the study of computers.

I am certain that Warner would have faith in the collective intelligence of former students and colleagues with whom he enjoyed sharing the podium in providing leadership education for the profession, especially through the two organizations he helped to create; namely, EPT and the ITEA. Particularly, he would encourage greater political intervention by technology educators to ensure the attainment of common goals. This initiative needs to reach the grassroots organizations and political policy decision makers in all states and, perhaps, it would be beneficial if the ITEA leadership spearheaded such efforts. Other professional organizations such as EPT and CTTE and the Association for Career & Technical Education (ACTE) should also be involved in these efforts. Partnerships with science, math, and engineering educators are a reality and, hopefully, this will become a mutually beneficial relationship.

Doctoral leadership programs in technology teacher education are virtually nonexistent today as evidenced by their closure, severe reductions in program and faculty, and/or changed programmatic focus. This includes most of the prominent universities that graduated the majority of doctoral recipients since World War II, including University of Maryland, University of Minnesota, University of Missouri, Texas A&M University, University of Illinois, Virginia Polytechnic and State University, University of Northern Colorado, University of West Virginia, Arizona State University, and Pennsylvania State University. Thus, Warner would strongly advocate the need for revitalization of our university graduate programs to ensure the operation of teacher education programs as well as preparing the future professorate and leadership.

And finally, leadership must be a "shared" responsibility that involves university faculty, state departments of education, classroom teachers, and supervisors. Professional associations have a responsibility to "serve" the profession and provide support to ensure the delivery and improvement of quality instruction. No one agency, organization, or entity must dominate the process if we are to be successful in managing this professional revitalization of technology education and to ensure quality instructional services to our youth and nation.

Some asked what technology education would be like today without the influence of William E. Warner. From my perspective, technology education might have evolved as a prevocational subject (and not necessarily relegated to that of a step-child of trade and vocational education) complete with federal funding and legislative support without Warner. But given Warner's insights and leadership in creating the AIAA (which later became ITEA) and EPT and an array of curricular-related initiatives, technology education has come into its own. And without a doubt, we would have enjoyed more progress if Warner and his colleagues had worked in harmony to achieve common goals.

In Retrospect

I'm delighted to have been a participant in this dialogue and celebration of the 75th anniversary of the founding of EPT. Warner was a very unique person and it was a bit difficult to get into his head, so to speak. On the plus side, he was very intelligent, professional, an educational visionary, a very successful innovator, and an outstanding leader! He was also thought to be egotistical, self-centered, overly confident, and a "master" at manipulating the power chain to achieve what he thought was important. Nevertheless, he was a "champion" for the evolution and promotion of what we now know as technology education. And as one of his former students suggested, champions are pioneers and often pioneers become popular targets, which he was and clearly his behavior often invited such responses!

One lesson we should learn from studying the professional work of William E. Warner is that the personality and leadership style of those responsible for charting the course of our profession will have a significant impact on the outcomes of any professional initiative they choose to sponsor. As we prepare for creating the technology education program for this new century, let us remind our colleagues of their moral responsibility to reach out and embrace the general membership to share in the refinement of goals and professional initiatives.

Petronius Arbiter said, "… reorganizing … could produce confusion, indifference, and demoralization." Clearly, these factors have been apparent, not only in technology education but in numbers of other disciplines. Let's not visit them as negative consequences, but as incentives and motivators to grow and prosper as Warner envisioned the field.

Finally, my expectation is that William E. Warner's final admonition would be a reminder that this has been and continues to be a *wonderful* profession! And, its future is in your hands, so go forth and be the best you can!

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Ethics for Industrial Technology

Kurt A. Rosentrater and Radha Balamuralikrishna

Abstract

This paper takes aim at one specific, as well as basic, need in teamwork and interdisciplinary projects – ethics and its implications for professional practice. A preliminary study suggests that students majoring in industrial technology degree programs may not have adequate opportunity to formally study and engage in ethical aspects of technology vis-à-vis the practices of the profession. It is reasonable to assume that the ethical dilemmas faced by an industrial technologist would parallel those of engineers and managers. To address this issue, this paper identifies a domain of knowledge that would constitute a necessary background in ethics for industrial technologists, examines various resources for teaching, and makes recommendations from a pedagogical point of view.

Keywords

Curriculum Development, Ethics, Industrial Technology, Professionalism, Societal Obligations

Introduction

The college education of engineers and technologists in the United States in key areas such as construction, manufacturing, communications, and transportation manifests itself in the form of three broad degree programs that can be identified as engineering, engineering technology, and industrial technology. Engineering degree programs have a long history in the U.S., and even though certain misconceptions regarding the profession of the engineer may still exist among the general public, it is fair to state that the profession is relatively well understood among high school students and the public at large.

All fifty states work with the NCEES (National Council of Examiners for Engineers and Surveying) in licensing and maintaining the professional competence of engineers (http://www.ncees.org). Engineering technology and industrial technology, however, belong to a newer class of degree programs that have generally eluded public knowledge (Minty, 2003). The four-year "technology" degree programs have been in popular existence for only the past 30 to 40 years, and currently the professions of "engineering technologist" and "industrial technologist" are not regulated by statutory agencies. Certain states do allow graduates holding engineering technology degrees to qualify for the title of "professional engineer" by examination. To date, however, a degree in industrial technology does not meet the educational requirements to seek licensure in engineering in any of the fifty states. It is also fair to state that the profession of "engineer" is universally understood; however, the terms "engineering technologist" and "industrial technologist" pose significant confusion for many, especially among educators based outside the United States. The fact remains that we have a large community of engineering and industrial technologists in American industry today, and that pool continues to expand on a yearly basis (www.nait.org).

Although much has been said regarding the distinctive competency of industrial technology (www.nait.org/jit/jit.html), there is overwhelming evidence that the industrial technology curriculum shares significant similarities with engineering and engineering technology programs (http://www.nait.org). Not withstanding the existing differences in status and mission of engineering, engineering technology, and industrial technology, students graduating from any of these three programs often serve at the forefront of present and future technical marvels and innovations. At the most fundamental levels, there should be a core body of knowledge that serves to unite the closely related professions of engineering, engineering technology, and industrial technology. From a societal viewpoint, the industrial technologist's responsibility towards safety and public health equals that of engineers. Due to this reason alone, a curriculum designed to prepare industrial technologists should include the teaching of ethics either as a separate course or blended into the curriculum. The rest of this paper is directed towards preparing a more substantial case for the formal inclusion of ethics in the industrial technology curriculum, and even more importantly, discusses implementation strategies for such an endeavor. The importance of ethics to these technical professions is underscored by the emphasis on ethics at the institutional, industrial, and national levels. In fact, during the last five years alone, 78 papers have been presented at the annual national ASEE conferences (http://www.asee.org) that discuss teaching ethics in the engineering and technology curricula.

Current Status of Treatment of Ethics in Industrial Technology

The discipline of industrial technology as we know it today has a relatively short history (Minty, 2003; www.epsilonpitau.org). Even so, significant contributions, both at the national and international levels, have been accomplished by affiliates of the discipline in the core areas of engineering and technology (Helsel, 2004). The National Association of Industrial Technology (NAIT) provides leadership and also provides a platform for its associates to constantly expand both the breadth and depth of the discipline. NAIT is also the official body responsible for accreditation and certification of industrial technology programs. Industrial technology courses often possess an "engineering" flair (e.g., knowledge base) with the caveat that (a) these are generally not as mathematically intensive as standard engineering courses and (b) industrial technology courses tend to be more laboratory oriented with emphasis on experiential learning Additionally, more than 25% of regular faculty members that teach in industrial technology programs today have terminal degrees in engineering (http://www.nait.org). Leaders and experts in industrial technology have acknowledged that the discipline needs to adapt and adopt from the best practices of other closely affiliated disciplines such as engineering and business in order to achieve success (Ward and Dugger, 2002). The accreditation standards for business programs established by the American Assembly of Collegiate Schools of Business (AACSB), and similar standards for engineering, established by the Accreditation Board for Engineering and Technology (ABET), have clearly specified "ethics" in the required content domain (i.e., knowledge base). Moreover, engineering ethics is one of the core areas in the Fundamentals of Engineering (FE) examination, which must be successfully completed by people seeking the status of registered or professional engineer.

Short of conducting a national survey or similar study, an effective means to gain insight into the existing status of ethics in the industrial technology curriculum is to examine the standards for both the accreditation of industrial technology programs as well as the certification exams for industrial technologists. The curricular requirements for NAIT accredited Bachelor's degree programs are summarized by its accreditation Standard # 6.3.5; specifically, Table 6.1 embedded under the said clause (www.nait.org). A study of this section reveals that ethics is not one of the required subject matter competency areas. It is true that some students may receive some background in ethics through general education courses or open electives. However, the wisdom in hoping that a student gains competency in ethics by chance or assuming that they are not going to gain professional benefits from this knowledge is highly questionable. Furthermore, the NAIT certification exam cites four key competency areas: production planning and control, safety, quality, and management and supervision. Here again, competency in ethics is not explicitly stated. It may be worthwhile noting that this national exam for certification of industrial technologists is in its infancy, having made its first appearance in 2003.

Additionally, an examination of curricular requirements across a broad range of NAIT accredited degree programs reveals that very few institutions offer coursework in ethics under the auspices of their industrial technology program (http://www.nait.org). We were unable to single out an industrial technology degree curriculum that mandates a course bearing the keyword "ethics." We realize that this observation in itself does not make a case for the lack of coverage of ethics in the curriculum. However, it may be a strong indicator of the presence of a void, which this paper seeks to address. It is quite possible that several programs assume that competency in ethics will be acquired through general education courses or open electives. We assert that if this is the case, the assumption is likely flawed and attempts should be made to correct this by ensuring that competency in ethics is spelled out as a specific requirement.

Current Needs in Treatment of Ethics

Graduates of industrial technology programs typically accept junior level management roles at the entry level or rise to this level quickly. They often provide a critical link between operating staff, senior management, and the engineering team. As hands-on professionals, they are often not only responsible but also accountable in critical operational areas such as quality approval, workplace hazards and safety standards, compliance with environmental laws, and dealing with customers. Each one of these, as well as other operational areas, could potentially pose a myriad of ethical issues. For example, in the quality approval area, the industrial technologist may have the responsibility to maintain records for continued ISO 9000 certification, approve parts that are either being sold to another vendor or end user, or she/he might be given the authority to approve incoming parts from a supplier. One can easily think of a multitude of ethical issues that relate to these responsibilities including integrity of data, integrity of process, maintaining appropriate confidentiality and privacy. The development of new products and services in the 20th century demand unprecedented levels of interdisciplinary collaboration and teamwork, and the 21st century promises to provide even greater challenges in these areas with attendant ethical issues. The switch to a simultaneous engineering mode of product development requires industrial technologists to be actively involved right from the initial concept design stage, thus posing greater involvement in product safety and environmental issues affecting both the individual workplace as well as society in general.

In a recent study (Helsel, 2004), an effective case was made for establishing a code of ethics for industrial technologists much along the lines of those codes that already exist for engineers, which have been ratified by respective professional bodies, such as NCEES, ABET, AIChE (American Institute of Chemical Engineers), ASCE (American Society of Civil Engineers), ASME (American Society of Mechanical Engineers), ASQ (American Society for Quality), and IEEE (Institute of Electrical and Electronics Engineers). In many ways, this paper complements and bolsters that argument. We agree with the delineated position, but go further to state that accreditation standards for industrial technology programs should clearly specify ethics in the content domain of knowledge and outcomes assessment. Contemporaneously, the Certified Industrial Technologist examination should reflect appropriate testing of a candidate's knowledge and skill in dealing with potential ethical issues of the profession.

Addressing the Needs

The field of industrial technology has had a long history of adapting to the needs of the profession so that it will remain relevant over time. Thus, to help fill this current need in industrial technology programs, several key elements are necessary to consider. Specifically, course content domain, teaching resources, teaching methods, and a subsequent plan of action are all necessary components to successful integration of ethics into mainstream industrial technology curricula.

Content Domain

As a discipline, industrial technology encompasses a distinct body of knowledge which is related to, but separate from, that of traditional engineering. This body of knowledge provides a framework from which to develop a course devoted to industrial technology ethics. An effective mechanism for establishing potential course content is the examination of textbooks which are currently being used. At this time, however, no ethics textbook solely dedicated to the discipline of industrial technology exists. Thus, in order to establish an appropriate content domain for ethics which is applicable to the discipline of industrial technology, an examination of tables of contents from several common engineering ethics textbooks would be useful. These are depicted in Table 1. Throughout the table it is evident that many of the topics covered in engineering ethics texts would be equally applicable to the field of industrial technology as well.

Examining Table 1, as well as delving into the substantive content domains of each of these books individually, has identified several areas of commonality that should be amalgamated and utilized in an appropriate course devoted to the ethics of industrial technology. These themes are outlined in Table 2. As this table delineates, the authors recommend essentially seven major focus areas for this type of course. The course should begin with an introduction to ethics, where the student is introduced to this area of study and why it will be essential for their professional careers. Second, the student should be exposed to the foundations of ethical theory, including a brief history of ethical thought, the major theories that are used, and tools for solving problems with moral dilemmas. Third, the student should understand that industrial technology and design are really applications of formal experimentation, and thus safety and responsibility are essential to this field. Fourth, the student should understand the concepts of risk and safety, because the field of industrial technology has many areas where uncertainty abounds, especially in the design and operations arenas. Fifth, the student should learn about the common rights and responsibilities they will have as both employees as well as professionals upon graduation. Sixth, with globalization becoming ubiquitous in the professional world, the student should be aware of the broad impacts that industrial technology can have, including international business concepts, as well as environmental consequences as a result of technological applications. Finally, the student should be aware of professional codes of ethics for other disciplines. Although the field of industrial technology does not currently have one established, there is momentum building to institute a code that formally delineates the common ethics for this profession (Helsel, 2004).

Teaching Resources

For both instructors who are interested in incorporating individual, specific educational modules into existing industrial technology coursework at appropriate locations during the semester, as well as those who may design and implement entire ethics courses devoted to industrial technology, supporting teaching materials are absolutely essential to success. Therefore, a comprehensive listing of both recent textbooks as well as current websites, many of which provide a multitude of case studies, is provided below in Tables 3 through 6. Moreover, these references are categorized according to the two disciplines that most closely intersect the field of industrial technology, namely, engineering (Tables 3 and 4) and business (Tables 5 and 6).

Teaching Methods

Although teaching the theoretical underpinnings of ethics lays essential groundwork, it should not be an end in itself for an industrial technology course. The main objective of this type of course should be to teach practical information and skills to students, so that once they are part of the work force, they will be able to elucidate and examine the moral issues of specific situations that may arise in their professional careers, and will hopefully have the ability to reach reasonable resolutions. Because of beyond the confines of their own educational settings and personal experiences, and to peer into the challenges, problems, environments, and operating conditions of the real world which, unfortunately, many students are never exposed to until after graduation. Moreover, well-defined, thorough case studies offer students insights into the strengths as well as the frailties of the human condition under the stress of the working world, which they are soon to enter themselves.

Introducing and analyzing case studies in the classroom provides opportunities to teach students how to formally and methodically examine industrial scenarios, and thus hone moral problem solving skills. By using this approach, students can practice discerning relevant facts from opinions, identifying specific moral dilemmas and disagreements, breaking down ethical issues into components, weighing risks and benefits of possible actions, choosing a course of action, justifying this action, and accepting possible repercussions from the choices made (NIEE, 2005).

A challenge for educators is to either develop or find appropriate case studies for use in their own classrooms. The aforementioned teaching resources, which include a fairly extensive listing of textbooks and websites, offer a plethora of case studies. Even though the authors have tried to be exhaustive, many more websites exist which are not listed here, and the reader is encouraged to explore the Internet for more.

Plan of Action

As already discussed, within the context of the industrial technology discipline, the essential need for ethics education is currently not being met. To adequately cover the extensive range of topics relevant to this proposal (i.e., Table 2), the authors recommend a full-semester standalone course. Understandably, not all academic programs will be able to accommodate this addition with all other programmatic requirements currently in place. Therefore, it is beneficial to examine other mechanisms for incorporating ethics instruction, either as individual topics, components, or units that can be used as into specific technical courses (Alenskis, 1997; Arnaldo, 1999; Case, 1998; Krishnamurthi, 1998; Whiting et al., 1998), examining ethical issues during technical problem solving in specific technical courses (Rabins et al., 1996), issues and topics for ethical review during capstone experiences (Pappas and Lesko, 2001; Soudek, 1996), ethics components in coursework dedicated to professionalism (Bhatt, 1993; Fulle et al., 2004), topical seminars (Alford and Ward, 1999), as well as integration throughout the entire curriculum (Marshall and Marshall, 2003; Davis, 1992; Leone and Isaacs, 2001).

Conclusions

The steady growth in the number of industrial technology programs, both at the two-year and four-year levels, during the past thirty years challenges associates of the discipline to constantly look for ways to identify gaps in the existing college curriculum and address these issues to further increase the value of its graduates, bolster their qualities and abilities, and enhance the image of the discipline. Our preliminary research indicates that industrial technology programs should immediately address the lack of a core body of knowledge in ethics specifically aimed to be of service to its students, alumni, and affiliates. Moreover, because this is such an essential area of training, future revisions of the NAIT accreditation standards should specifically include ethics as a core competency requirement, and the Certified Industrial Technologist examination should duly emphasize ethics as an area of testing.

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Table 1: Sample Tables of Contents from Several Contemporary Engineering Ethics Texts

	Textbook				
Chapter	Fleddermann[a]	Harris[b]	Martin[c]	Mitcham[d]	Schinzinger[e]
1	Introduction	Engineering Ethics: Making the Case	Scope & Aims of Ethics	Is Ethics Relative?	Profession of Engineering
2	Professionalism & Codes of Ethics	Framing the Problem	Moral Reasoning & Ethical Theories	Exploring Different Dimensions of Ethics	Moral Reasoning & Ethical Theories
3	Understanding Ethical Problems	Methods for Moral Problem Solving	Engineering as Social Experimentation	Ethical Theories	Engineering as Social Experimentation
4	Problem Solving Techniques	Organizing Principles	Responsibility for Safety	Ethics & Institutions	Commitment to Safety
5	Risk, Safety, Accidents	Responsible Engineers	Responsibility to Employers	Models of Professionalism	Workplace Responsibilities & Rights
6	Rights & Responsibilities of Engineers	Honesty, Integrity, Reliability	Rights of Engineers	Loyalty	Global Issues
7	Ethics in Research & Experimentation	Risk, Safety, Liability	Global Issues	Honesty	Sample Engineering Codes
8	Doing the Right Thing	Engineers as Employees	Engineers as Managers, Consultants, & Leaders	Responsibility	
9		Engineers & the Environment	Sample Engineering Codes	Informed Consent	
10		International Engineering		Ethical Engineering & Conflict Resolution	
11		Professionalism & Ethics		Engineering & the Environment	

Notes:

[a] Fleddermann, C. 2004. Engineering Ethics. Upper Saddle River, NJ: Pearson Education, Inc.

[b] Harris, C., M. Pritchard, and M. Rabins. 2004. Engineering Ethics: Concepts and Cases. Belmont, CA: Wadsworth Thompson Learning.

[c] Martin, M. and R. Schinzinger. 2004. Ethics in Engineering. New York, NY: McGraw-Hill.

[d] Mitchum, C. and R. Duvall. 2000. Engineering Ethics. Upper Saddle River, NJ: Prentice Hall.

[e] Schinzinger, R. and M. Martin. 2000. Introduction to Engineering Ethics. Boston, MA: McGraw Hill Higher Education.

Table 2: Essential Content Domain for an Industrial Technology Ethics Course

Introduction to Ethics	**Workplace Responsibilities and Rights**
Professional environments for industrial technologists	Employee relationships
Design processes	Employee responsibilities
Importance of morals in professional life	Ethical responsibilities • Minimalist • Reasonable care • Good works
Defining morals	Impediments to responsibilities
Defining ethics • Personal ethics • Professional ethics	Honesty
Moral dilemmas	Integrity
Why study ethics?	Reliability
Codes of ethics • What are they? • What are they used for? • What are their limitations?	Confidentiality
Corporate climates and ethics	Conflicts of interest
Ethical Theories and Moral Reasoning	Professional rights
History of ethical thought	Employee rights
Ethics of Utilitarianism	Company loyalty vs. whistle blowing
Ethics of Rights	**Global Issues**
Ethics of Duty	International business • International corporations and economics • Technology transfer • International values and practices • International rights • Human rights
Truthfulness	Environmental Ethics • Status of the environment • Stewardship vs. corporations and industry • Stewardship vs. government • Stewardship vs. society • Stewardship vs. economics and costs
Virtue	**Professional Codes of Ethics**
Customs and ethics	
Religion and ethics	
Self interest and ethics	
Professional commitments	
Methods for moral problem solving	
Design and Technology as Experimentation	
Design process as a process of experimentation	
Need for responsible experimentation	
Accountability in design	
Industrial standards for design	
Commitment to Safety	
Definitions of safety	
Risk and uncertainty in design	
Personal risk vs. public risk	
Assessing risks	
Accepting risks	
Reducing risks	
Accidents	
Risk-benefit analysis	

Table 3: Engineering and Technology Ethics Books

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Beder, S. 1998. *The New Engineer: Management and Professional Responsibility in a Changing World.* Macmillan Education.
Davis, M. 1998. *Thinking Like an Engineer: Studies in the Ethics of a Profession.* Oxford University Press.
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Gunn, A. and P. Vesiland. 2002. *Hold Paramount: The Engineer's Responsibility to Society*. Thompson Engineering.
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Unger, S. 1995. *Controlling Technology: Ethics and the Responsible Engineer.* Holt Rinehart and Winston.
Vesilind, P. and A. Gunn. 1998 *Engineering, Ethics, and the Environment*. Cambridge University Press.
Weston, A. 2002. *A Practical Companion to Ethics.* New York, NY: Oxford University Press.
Wilcox, J. and L. Theodore. 1998. *Engineering and Environmental Ethics: A Case Study Approach*. Van Nostrand Reinhold Company.

Table 4: Business Ethics Books

Adams, D. and E. Maine. 1997. *Business Ethics for the 21st Century*. McGraw Hill.
Andersen, B. 2004. *Bringing Business Ethics to Life: Achieving Corporate Social Responsibility*. ASQ Quality Press.
Axelrod, A. 2004. *My First Book of Business Ethics*. Quirk Books.
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Table 5: Engineering and Technology Ethics Websites

Case Studies in Economics and Ethics in an Early Biomedical Engineering Class – Vanderbilt University, http://www.vanth.org/docs/003_2002.pdf#search='engineering%20ethics%20case%20studies'
Case Studies in Failures and Ethics for Engineering Educators – University of Alabama, http://www.eng.uab.edu/cee/faculty/ndelatte/case%5Fstudies%5Fproject/
CEE 440: Design Seminar – University of Washington, http://courses.washington.edu/cee440/
Center for the Study of Ethics in the Professions – Illinois Institute of Technology, http://ethics.iit.edu/
Center for the Study of Ethics in Society – Western Michigan University, http://ethics.tamu.edu/
Earthquake Engineering Research Institute, http://www.eeri.org/home/programs_ethics_previous.html
Engineering Ethics – University of Virginia, http://repo-nt.tcc.virginia.edu/ethics/
Engineering Ethics Case Studies – Lake Superior State University, http://asl.lssu.edu/ethics/cases.htm
Murdough Center for Engineering Professionalism – National Institute for Engineering Ethics, http://www.niee.org
Murdough Center for Engineering Professionalism – Texas Tech University, http://www.coe.ttu.edu/ethics/ethics.htm
Philosophy 330: Engineering Ethics – Loyola Marymount University, http://myweb.lmu.edu/jkasmith/phil330.htm
The Internet for Civil Engineers, http://www.icivilengineer.com/General/Engineering_Ethics/
The National Center for Case Study Teaching in Science – State University of New York at Buffalo, http://ublib.buffalo.edu/libraries/projects/cases/ubcase.htm#physics
The Online Ethics Center for Engineering and Science, http://www.onlineethics.org/

Table 6: Business Ethics Websites

American Institute of Certified Public Accountants, http://www.aicpa.org/antifraud/spotlight/030409_cases.asp
Business Ethics – Sharon Stoerger, University of Illinois, http://www.web-miner.com/busethics.htm
Business Ethics ca – The Canadian Resource for Business Ethics, http://www.businessethics.ca
Business Ethics Case Studies – Colorado State University, http://www.e-businessethics.com
Business Ethics Center – Junior Achievement Worldwide, http://www.ja.org/ethics/case_studies.shtml
Case Studies in Business Ethics – Gruner & Jahr USA Publishing, http://www.inc.com/guides/growth/20806.html
Center for Ethics and Business – Loyola Marymount University, http://www.ethicsandbusiness.org/index3.htm
Center for Ethical Business Cultures – University of St. Thomas, Minnesota, http://www.cebcglobal.org/
Center for the Study of Ethics – Utah Valley State College, http://www.uvsc.edu/ethics/curriculum/business/
Complete Guide to Ethics Management: An Ethics Toolkit for Managers – Authenticity Consulting, LLC, http://www.mapnp.org/library/ethics/ethxgde.htm
Ethics Case Studies – Sharon Stoerger, University of Illinois, http://www.web-miner.com/ethicscases.htm
EthicsCenter.ca – Canadian Centre for Ethics and Corporate Policy, http://www.ethicscentre.ca/
Ethics Update – University of San Diego, http://ethics.acusd.edu
EthicsWeb.ca, http://www.ethicsweb.ca
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Arnaldo, S. (1999). Teaching moral reasoning skills within standard civil engineering courses. Proceedings of the 1999 American Society for Engineering Education Annual Conference & Exhibition. Session 1615.

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Evidence Related to Awareness, Adoption, and Implementation of the Standards for Technological Literacy: Content for the Study of Technology

Jill F. Russell

Over the past twenty years American education has seen many changes, and most notable have been those related to accountability and assessment. One aspect of these changes has been the movement toward more specified student learning outcomes. In discipline after discipline content standards have been developed outlining that which students should achieve as a result of their schooling. The field of technology education has been no exception. Early in the game, in the 1980's, standards for technology education programs (although not for student achievement, per se) were developed. Then in the fall of 1994, the International Technology Education Association (ITEA) initiated the Technology for All Americans Project. This project received grant support from both the National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA).

To this point the Technology for All Americans Project has included three phases. Cumulatively the following have been developed: (1) a rationale and structure for technology education (ITEA, 1996); (2) content standards elaborating what K-12 students should know and be able to do with respect to technology (ITEA, 2000); and (3) standards for technology education programs, professional development, and assessment of student achievement (ITEA, 2003). As such, these efforts over the past decade have constituted an important movement for the promotion of technological literacy both within technology education and in related circles.

Although the development of the various standards has been an important task, implementation becomes the critical next step if the standards are to ever reach fruition. The most well-conceived, quality-crafted standards do little good if they sit on the shelf unused. The purpose of this paper is to examine the evidence related to awareness, adoption, and implementation of ITEA's *Standards for Technological Literacy: Content for the Study of Technology* (ITEA, 2000). The standards will be referred to here as *STL*. The information presented is in part related to the data generated through the external evaluation of the Technology for All Americans Project. Methodology will be described briefly and findings reviewed. Conclusions as to progress will then be presented.

Background

A concern regarding the achievement of technological literacy for all Americans is that although technology education has been taught in schools for years, it has often been delivered as a single short course. In that context, there is limited opportunity for significantly influencing the technological literacy of the general public. Yet as the years have passed, technology has advanced at an exponential rate such that it now has a huge impact on life for almost every American. As a result, the citizens of the United States are somewhat handicapped by this heavy reliance upon, but lack of knowledge about, technology. Simultaneously, Trends in International Mathematics and Science Study (TIMSS) testing has revealed math and science achievement among youth in America does not compare well internationally. All of this contributes to a potentially weakened scenario in relation to maintaining the Nation's quality of life, defense, and productivity (National Academy of Sciences, 2002).

In an effort to assess, at a broad level, the American public's views about technology education, the International Technology Education Association sponsored a Gallup Poll on the topic of technological literacy (Rose and Dugger, 2002). A follow up poll was conducted in 2004 (Rose, Gallup, Dugger, and Starkweather). The results of these polls further document the importance of technological literacy. In both national samplings, three-quarters of all respondents indicated they felt it was very important "for people at all levels to develop some ability to understand and use technology." And in general, the respondents felt the study of technology should be included in the school curriculum.

Of course technology educators would agree, and many would argue further that technology education should be delivered within the context of a K-12 articulated model – whether it is taught solely by technology educators, or infused throughout the curriculum and taught by educators in many disciplines. The technological literacy standards movement has helped to create awareness of the need and prompted discussion of the issues. But large-scale implementation will be required to actually move forward in achieving technological literacy by the American populace.

Methods

This article will present data and information collected by this author, and others (see section entitled Related Evidence) regarding awareness, adoption, and implementation of the *STL*. In terms of this author's work, data collection has included both surveys and interviews/observation. At each of the ITEA annual conferences of 2003, 2004, and 2005 a survey of participants regarding their awareness of, and views about, the standards for technological literacy, was conducted. This target group included technology education teachers, elementary teachers, teacher educators, technology education supervisors, and others. In addition, a survey of technology education teacher preparation institutions was conducted specific to the topic of teacher preparation. The data generated from those surveys will be presented herein. A visit to the Boston Museum of Science included observations and an interview with the Senior Vice President for Research, Production, and Development, who provided further information.

Findings

The findings will be presented in accordance with each specific data collection initiative.

Surveys at the ITEA Annual Conference

A short survey about awareness of ITEA's standards for technological literacy was included in the registration packet for all attendees of the ITEA Annual Conference in Nashville (spring 2003) and in Albuquerque (spring 2004). The survey included a brief request for input from the Executive Director of ITEA, and the promise of inclusion in a prize drawing if the survey was completed and submitted. Two hundred and sixty-three of the 1195 conference registrants in 2003 completed and returned the survey (22% of those present at the conference), as did 125 of the total (1042) conference registrants at the 2004 conference (constituting a 12% rate of participation).

Table 1 shares the respondents' familiarity with and views about the *Standards for Technological Literacy.* Familiarity with the *STL* has grown from 57% to 86% from 2003 to 2004 for ITEA conference attendees responding to the survey. The ratings of quality have increased over that time period as well. Although positive initially, with just over one-third rating the *STL* as excellent in 2003, almost half rated the *STL* as excellent in 2004. Likewise, the expectations for *STL* to have a significant impact on technology education and K-12 education in general, both increased from 2003 to 2004 (69% expecting a significant impact on technology education, and 51% expecting a significant impact on K-12 education in general – both in 2004). Opinion was almost unanimous both years as to the perceived importance of *STL*.

As a follow up to item 5 (in Table 1) above, when asked why they felt the standards were important, the respondents provided a range of opinions, including the following representative reasons. They reported that the *STL*: provide credibility, viability, validity, and accountability; serve as a guide; offer goals; enable political momentum; provide a means for communicating with the public; give continuity and standardization for teaching; reflect and explain the best thinking of technology educators; and respond to the fact that technology is integral to life in America today.

Clearly these respondents value the technology education standards, understand and can articulate their importance, and expect the standards to impact both the field of technology education as well as K-12 education generally. As such, a conclusion that some portion of these people may make efforts to incorporate *STL* in their teaching, is likely warranted.

A similar survey was made available at the 2005 ITEA conference (highly visible, at registration area). The survey promised entry into a prize drawing for an Ipod Player. Ninety-six individuals completed and returned the survey of the 1548 conference attendees, constituting a 6.2% response rate. The 2005 survey questions varied somewhat. Those results are presented in Table 2.

Table 1: Survey Results – 2003 and 2004 Conference Respondents' Familiarity With and Views About the *STL*

Question	2003 N	2003 %	2004 N	2004 %
1) Are you familiar with the ITEA's *Standards for Technological Literacy*?				
Yes	151	57.4%	107	85.6%
Somewhat	97	36.9%	12	9.6%
No	15	5.7%	6	4.8%
2) How would you rate the quality of the *Standards for Technological Literacy*? (*Note:* "Good" was not offered as a response option in 2004)				
Excellent	90	34.2%	60	48.0%
Very Good	105	40.0%	51	40.8%
Good	42	15.9%	0	0 %
Fair	7	2.7%	6	4.8%
Poor	0	0%	1	0.8%
Don't Know	19	7.2%	6	4.8%
No Response	0	0%	1	0.8%
3) What impact would you expect the *Standards for Technological Literacy* to have on Technology Education?				
Significant Impact	162	61.6%	86	68.8%
Some Impact	91	34.6%	38	30.4%
Very Little Impact	3	1.1%	0	0%
No Impact	0	0%	0	0%
Don't Know	7	2.7%	0	0%
No Response	0	0%	1	0.8%
4) What impact would you expect the *Standards for Technological Literacy* to have on K-12 education?				
Significant Impact	117	44.5%	64	51.2%
Some Impact	126	47.9%	51	40.8%
Very Little Impact	9	3.4%	7	5.6%
No Impact	3	1.1%	0	0%
Don't Know	8	3.0%	0	0%
No Response	0	0%	3	2.4%
5) Do you think the *Standards for Technological Literacy* are important? Why?				
Yes	258	98.1%	122	97.6%
No	2	0.7%	1	0.8%
Don't Know	3	1.1%	0	0%
No Response	0	0%	2	1.6%

Table 2: 2005 ITEA Conference Survey Results

Question	N	%
1) Do you believe the *Standards for Technological Literacy: Content for the Study of Technology* (2000) are having a positive impact upon technology education?		
Great Impact	43	44.8%
Some Impact	41	42.7 %
Limited Impact	12	12.5%
2) Do you believe the *Standards for Technological Literacy* have the potential long-term to improve technological literacy among K-12 students?		
Greatly	73	76.0%
Somewhat	22	22.9%
Very Little	1	1.0%
3) Please provide your opinion as to the quality of the *Standards for Technological Literacy*:		
Excellent	38	39.6%
Very Good	48	50.0%
Fair	9	9.4%
Poor	0	0%
No Response	1	1.0%
4) Are you familiar with *Advancing Excellence in Technological Literacy: Student Assessment, Professional Development, and Program Standards* (2003), also known as *AETL*?		
Very Familiar	27	28.1%
Somewhat Familiar	54	56.3%
Not Familiar	15	15.6%
5) If you answered above that you were 'very' or 'somewhat' familiar with *AETL*, do you think these standards will assist you in preparing for standards-based student assessment, professional development, and programs in technology education?		
Yes	63	65.6%
Not Sure	19	19.8%
No	0	0%
No Response	14	14.6%

The 2005 results were very positive. Most respondents believe the content standards (*STL*) are having a positive impact and have the potential for long-term benefits for K-12 students' technological literacy. Almost ninety percent (89.6% of the 96 respondents) feel the *STL* quality is either excellent or very good. Eighty-four percent say they are somewhat or very familiar with the *AETL*, and approximately two-thirds feel the *AETL* will be useful in assisting them in preparing for standards-based student assessment, professional development, and programs.

Survey of Teacher Preparation Programs

In the spring of 2003 a survey was conducted of teacher preparation organizations. The mailing list was based upon the ITEA's institutional membership category. Fifty-one out of the total list of fifty-nine institutional members represented teacher preparation organizations in the United States. The invitation to participate in the survey was extended by the Executive Director of ITEA to those fifty-one organizations. The primary purpose of the survey was to ascertain the extent to which the teacher preparation organizations were making changes in their programs to reflect the *Standards for Technological Literacy*. Fifteen responses were received, constituting a 29% response rate. Fourteen of the fifteen respondents (93.3%) reported accreditation by the National Council for Accreditation of Teacher Education (NCATE).

Although the data will be presented in the aggregate, the fifteen responding institutions are named here to demonstrate their representativeness: Appalachian State University, Ball State University, Illinois State University, Indiana State University, Mankato State University, Millersville University, North Carolina State University, Ohio State University, Old Dominion University, St. Cloud State University, Southern Utah University, University of Idaho, University of Maryland Eastern Shore, Utah State University, and Valley City State University.

Table 3 describes the participating teacher preparation programs in terms of size. The average number of students enrolled by these institutions was fifty-two students, with an average of eleven expected to graduate that year.

Table 4 presents information on the extent to which these programs have addressed *STL*. It is evident these respondents have gone to great lengths to address *STL* in their programs. Almost all of the respondents indicated they agree that: their program explicitly addresses *STL*, students are required to have a copy of the *STL*, students are required to prepare *STL*-based lesson plans, graduates use *STL* in their teaching, and their faculty are familiar with *STL* and participate in outside-the-department work related to *STL*. The majority of the respondents offer a course specific to *STL*.

Table 5 describes how these teacher preparation programs assure graduates' knowledge and competency with respect to the *STL*. These programs indicated the students study and practice with the *STL* through various courses and field-work experiences, that program changes have been introduced specific to the *STL*, that there are *STL* benchmarks incorporated within the program, and that posters and portfolios reflect the *STL*.

These respondents have updated their programs, student assignments, and expectations to align with *STL*. This has been accomplished in a myriad of ways that could be helpful to others at the point of beginning the alignment process.

Although only 15 responses were received to this survey, these respondents are all very involved with *STL* and the professional development standards. This is likely influenced by the

Table 3: Program Demographics

Question	Range	Mean	Median	Standard Deviation
1) How many technology education undergraduate majors are enrolled in your program?				
	15-200	52.4	40	42.94
2) How many graduates in technology education do you expect for 2002-2003?				
	2-45	11.4	8.5	10.27

Table 4: The Extent to Which the Programs Have Addressed the *STL*

To what extent do the following statements characterize your technology education teacher preparation program?

Statement	N	%
1) The *Standards for Technological Literacy: Content for the Study of Technology (STL)* are addressed explicitly within our program.		
Strongly Agree	10	66.7%
Agree	5	33.3%
Disagree	0	0%
Strongly Disagree	0	0%
2) Our teacher preparation students are required to have a copy of the *STL* for their coursework.		
Strongly Agree	8	53.3%
Agree	6	40.0%
Disagree	1	6.7%
Strongly Disagree	0	0%
3) Our teacher preparation students are required to prepare a lesson plan this is *STL*-based.		
Strongly Agree	8	53.3 %
Agree	7	46.7%
Disagree	0	0%
Strongly Disagree	0	0%
4) Our faculty are very familiar with the *STL*.		
Strongly Agree	9	60.0%
Agree	6	40.0%
Disagree	0	0%
Strongly Disagree	0	0%
5) We have a course that concentrates primarily on the *STL*.		
Strongly Agree	4	26.7%
Agree	5	33.3%
Disagree	6	40.0%
Strongly Disagree	0	0%
6) Our faculty work with state department or local technology education supervisors or teachers in k-12 schools to support implementation of the *STL*.		
Strongly Agree	7	46.7%
Agree	7	46.7%
Disagree	1	6.7%
Strongly Disagree	0	0%

Statement	N	%
7) Our faculty present on the *STL* outside of department course offerings (e.g. at in-services for a school/district, or at state/regional conferences).		
Strongly Agree	6	40.0%
Agree	6	40.0%
Disagree	3	20.0%
Strongly Disagree	0	0%
8) Our TECA student group has engaged in *STL*-based activities (the statistics for item 8 represent the 12 out of 15 respondents with a TECA organization):		
Strongly Agree	4	33.3%
Agree	7	58.3%
Disagree	1	8.3%
Strongly Disagree	0	0%
9) We would find a user's guide for the *STL* very helpful.		
Strongly Agree	4	26.6%
Agree	8	53.3%
Disagree	26	13.3%
Strongly Disagree	0	0%
No Response	1	6.6%
10) Our graduates make use of the *STL* as the foundation for their teaching.		
Strongly Agree	4	26.7%
Agree	10	66.7%
Disagree	1	6.7%
Strongly Disagree	0	0%
11) Our faculty have identified and implemented expected outcomes specific to the *STL* for teacher preparation students.		
Strongly Agree	5	33.3%
Agree	9	60.0%
Disagree	1	6.7%
Strongly Disagree	0	0%

Table 5: Means of Assuring Graduates' Knowledge and Competency

Examples Provided

1) Students study, evaluate and practice *STL* through all methods, subject areas, and educational coursework
2) Revisions were made to the undergraduate program – changing and/or designing new courses
3) Benchmarks are included in all courses
4) Students are required to prepare lesson plans that include an assessment of those standards being addressed
5) *STL* are addressed through field based and student teaching experiences
6) A poster of the *STL* and state content standards is posted in all classrooms
7) Students are required to complete a portfolio that relates to the standards. They also present a standard in class
8) *STL* are integrated with learning outcomes

Note: Original question was stated as follows – How does your program assure graduates' knowledge and competency with respect to the Standards for Technological Literacy?

fact that 14 of the 15 respondents indicate they have NCATE accreditation, and that NCATE-approved institutions are already in the mode of curricular alignment with various important criteria, such as the *STL*. In addition, the NCATE criteria for technology education programs were developed based on ITEA input. In that sense, it may have been easier for these programs to respond to the questions posed in the survey because they had already taken these steps.

Boston Museum of Science Activity

Another indicator of the impact of the *STL* is evidenced by the activity underway at the Boston Museum of Science. Following are the conclusions from a visit to the Boston Museum of Science where the Senior Vice President for Research, Production, and Development was interviewed (L. Bell, personal communication, March 6, 2004), and a personal tour was offered to the author.

The Boston Museum of Science has been moving from an almost exclusive science focus to a broader science and technology emphasis over the past several years. The museum hopes to serve as a "lighthouse" organization in leading the way within the museum world to technological literacy. They have used the *STL* as an organizing mechanism in their work.

The activities in which they have engaged are ambitious. They include the following (Boston Museum of Science web-site (2005)):

A Star Wars Exhibit is being developed (with help from Lucasfilm Ltd.) which will implicitly address a number of *STL* standards and benchmarks. This exhibit will be constructivist in its approach. It will open first in Boston and will subsequently become a traveling exhibit across the country. Web resources will be available for teachers to use before and after a visit to the exhibit classes.

The museum has established the National Center for Technological Literacy. Its purpose is to: create educational products that promote technological literacy, conduct research about teaching and learning related to technological literacy, and reach out to other organizations to share useful information regarding technological literacy. The Center has multiple means through which it works: (1) advocacy and standard development, (2) curricular materials, (3) an educational resource center, and (4) professional development.

Funding has been awarded to the Museum to develop middle level and high school technology/engineering courses. Teachers are being used in the development process.

The Boston Museum of Science has been "high-profile" in its adoption of the *STL*. The staff have reported on their activities to museum professionals, school professionals, and presented to national audiences. In addition, they have published accounts of their work and progress.

Related Research

Related research has been conducted on awareness, adoption, and implementation of the standards.

In October 2002 Phillip Cardon reported on the "Acceptance of National Standards for Technological Literacy by Technology Teacher Educators" at the Mississippi Valley Technology Teacher Education Conference (Cardon, 2002). Cardon had surveyed 102 institutions offering technology education programs, and received a 51% response rate. His research questions focused on the extent to which the *STL* would provide direction and drive reforms in technology teacher education, and whether or not teacher educators were ready to adopt the new standards.

The survey results shared indicated that at that time almost 30% of the programs had already implemented the *STL* and another 62% were in the process of doing so. The reasons cited for implementing the *STL* included: for program improvement, to address a state mandate to use the standards, to be more competitive, and because the standards were perceived as being "the guiding force" and the "most current approach."

A survey conducted by Daugherty of individual faculty in technology education teacher preparation programs was sent in the fall of 2003 to 123 faculty listed in the *Industrial Teacher Education Directory* (Bell, 2002). A 55% response rate was achieved. The survey was designed to assess: (1) the degree to which technology teacher educators support the *STL* and the corollary professional development standards from *Advancing Excellence in Technological Literacy* (ITEA, 2003), and (2) the extent to which substantial curricular and pedagogical change is viewed as being needed.

Daugherty (2003) found much support for the standards being taught in teacher preparation programs. When the standards were stated, and respondents were asked to rate the agreement with technology teacher education programs preparing individuals to teach those items, all items except two (out of 22) received a mean rating between 4 (agree) and 5 (strongly agree). The highest rated items were: "core concepts of technology," "attributes of the design process," "role of experimentation in problem-solving," and "effects of technology on the environment." The two lowest rated items, receiving a rating between 3 (undecided) and 4 (agree), were "core concepts of medical technologies," and "core concepts of agriculture and biotechnologies." In terms of the perceived need for change, over 62% of the respondents indicated that "major change was called for in the field." Many of those indicating major change was not needed, felt that such change had already occurred.

Survey on the Status of Technology Education in the U.S.

In the spring and summer of 2004 the Technology for All Americans Project staff conducted a survey of the states as to the status of technology education, including use of the *STL*. They contacted the state technology supervisor or their alternates to collect their data. Following are the results regarding *STL* usage (Meade and Dugger, 2004): Forty of the fifty states (80%) reported that the *STL* is used at the state, district, or local level within their state; 14% said that it is not used; four percent said they did not know; and two percent did not respond to the item. In addition, Meade and Dugger reported that more than half of the states indicated they "have either based their own standards and curricular materials on the *STL* or aligned their standards and curricular frameworks with the *STL*."

West Ed/Edward (Ted) Britton Research

A new publication, *Bringing Technology Education into K-8 Classrooms: A Guide to Curricular Resources About the Designed World* (Britton et. al, 2005), shares the results of an NSF-funded project that conducted a comprehensive and rigorous review of curricular materials published since the year 2000. The review specifically examined the extent to which the *STL* were incorporated into major technology textbooks and other curriculum resources. The primary intent of the project was to help teachers in the selection process, but it also provides input as to the influence of the *STL*.

Findings indicate that although there is variation among the new textbooks released since the publication of the *STL*, the books generally do address the standards and benchmarks. Britton notes that some books address certain areas better than others, and that ideally a teacher would have access to several textbooks, so that he/she could make use of the best information and activities from each.

Doctoral Dissertation in Florida

A doctoral dissertation entitled "District-level Predictors of Implementation of the Standards for Technological Literacy in Florida" reported that the extent to which *STL* had been implemented in 60 school districts in Florida was related primarily, among a number of variables, to district enrollment (Loveland, 2003). That is, larger districts were more likely to have adopted *STL*.

Sales of STL

At the point of preparation of this document, almost 15,000 copies of the *STL* have been sold (August, 2005). This figure is above and beyond the distribution of copies as a part of the Technology for All Americans Project dissemination efforts. Although purchase of the *STL* does not guarantee adoption or implementation, it is a prerequisite step.

Standards Specialists

As a part of the Technology for All Americans Project, six technology educators were identified as standards specialists who would be available to districts, states, and professional organizations to provide presentations and workshops on the *STL*. This offering has been in place several years now, and over that time period approximately 85 presentations/workshops have been delivered to almost 3,500 participants. The standards specialists have also authored various articles and supplementary materials in support of the *STL*.

Translation to Other Languages

Since the 2000 publication date, the *STL* has been translated and published in Chinese, German, Finnish, and Japanese (for further information on the international translations, contact William Dugger, Jr. via email: wdugger@iteaconnect.org). It is serving both an international and national role in promoting the use of standards for technological literacy.

Supplementary Materials

Through ITEA's Center to Advance the Teaching of Technology and Science (CATTS) multiple documents have been prepared which serve as supplements to the *STL*. These include curricular materials for various grade levels and specific courses, program guides, and resources to help implement the standards. In addition, there are numerous curriculum development and assessment efforts underway at institutions across the country with funding from such sources as the National Academy of Engineering and the National Science Foundation.

Conclusions

Cumulatively, the data from these various sources support the conclusion there has been extensive activity related to the promotion of awareness, adoption, and implementation of the *STL* since its publication in 2000. Broad awareness of the *STL* among technology educators is fairly certain. Many value the *STL* and believe in its importance; they have purchased materials and participated in professional development. Adoption is claimed in a number of cases in that many states, districts, and teacher preparation institutions have made the choice to align with the *STL*. *STL* is being incorporated in textbooks and curricular materials. Organizations outside the traditional K-16 world have chosen to align their efforts with the *STL*. Internationally there is evidence of interest in the standards. Researchers are looking at the use of the *STL* in teacher preparation, in textbooks, and in school districts. True implementation is an activity that happens primarily behind closed classroom doors, and hence can be less amenable to measurement. But progress in the desired direction is underway.

Any single piece of evidence that has been presented here would likely be insufficient to answer the question of extent of adoption of *STL*. However, in combination, the data are supportive of change taking place. As the choice is made in more and more states, districts, schools, and individual classrooms to orient curriculum and instruction towards the *STL*, the impact on student knowledge and competency will become increasingly evident. This will require, though, continued work in the areas of teacher preparation, professional development, and assessment.

Change in education in America, due to its highly localized nature, can be slow, yet the goal of technological literacy for all Americans appears to be gaining in momentum. Although it may take some time to detect variation in the pattern of responses on a Gallup Poll of the overall adult population (and even so, it could not be attributed exclusively to the *STL*), enhanced K-12 student achievement will likely be demonstrated more quickly. This standards-based reform effort gives clear evidence of progress.

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The Gary Plan and Technology Education: What Might Have Been?

Kenneth S. Volk

This story actually started about 100 years ago and continues today. The cast of characters remains essentially the same, with corporate interests, government, educationalists, parents, and students being involved in ideological debate about education reform. Hope, fear, coercion, intimidation, and promises of a panacea all play supporting roles—with challenges to the status quo and the questioning of tradition remaining common threads throughout this tale.

The Gary plan of "work-study-play" was the brainchild of William Wirt (1874-1938), though largely influenced by the philosophy of John Dewey (1859-1952). Introduced in 1907 to the schools of Gary, Indiana, by Superintendent of Schools Wirt, the Gary plan had organizational and curriculum features that fostered hands-on activities relating to occupations and daily life. It was considered progressive in nature, with an articulated and broad program being offered from primary through secondary grades. The increased notoriety of the plan's social and financial benefits led New York City to invite Wirt as a consultant to transform its overstretched schools. What followed were several acrimonious years of position papers, posturing, and propaganda by all sides, culminating in a swift end to the plan. The demise of the Gary plan in New York and then slowly in other locales throughout the nation that introduced it raises questions as to what might have been, especially as it accentuated manual arts and training, forerunners to today's technology education programs.

This article first presents the issues, actors, and events surrounding the Gary plan and associated reform efforts in New York City. The inclusion of manual arts and vocational education as a fundamental feature of the plan also described. On a macro level, the politics of American education is examined as to how other reform efforts have been influenced by various factions. Finally, efforts to improve and change technology education through the recent *Standards for Technological Literacy* (International Technology Education Association [ITEA], 2000) are examined as to their potential for success, based on the outcomes and lessons learned from the past.

New York City at the turn of the 20th century was a growing and dynamic place, full of economic and industrial energy, as well as an influx of new immigrants. According to Bonner (1978), during the first decade, over 70% of the students were classified as foreign-born, with Russian Jews, Germans, and Italians comprising two thirds of the school population. The total school population was also increasing around 5% each year, placing great pressure on the city to complete new schools. Despite being considered "one of the marvels of the world of education" (S. Cohen, 1968, p. 96), the schools were not without problems.

Dominated by Tammany Hall, the political machine of the Democratic Party, the city was noted for corruption and poor management. As the Fusion candidate, John Purroy Mitchel was elected mayor in 1913 and brought a "progressive passion for business-like efficiency" (Mohl, 1972, p. 41) to city government. Mitchel was also sympathetic to reform and progressive efforts in education, which soon became the focus of his administration.

Before Mitchel's election as mayor, Alice Barrows (later Fernandez) was heading up the *Vocational Guidance Survey* under the Public Education Association (PEA) of New York City. As a private organization promoting progressive educational reform, PEA often advised the Board of Education on matters (S. Cohen, 1964). Barrows studied under Dewey at Columbia University and like Wirt, was greatly influenced by Dewey's philosophy. One outcome of her review of occupations and the vocational training being offered in schools was the recommendation that all children between the ages of 14 and 16 should receive broad experiences in pre-vocational (industrial) education, so as to meet the "practical demands of industry, be consistent with democratic ideals, and be financially practical for New York City" (Barrows, 1914, p. 230). Barrows also recommended "to make an experiment" for pre-vocational training in elementary schools; and being familiar with innovative approaches used elsewhere, suggested that "it would be most profitable and practical if it were carried out along the lines developed in Gary, Indiana" (p. 230).

William Wirt's "Gary plan" was receiving national attention. Founded in 1906 by Elbert H. Gary, the chairman of United States Steel, the new industrial city of Gary, Indiana, hired Wirt as superintendent, where he quickly developed his innovative school system. Also known as the "work-study-play" or "platoon" system, the Gary plan divided school populations into two groups, so that while one group was receiving the three Rs by specialized teachers, the other studied in specifically equipped facilities such as art, gym, and shop (Rich, 1992). Wirt's program also adopted Dewey's idea of a community within the school, so that in an ideal situation, both elementary and secondary students would be housed in the same school in order to learn from each other. According to Wirt (1937/1995), "the school is a playground, garden, work shop, social center, library, and traditional school combined in one plant and under the same management" (p. 23).

Wirt was also a firm believer in manual arts and training, with industrial school shops situated in each school, but often with the added purpose of allowing students to actually build and repair items for the school. In this way, students would participate "in a real industrial business in an environment similar to the old-time industrial home and community" (Wirt, 1937/1995, p. 32). Students in upper grades would be expected in woodworking shops to perhaps build desks, chairs, bookcases, and cabinets. In the printshops, students would handle all the school's printing needs. Painting, electrical, and plumbing needs were also done by students, but under the supervision of teacher-artisans (R. Cohen & Mohl, 1979). As for girls in the program, they were generally not permitted to do work that was beyond their strength or ability, "but with these limitations assumed, a girl may learn cabinet making, printing, electric wiring and other processes" (Dorr, 1915).

The Gary plan also included the absorption of industrial education into the regular school curriculum, which included elementary school-aged children. With the shops to be distributed throughout the building, it gave children an opportunity to become familiar with them by seeing older children at work. As Rheta Childe Dorr (1915), a social reformer, described in euphoric terms, "curiosity is soon aroused, and it is common to see the little ones with their noses flattened against the glass, peering intently at a carpentry or printing class at work." Children would also be allowed into the shops at regularly scheduled times to help the older students. As Dorr continued, "the dread rule of silence has no part in the Gary system. The little boy asks a thousand questions of the older worker . . . thus helping himself to learn."

Reflecting Dewey's "learning by doing" philosophy, Alice Barrows (1915) explained that activities for an elementary grade student might be to help "the seventh grade boys in the foundry moulding the sand for the casting, learning the names of the tools and taking in with all of his eyes how the castings are made." In an integrated and democratic manner, the upper grade students would also help in the education of the younger students. Table 1 shows a typical fourth grade student's day according to Barrows.

Table 1: Fourth Grade Student Schedule Under Gary Plan

Time	Activity
8:15-9:15	Reading, Writing, Arithmetic. A formal study and recitation period in a regular classroom.
9:15-10:15	Shop work (for three months, followed by drawing, science).
10:15-11:15	History and Geography. Another formal recitation period.
11:15-12:15	Lunch—cooked and served by girls in the cooking class.
12:15-1:15	Reading, Writing, Arithmetic. Another formal study and recitation.
1:15-2:15	Reading, Writing, Arithmetic—Or may substitute for the first three months, music, second three months mechanical drawing, etc.
2:15-3:15	Play—most of this hour is given to free play, although suggested and guided by a playground teacher.
3:15-4:15	Auditorium—fifteen minutes of singing, led by the singing teacher. "The rest of the time children from different classes give in dynamic form some of the things they have been learning in their classrooms." For example, students in the foundry class can tell fourth grade students about a casting or about the different parts of an automobile by the machine classes.

With advocates like Mitchel, Barrows, and Dorr supporting Wirt's program, the plan was introduced in 1914 into two elementary public schools (P.S.)—P.S. 89 in Brooklyn and P.S. 45 in the Bronx—as a test before it was to be expanded. To convert the schools, they first needed to be extended with five-floor additions expected to cost approximately $150,000 ("Fitting School," 1915). Provision was to be made for a foundry in the basement with a cupola. An office for the instructor was also to be included, "in which can be maintained experimental models, drawings, etc." Tool rooms and a room for clay modeling were to be placed adjacent to the foundry. With about 4,000 square feet of additional space, it was to be subdivided into other shops such as woodworking, mechanical drawing, and electricity. The remaining floors were to be used for the homemaking model apartment, science labs, and additional classrooms.

For Mayor Mitchel and his Fusion party's progressive enthusiasm for efficiency, the plan was viewed as having enormous economic benefits, as it could reduce the physical overcrowding of schools and demand for new buildings. This was important, given the serious budget problems the city was facing. For social progressives like Barrows and Dorr, the plan provided a natural environment in which children learned by doing. "Barrows and her friends recognized the technological efficiency of the new school plan, but for them the more efficient school had broader and more humanistic purposes—more freedom, more opportunity, more educational enrichment." "Technology, in other words, was accepted as a given, but it was to be used for humanistic, rather than impersonal business ends" (R. Cohen & Mohl, 1979, p. 64).

However, as this story was unfolding, there were other individuals and groups that were about to voice their opinions about the Gary plan. With the plan gaining momentum to expand to other schools, the strength and resolve of the opposition's opinions and actions also increased. Bonner (1978) described the situation at the time: "For critics, the Gary plan was an issue; for advocates, the Gary plan was a cause. While the former took illogical and even misleading positions in the Gary debates, the latter occupied a high-minded and hamstrung political stance" (p. 154).

One leader of the rising criticism was William Ettinger, the associate superintendent of schools. He initially viewed the plan with enthusiasm after an early fact-finding trip to Gary, Indiana, with the newly elected mayor, but he soon became disillusioned with it as he felt the curriculum changes and costs for equipment were too great (R. Cohen & Mohl, 1979). His "Ettinger plan" for manual and vocational education would have one group of secondary students in school for a week, while the other students would be assigned, in pairs, to real work experiences in a business. At that site, they would receive limited training by the company, vocational counseling, and even a small salary. His plan was also being introduced to several schools and was seen as an alternative (competitor) to the Gary plan for secondary school students. Ettinger was also skeptical of the relative value and limited vocational experiences elementary school students would actually receive.

The Board of Education was also an important player in this debate. Thomas Churchill received his appointment as president of the board from the past mayor in 1913, and like Ettinger, became disillusioned with the plan, but for different reasons (Bonner, 1978). Churchill wanted the board to have more power and not to have superintendents implement policy. However, most progressives wanted "experts" running the schools. As an economic progressive, Mayor Mitchel proposed reducing the number of board members from 46 to 7 for greater oversight and efficiency; but when this initially failed due to the state not backing it, he resorted to other means to secure his agenda. What Mitchel did was to have the Board of Estimate that controlled all public funds deny any increased funding for schools in 1916, thus making the Gary plan the only other logical alternative to the expected overcrowded conditions. Hostility between Churchill and Mitchel then escalated, with Churchill believing the plan was not adequately evaluated and that his board would lose authority and control. Eventually, Mayor Mitchel prevailed, with a smaller board bill passing in the state legislature and a new Mitchel-supporter, William Wilcox, elected as board president in 1916.

Teachers also had their own professional and personal opinion of the plan. For example, the New York City Teacher's Association urged a "go-slow" attitude on implementation, as they were not convinced of the benefits (Bonner, 1978, p. 177). For more selfish reasons, teachers generally objected to the one more hour of work the plan required each day, even though the additional hour was to be used for lesson preparation, not teaching. Principals were also generally not in favor of the plan. While Alice Ritter and Angelo Patri, principals of "Garyized" P.S. 89 and P.S. 45, respectively, would often speak at school parent-teacher meetings about the positive aspects of the plan, there regularly would also be in attendance principals such as William Grady, an Ettinger school supporter, presenting views for the opposition (Metcalfe, 1915a).

Even respected educators such as David Snedden and John Dewey lent their names to the plan. According to Snedden ("Tell of Value," 1917), the two hours a day shop experiences for boys and girls under the age of 11 was "not to make him an expert in any vocation." The plan's "industrial arts . . . afforded the children the opportunity to do things with their hands and by applying their minds to their work meant a growth in experience." Dewey also described the plan in positive terms, even praising the Gary plan in his 1915 book *Schools of To-morrow* (Dewey & Dewey, 1962), despite the fact that he never visited Gary, Indiana. As a professor at Columbia University, he also was a supporter of the plan in New York City. Responding to concerns about the lack of evaluation before it was to be expanded to more schools, Dewey stated, "In my opinion, the work-study-play plan as developed by Mr. Wirt does not need any further evaluation before it is extended to other schools in the city. On the contrary, I am already convinced that its value is established" ("Professor Dewey of Columbia," 1915).

Stoking the fires of this public debate was the members of the press, who made the controversy over the plan daily reading matter. The progressive intellectual Randloph S. Bourne wrote a series of pieces for *The New Republic*, later compiled into a book entitled The Gary Schools (Bourne, 1916). Newspapers would also regularly take positions in the debate. For example, Rheta Childe Dorr would have a daily school page promoting the plan in the *New York Daily Mail*, no doubt due to the new owner of the *Mail* being from Indiana and publishing stories solidly in favor of the plan (i.e., "Visiting Clubwomen Impressed" 1916). *The New York Times* was also publishing stories touting the Gary plan (i.e., "The New School Plans," 1916; Wm. G. Willcox Urges," 1915). Perhaps most influential was the voice of Alice Barrows, now hired as William Wirt's personal secretary. As secretary, she skillfully presented Wirt's agenda and her own progressive philosophy in meetings and to the press. Her twice-weekly *New York Tribune* articles promoting the Gary plan assured *Tribune* readers in the banner header that they "will find in this department a clear and authoritative account of the Wirt school system" (i.e., Barrows, 1915).

On the opposition's side, certainly no individual was more influential than Tristam Walker Metcalfe, who had a daily education column in the *New York Globe*. His earlier public backing of Churchill to head the Board of Education, attacks on the Board of Estimate for its stinginess, and rebuttals to any statement made in defense of the plan were unending. Examples of his position can be seen in the headlines: "Emphasis Put Upon Saving in Buildings and Teachers" (Metcalfe, 1915b), "Less Play Space and Much Less Shop Equipment Provided" (Metcalfe, 1915c), and "Estimate Board is Forcing Adoption of Gary School Plan" (Metcalfe, 1916b).

Trade unions were also against the plan. Some saw it a being a plan devised by Elbert H. Gary or John D. Rockefeller. Regarding the U.S. Steel connection, the city of Gary, Indiana, was specifically built to house the workers, with the schools built on donated land, and the superintendent's work supported by officers of the company. It was thus not surprising unions felt "the entire system was designed to train the children of steel workers to be efficient cogs in the industrial machine" (Gilroy, 1917). R. Cohen and Mohl (1979) also described how unions perceived the Gary plan for New York schools as being "designed to stifle mobility and turn out 'wage slaves' for American capitalism" (p. 46). Adding credence to this perception was that two of Mitchel's appointees to the Board of Education were also associated with the Rockefeller-financed and pro-Gary plan General Education Board—a fact regularly brought up in union meetings about the plan (Bonner, 1978).

The End of the Gary Experiment in New York

For nearly four years, the public debate about the Gary plan raged. On one side were the efficiency progressives such as Mayor Mitchel and the Board of Estimate; social progressives such as Alice Barrows, Rheta Childe Dorr, Randolph S. Bourne, and John Dewey; as well as liberal newspapers such as the *Tribune* and *Times*. On the other side were interests that may be considered more self-serving, with William Ettinger, the associate superintendent of schools; Thomas Churchill, president of the Board of Education, Tristam Walker Metcalfe, writing for the *Globe*; teachers; and unions such as the New York City Teacher's Association. However, it was to be the organization and voice of the parents and students that put an abrupt end to the plan.

The main parent's group leading the charge in favor of the Gary plan was called the Gary School League, organized in 1916. An outgrowth of the Women's Municipal League, the Gary School League consisted of reform-minded women elites, among whom Mrs. John Dewey was the most noted from academia. This group of women presented their views at school meetings, were available for interviews in newspapers, and used automobiles to take visitors to Garyized schools. By the late summer of 1917, the league even sponsored the showing of a motion picture for the public to view what a typical day in a Gary school would be like (Bonner, 1978).

Another group formed in September 1917 to promote the plan was called the Committee on Public Education. While the *Tribune* considered the committee to be "non-partisan" and formed "for the purpose of informing the voters about the constructive work carried on in the schools by the city government during the last four years" ("Voters to Learn," 1917), the Globe labeled it as part of Mayor Mitchel's Fusion campaign committee for his upcoming re-election in November of 1917 ("Tell of Value," 1917). The committee was headed by Michael Friedsam, president of B. Altman & Company, but also included academics such as John Dewey and David Snedden. In their committee statement issued on the subject, they mentioned in the very first paragraph the upcoming election and the other candidates' objective to "create passion and obscure facts" ("Voters to Learn," 1917). They further stressed that "under modern industrial conditions which exist in the most intense form in the world and in New York City, opportunity for recreation and the experience, skill and character development that come from the use of tools . . . must be met by the schools."

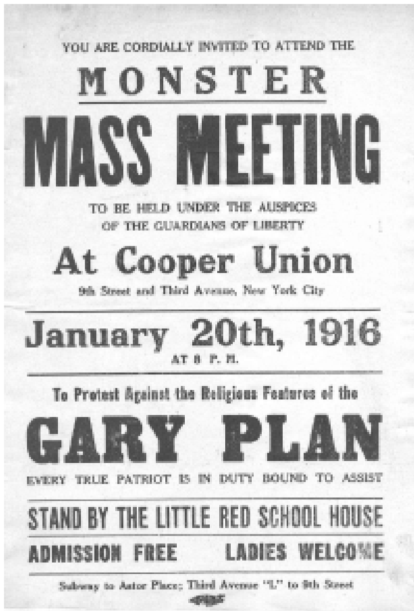
Opposition groups were also being formed. One such group was the Mothers' Anti-Gary League formed by mothers of students attending Garyized P.S. 89 in Brooklyn. Through a petition submitted to the Board of Education and signed by over 400 mothers, objections were raised concerning a number of issues including the neglect of academic work due to the diversity of interests ("Petition Signed," 1916). As noted by R. Cohen and Mohl (1979), many of the other "anti-Gary leagues" that were being formed at schools were actually pushed by Tammany politicians and school principals.

Testimonies by parents were also heard at public meetings to present both sides of the Gary debate. These meetings were often heated and very emotional. At one large public hearing held at the Board of Education, each speaker was to be limited to five minutes. However, the lack of control the president was able to exhibit at this meeting was later explained as "limiting a woman with an hour's worth of conversation to five minutes is sure to enact a certain amount of misdirected energy" ("Two Girl Graduates," 1916). With opposition groups such as Federation of Parent's Association, Mother's Council of the City of New York, School Welfare Association, Bronx Anti-Gary League, Conference of Organized Labor on Industrial Education, and parent's associations from over 10 schools present, the three groups in favor of the plan, including the Gary School League, were vastly outnumbered.

Concerns were also being raised by groups about Wirt's proposal to have release-time religious instruction as part of the plan. With this feature, students were to be released two times per week to attend instruction at their own local church or synagogue. Along with Constitutional issues about the separation of church and state, there were fears students would be pressured by their teachers to attend a specific church, or that they would be ostracized by fellow students for their particular beliefs. One such meeting on this issue was sponsored by the Guardians of Liberty, an anti-Gary group (see Figure 1).

Headlines about the meeting the next day in the Globe stated "Liberty Guardians Accuse Catholics" (1916), while the pro-Gary Tribune's was "Gary Meeting Ends in Disorder" (1916). The Tribune described how "there was considerable confusion when several of the speakers made attacks upon the Catholic Church. . . .

Figure 1. Poster for anti-Gary meeting



It looked for a while as though fists fights would result." One speaker at the rally stated, "I accuse some of the teachers in the public schools of using the schools for the purpose of which they were not intended—that of attempting to make this a Catholic nation."

Despite the propaganda and efforts from both sides, it was the students who actually settled the debate in a very quick manner in the autumn of 1917. With municipal elections scheduled in November, and only 30 out of 680 schools Garyized, the opposition voices became even louder (R. Cohen & and Mohl, 1979). Mayor Mitchel was running again as the Fusion candidate, John F. Hylan as the Tammany candidate, and Morris Hillquit from the Socialist party. Hyland was squarely against the plan, while Hillquit was more neutral and even questioned why many of the best features of the plan were never implemented. Against this heated backdrop, the Gary plan remained at the center of political controversy, but it was the sudden and violent actions of the students that determined the fate of the Gary plan in New York.

The headline in the *Globe* on Tuesday the 16th of October 1917 was "1,000 Pupils Riot Against Gary System." The morning before, a large group of boys refused to go into P.S. 171, a school where the Gary plan was just introduced. Police quickly "rounded up the malcontents and dragooned them into the building." When school ended, the actual riot started, with windows broken and students arrested. So widespread was this anger that even "fathers and mothers encouraged the event" and "girls were taking a leading part."

The next day at P.S. 147, what started out as a meeting for parents and students to explain the Gary plan, also turned into a "riotous anti-Gary demonstration" after the replies to questions were not satisfactory "concerning the practical operation of the plan and the Rockefeller influence upon the public school system" ("Trouble at Gary Meeting," 1917). P.S. 171 problems also continued that day and spread to several other schools. The press immediately placed blame on the Socialists, as signs were waved supporting Hillquit, as well as the chanting of slogans against Mayor Mitchel ("1,000 School Children Strike," 1917). Police estimated the increased numbers from the participating schools were over 4,000.

By the end of the week, the strikes escalated, with an estimated 5,000 students out in the Bronx (Bonner, 1978). Police were injured from stones thrown, resulting in several students being arrested. That next Monday, October 22, things continued to get worse. Several schools in Brooklyn and the east side of Manhattan had demonstrations, with an estimated 10,000 taking part ("10,000 Pupils in Brooklyn Out," 1917). Even at an elementary school in Brooklyn, children smashed windows and were joined by their mothers with banners inscribed "Down with the Gary System" and "Down with Mitchel." Tuesday the 23rd was considerably quieter, with only a few minor incidents at a few schools. However, by that time, it was becoming more evident that Tammany members and their candidate, and not the Socialists, may have had something to do with the events.

While it may never be known whether students acted on their own in order to return to a shorter school day, teachers gave subtle encouragement to their movement, parents desired to protect their children, or political "operatives" instigated the strikes, the riots caused serious damage to the candidacy of John Purroy Mitchel. In two weeks time, he lost the election in a Tammany landslide, with Hylan receiving twice as many votes. Soon after his inauguration, Hylan began to pressure the Board of Education to remove any superintendents who favored the plan in order to expedite the elimination of the Gary plan from schools

("Elimination of Gary Plan," 1918). Recognizing William Ettinger's reputation as an outspoken opponent to the plan, Mayor Hylan swore Ettinger in as the new superintendent that May ("Supt. Ettinger," 1918).

Obstacles to School Reform

Years later, reflecting on the Gary plan, William Wirt (1937/1995) stated, "One must not only recognize that opposition is to be expected . . . as a rule progress is made because of opposition. Sometimes one must recognize that the value of a new proposal can be estimated by the extent of the opposition" (p. 112). As reflected in the example of the Gary plan in New York City, it was very difficult to initiate and sustain change, with teachers in particular very resistant. However, as witnessed by the strength of resolve against it, perhaps there were features of the Gary plan that were of great *potential* value.

Was the Gary plan so flawed and/or had few features that were acceptable that it would never have been accepted? Weischadle and Weischadle (1990) identified the elements of time, trust, team, and training as necessary elements in order to have a chance at successful change. It appears that with the attempted implementation of the Gary plan, little if any of these elements were present. Initially placing the plan in two schools without adequate training for staff, not having the schools fully equipped, then rushing to expand the program to other schools without demonstrating its proven value led to a huge lack of trust. Certainly, attempts were made by the progressives to help educate and convince the teachers and prepare the public, as witnessed by their many public debate appearances and writings for the press. But eventually, these were not enough.

The debate over the Gary plan can also be looked at as a conflict over knowledge and power (Spring, 2002). One arena includes those seeking to have their ideas placed in schools, while another arena wants schools to teach children particular values and ideas. While it is possible these two can overlap, they may also be a source of contention. The actors in New York's different arenas contained politicians, administrative politicians, school boards, progressives, labor unions, corporate interests, groups/organizations, media, the public, parents, and students. Perhaps it was the public's view that schools should be traditional. There was a perception that manual training was part of a "Rockefeller" agenda. Many did not accept the religious instruction feature of the plan. These elements coupled with the frustrations felt by students led to almost insurmountable problems.

As for the teachers' position, Germinario and Cram (1998) described how resistance to change can manifest itself in both subtle and not so subtle ways. Illusions of support, manipulative behaviors, or outright refusal to cooperate are resistant behaviors exhibited in schools. The teachers' reaction to the Gary plan in the early 1900s contained all of these features.

Resistance to educational reform, the agenda of competing interests, and inherent contradictions have occurred in many other educational movements since the Gary plan was introduced in the early 1900s. One example would be reform efforts in the 1960s and 1970s to both increase parental influence on schooling and to reduce racial segregation (Katz, 1987). To implement one policy would require radical decentralization, while the other would lead to larger and more heterogeneous schools. The level of federal initiatives and control over education policy is another area of contention and contradiction. For example, in the 1980s, Republican platforms (Republican Party Platform, 1984) promised fewer federal regulations and less intrusion into local governments, yet initiatives such as the *New American Schools Development Corporation* and *Goals 2000* initiated by President George H. W. Bush seemed to contradict this position. The more-recent *No Child Left Behind Act* developed by the administration of President George W. Bush also reflects, for many, contradictions and fosters a lack of acceptance. The historical role of local schools, the level of funding to adequately support requirements, and the degree by which curriculum and pedagogy change in order to match goals and evaluation pressures are issues raised by this piece of legislature.

Reform efforts in technology education have also had obstacles and contradictions. Since major endeavors in the mid-1980s to transform what had traditionally been accepted and practiced (i.e., industrial arts), there has been a lack of acceptance by teachers (Bussey, Dormody, & VanLeeuwen, 2000; Rodgers & Mahler, 1994), a lack of public understanding (Pearson & Young, 2002), and a lack of understanding by educators (Gray & Daugherty, 2004). Referring to Weischadle and

Weischadle's (1990) elements of time, trust, team, and training as necessary for having successful change, perhaps the limited inroads and health of the technology education profession (Sanders, 2001; Wicklein, 2004) point out deficiencies in meeting some of these conditions.

The recent *Standards for Technological Literacy* (ITEA, 2000) may also face much the same fate as past reform efforts. Will it parallel the Gary plan as a short-lived effort forced into a society with divergent political, administrative, corporate, public, and professional interests that are liable to change, or will it develop into a movement that will transcend differences and stand the test of time? In essence, are the *Standards* a "fad," exactly the same concerns raised at the time about the Gary plan (Metcalfe, 1916a;Vance, 1916)?

Merrill and Comerford (2004) stated that "the use of standards-based teaching and learning has been gaining significant attention . . . [and that] state boards of education are holding school districts accountable" (p. 8). They also confidently maintained that "standards-based instruction is not an educational fad" (p. 8). Despite this optimistic assessment, Wicklein (2004) identified a substantial lack of curriculum consensus about the content of technology education by teachers and university professors. This may suggest that the *Standards*, although presented to the profession for several years now, may still not be universally accepted or implemented. Their genuine acceptance by teachers and the public, as well as how students accept them, will ultimately determine their impact. Time will tell if the *Standards* become a footnote in the field of technology education, just like the Gary plan.

Conclusion

The Gary plan had the potential to be a great influence on technology education. Based on social progressive philosophy that influenced early manual and industrial arts (Petrina & Volk, 1995), it featured many aspects that would be appreciated in today's technology education programs. For example, the Gary plan had all secondary school students involved in technical education, there was clear articulation between elementary and secondary programs, and the school had facilities for the entire school population to use. It also embodied education ideals that centered learning on social conditions and needs through experiential, hands-on activities.

While the Gary plan did not last long, some features of the plan remain in many of today's schools, such as departmentalized teaching in upper elementary grades and an end-of-day "activity period" for students to attend specialized areas in chorus, band, or even technology labs. Had the Gary plan in New York City and elsewhere been successful, instead of technology education programs remaining largely marginalized, they would have remained much more the focal point in schools—and should this have happened, no doubt the health, status, and accomplishments of technology education would be a different story today.

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Electronic Performance Support Systems and Technological Literacy

George R. Maughan

Abstract

Electronic performance support systems (EPSS) can provide alternative learning opportunities to supplement traditional classroom or training strategies. Today's students may benefit from educational settings and strategies that they will use in the future. In using EPSS to nurture the development of technological literacy, workers and students can achieve higher level cognition skills while they perform tasks. Although there are unique challenges to the development and use of EPSS, efforts to overcome these challenges are becoming more widespread.

Introduction

Whether it is planning new highway construction, calibrating a stamping machine, or assembling a tricycle, humans cannot escape using information, tools, energy, and materials when performing a task. Technology has become a powerful force in the world, forming a totality that is difficult to understand as a whole (Ellul, 1954; Winner, 1977; Postman, 1993; Sismondo, 2004). The nature of modern work and rapidly changing conditions in the workplace demand that workers to be very agile in their use of information, tools, energy and materials, and continuously engage in learning.

It is because of this evolving and complex nature of technology that work in advanced technological societies frequently requires skill and knowledge development beyond the scope of standard education and training programs. As tasks become more systemic and highly integrated within a complex workflow, traditional training fails to adequately prepare workers. While traditional training and job aids predominate, increasingly Electronic Performance Support Systems (EPSS) are employed to support skill and knowledge development in real-time and at the work station (Gery, 1995). An EPSS is a configuration of hardware, software, and content accessible by employees or students and structured to provide users with information to permit them to do their jobs or perform tasks with minimal intervention by others. EPSS are an important link between task support, the acquisition of new knowledge and skills, and the development of broader technological literacy (Wittmann & Süß, 1999).

Traditional pre-work and on-the-job training have evolved in such a way that in some cases training is embedded in the work process itself. In the past decade the promise of cost savings and more efficient labor initially provided the impetus for EPSS (Gery, 1995). By eliminating much of the traditional training of workers and providing a smart electronic coach, individuals can use performance support systems to learn while working, and at the same time have instant access to vital support information such as conversion tables, schematics, and flow diagrams. By harnessing computer systems to accumulate information, coach, and respond to user requests, contemporary EPSS are beginning to fulfill their promise of efficiently supporting the performance of tasks. EPSS may deliver even greater benefits than first imagined as these systems actually learn through individual user interaction.

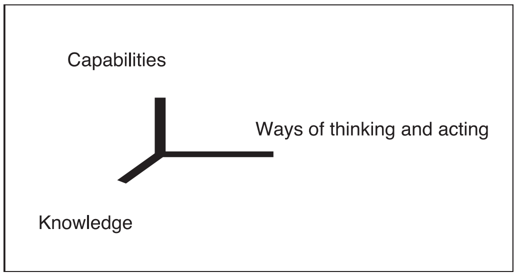
In EPSS, information regarding the performance of technical work is cumulative, expansive, and, as the task is performed, contributes to knowledge constructed by the user. These features are frequently observed in journeymen and master technicians. Performance support systems provide prescriptive information to enable a user to accomplish a task such as locking-up a piece of stock in a vertical milling machine. Expanded information in the form of troubleshooting rubrics, case studies, workflow summaries, and calculation wizards are also provided in the context of the specific task. A user's interaction with this information can lead to higher level thinking and the construction of knowledge enabling the user to realize concrete and abstract concepts and principles (Hambrick, Kane & Engle, 2005). When blended with social learning, scaffolding can contribute to new technical as well as technological literacy both in the workplace and the classroom.

This article explores the relationship between EPSS used to assist workers in the performance of complex tasks and the contributions these systems can make to the development of overall technological literacy. Several themes are discussed. First, the nature of technological literacy is described. Second, electronic performance support systems and how they are used to support work is explored. Third, the role of theoretical constructs within cognition and constructivism and their relationship to the development of technological literacy is discussed. Finally, the challenges faced by trainers and technical educators as they integrate these themes into their work is considered.

Technological Literacy

The National Academy of Engineering and the National Research Council's jointly published book *Technically Speaking*, opens the executive summary by describing "an unacknowledged paradox" (Pearson & Young, 2002, p.1). This paradox is the current low level of technological literacy in the midst of the widespread use of technology. The authors challenge K-12, higher education and adult education to do their part to address this situation. One of the most intriguing aspects of the work is the manner in which technological literacy is described. Three axis: knowledge, ways of thinking and acting, and capabilities are conceptualized. (See Figure 1.) Knowledge represents "knowing about" and being able to recognize the numerous ways technology is represented in our society, including both devices and techniques and large systems, as well as their impacts. Ways of thinking and acting refers to one's participation in asking questions, seeking information and making decisions about the use of technology. Finally, capabilities refer to skills and abilities to recognize and use tools, including such diverse examples as cell phones and programmable control units. This also includes the ability to apply theories and principles.

Figure 1. Dimensions of technological literacy (p.15)



It is within these dimensions that technological literacy develops. Constructivist learning theory suggests that when a user is engaging technology and actively questioning and learning, it is quite likely that knowledge and ways of thinking and acting will develop (Fox, 2001). Through the use of EPSS, employees may construct knowledge necessary to perform complex tasks in the workplace (Wittmann & Süß, 1999). When coupled with social learning, EPSS may assist learners in gaining new ways of thinking and provide greater insight into the larger technological world.

Electronic Performance Support Systems

EPSS exists as **stand-alone** systems or as systems **embedded** in the work process. **Stand-alone** electronic performance support is made available to the user while the work is on-going but requires the user to seek or pull information by querying. Many times this information is displayed alongside work information. A device such as the scan-tool marketed by Snap-on is a good example. This device functions like most scan tools used in automobile service settings by providing troubleshooting codes for malfunctioning engine, transmission, and ABS systems. Yet, this tool goes a step further by providing "troubleshooting" advice to technicians and work-context answers to questions about problems and possible solutions. These functions operate in real-time and can also provide live instrumentation on the actual system in question.

In another example of a stand-alone EPSS application, many Sears service technicians use laptop computers when servicing home appliances. Although the laptop is networked to an external database, the laptop does not directly interface with the malfunctioning appliance. It is quite common to see a technician referring to his/her laptop while diagnosing or repairing an appliance. The laptop communicates wirelessly with the service vehicle parked in the driveway. There the signal is transmitted to a comprehensive database via a satellite link. This communication illustrates the networking of the user's access device with external information. Technicians can check model numbers against parts lists, inventory and price information as well as view diagrams and illustrations.

Finally, another example of a stand-alone EPSS is that of a European automobile manufacturer that employs a "guided fault-finding" system used by service technicians. A laptop computer provides decision-branches for the technician to follow in order to ensure consistency in diagnostic efforts across dealerships. This support system also provides documentation of the technician's work. The system is based on a prompt-and-response procedure that requires the technician to respond at each stage of the guided process thereby tracking workflow. The documentation is then transferred to the technician's memory stick and presented to the service manager for analysis or payment calculations.

Embedded electronic performance support is provided by devices that are interfaced into the work process. They provide suggestions and relevant information to the user during the performance of work by pushing some information to the user as well as responding to user queries. A simple example of an embedded EPSS system is the ubiquitous word processing software that corrects or underlines misspelled words as one types on the computer. Another type of support is the feature that recognizes the task one is performing and offers to provide support via an intelligent agent. For example, when beginning a new word processing document with "Dear Sir," the intelligent agent may query you to offer assistance by displaying a text box that reads, "It looks like you're writing a letter. Would you like help?"

Intuit's Turbo Tax is another example of a user-friendly embedded support system that prompts users for information and is capable of running complex calculations. An on-line example of a relatively powerful embedded system is found at www.expedia.com. Here, the system responds to information the user provides and seeks clarification when necessary before launching a search for airlines or hotels. A complete "vacation wizard" is also available to provide assistance to those who are "vacation challenged."

A unique aspect of stand-alone or embedded EPSS is the wearable feature. Demonstrated in science fiction and action movies, wearable EPSS devices have been portrayed as miniature display panels in glasses or headbands that provide text and imagery along with tiny ear pieces and microphones that provide voice activated commands or instructions. For these systems to qualify as EPSS as described in this article, they would provide only pre-created information, learned information, or real-time information without the intervention of people.

Wearable EPSS systems are no longer relegated to the movies. A few years ago, researchers at Georgia Tech studied the use of stand-alone wearable computers for task guidance in aircraft inspection. The equipment configuration consisted of very small computer with data storage and voice recognition software worn on a belt, a head strap with monochrome display and a microphone. The task performed by subjects using the EPSS was the external preflight inspection of a Cessna 172. Three experimental groups performed the task from memory, using text, or using photographs taken from the operating manual of the aircraft. Although no significant difference was found among the groups, the observable lack of physical contact with the aircraft by the pilots, who seemed to rely heavily on the EPSS to guide their preflight inspection, prompted researchers to suggest additional study of the task context and environmental context when using EPSS so that users will be able to discriminate between interacting with the EPSS and performing the work task (triton.cc.gatech.edu/ubicomp/614).

Regardless of the degree of embeddedness, EPSS consists of twelve possible support structures for workers. Each is tailored to a related set of work tasks, the level of task complexity varying for each. Imagine each of the following being used to support the multi-step task of replacing a residential hot water heater or performing a pre-flight inspection of a single engine aircraft. These structures, adapted from Gery (1995, p. 52), include:

Cue Cards. Single ideas or small sets of facts.

Explanations or Demonstrations. Mini lessons that explain concepts or processes, or graphical presentations of the effect of variables (heat, pressure, time, etc) on materials.

Wizards, Assistants, or Helpers. Sets of queries and prompts that enable the system to perform relatively complex plans or solutions.

Coaches or Guides. Step by step instructors to perform a task.

Searchable Reference. Presentations of glossary, safety precautions, specification charts, tables, and graphs.

Checklist. Mini check lists of flow charts or processes.

Process Map. Graphical representation of flow charts or decision trees.

Examples. Mini cases representing solutions to similar problems.

Templates. Pre-existing solutions to design or process problems.

Tips. Hints to optimize efficiency, avoid problems or to alert users to unique situations.

Practice Activities. Sample problems or exercises to develop skills.

Assessments. Clusters of questions to be used as self-assessment and/or to engage in some type of pin-point diagnostic.

It is apparent that a great deal of effort goes into the creation of EPSS. Of course, more than a single task-set is supported; related tasks may also be supported. The hot water tank replacement task support would probably be accompanied with support structures for related home maintenance tasks such as replacing a kitchen sink and replacing windows. The variety of support structures provides flexibility for individuals who require specific information, yet can accommodate the individual needs of a number of workers.

The degree to which EPSS can support workers or students is influenced by the means of access a user has to the system, and the level of intelligence built into it. Access is influenced by the type of work the system is supporting and the manner through which the user interfaces and navigates within the system. Devices such as optical scanners, keypads, touchscreens, visual displays or voice controlled devices have unique impacts on navigation within the EPSS. Graphical user interfaces that provide alternative views, multiple reference and access points and contextual feedback - all with text and imagery, is desirable. A “text only” default is rarely adequate. Access points and strategies can vary between novice and experienced users frequently requiring multiple pathways to the same information. For example, if an EPSS were available for diagnosing drivability problems on a motorcycle, it could be embedded into a dynamometer (Maughan, 2005) and provide real-time graphical displays of engine performance while identifying faults when the engine is under different loads and supplying the technician with possible repair strategies.

Levels of intelligence built into EPSS determine how adaptable the interface can be and how the system can acquire new knowledge. According to Janet Cichelli, Chief Technologist, SI International, Inc., five levels of intelligence have been described: static, maintained, standardized, dynamic and intelligent (Cichelli, 2004). A static level of information may be information about specifications, procedures, or frequently asked questions/answers associated with the task. As systems are given the capacity to learn, they progress in sophistication by updating changes in the basic information available and creating more standardized task scenarios of “if this, then this.” These features are very useful to typical users. However, it is the top two levels, dynamic and intelligent, that represent the power of EPSS to adjust to various users’ entry levels and link learned information about the user’s experience in relation to the specific task as well as universal task issues. Truly intelligent EPSS may acquire sufficient knowledge to provide suggestions to overall workflow, previous unconsidered efficiencies, as well as simple task completion information.

Constructed Knowledge and Cognition

Training and education activities are informed by various theories of learning. Although a number of theories may apply, the theory that relates most to the fundamental practice of using EPSS to support the performance of workers and develop a broader technological literacy is constructivism. Constructivists view the learner as actively constructing new knowledge drawing upon pre-existing information and past experiences. As experience is gained and knowledge is built, learning opportunities produce new concepts or ideas (Maughan & Anderson, 2005). Most workers are actively engaged in the learning experience. In addition to engagement through doing, reading, calculating and viewing, collaboration with other learners provides alternate perspectives to consider and adds meaning to new knowledge. In addition, learners bring experiences as consumers or hobbyists to the learning process, helping fill in gaps with new knowledge and facilitating higher order thinking.

Fox (2001) explains that learning constructed by the individual can be achieved in many ways and that the paths to learning are not always compatible. The learner may realize the path they decide to take is incorrect and learn from this mistake; thus, the experience of the mistake has assisted in the learning process. Multiple pathways to information need to be provided for different learners. Facilitating the learner's demand for information, when and in what form the learner prefers, is an important function of EPSS.

Learning requires activity and is best facilitated through action. For example, one can better understand the concept of torque if he/she has turned a torque wrench on a bolt and felt the tension while watching the pointer move across the scale. Technology education and vocational and career tech programs have long recognized the importance of this type of active learning. Most industry training programs are also based on a praxis or doing model. EPSS engages the learner by providing highly relevant information while tasks are performed.

The process of turning information as a commodity into knowledge as it is conceptualized by cognitive scientists involves stringent analysis. On a conceptual level, Brown and Duguid (2000) offer three distinctions: 1. knowledge is associated with an individual, 2. knowledge transfer is not easy, and 3. knowledge acquisition requires assimilation based on the knower's "understanding and some degree of commitment" (p. 120). Obviously, to benefit an organization, knowledge must inform practice. In the workplace, that means that knowledge must contribute to the act of work by an individual or through collaboration with workgroups. The third distinction relates to a direct benefit of the use of EPSS since the learner's assimilation occurs within, and because of, the work situation in which the learner is committed to learning en-route to successful completion.

The potential of achieving higher-level cognition from the use of EPSS is probably dependent on the relationship among working memory, short-term memory (STM), and long-term memory (LTM) (Wittmann & Süß, 1999; Hambrick, Kane, & Engle, 2005). STM is influenced by sensory input of information in the common domains of language, text, sights, sounds and smells. This information remains available to the individual for only a matter of seconds or minutes. The variance among individuals may be influenced by their ability to attend and the nature of what is to be learned (Hambrick, Kane, & Engle, 2005).

Repetition or scaffolding techniques applied to information in STM may cause it to become stored as LTM. Once there, LTM is generally not influenced by time – in fact, it can be theorized that once information is accumulated into LTM it may reside there indefinitely. Problems with LTM usually relate to accessing information and integrating smaller bits of information into larger concepts and principles from which higher-order thinking might occur. Furthermore, the cognitive capacity to plan how to apply information from memory to perform a task, known as executive functioning, can influence the overall effectiveness of using EPSS. These cognitive processes become very important to consider in their relationship to the development of technological literacy through the use of EPSS.

One way LTM may be accessed and integrated is through interaction with others. By communicating across the workgroup, the assimilation of information can result in the evolution of various levels of knowledge (Lave & Wenger, 1993). In their recent book, Salas & Fiore (2004) postulate that a key to understanding work process and performance is team cognition, the collective level of thinking within a group. Recent evidence supports that there exists "direct and indirect relationships between team effectiveness and various operationalizations of common cognitions among team members (Rentsch & Woehr, 2004, p.11).

The construction of technological literacy through the use of EPSS requires an understanding of work tasks, cognitive functioning, and design principles for electronic performance support devices, software, and interfaces. The social learning that occurs in a work or learning environment contributes to individual high-level thinking and team knowledge. Although these variables and subsequent systems are often considered in the workplace, it is important to recognize the potential of EPSS in schools. Most certainly the development of performance systems in business would look different than those in schools (Sleight, 1992). Educators are encouraged to think about the comprehensive nature of EPSS development and select those features and systems that can be created and used in settings that do not have the resources or infrastructure for fully developed systems.

Challenges

Although the challenges to trainers and teachers developing and using EPSS are many, the following describes four categories.

Communication and computer infrastructure

The creation of a seamless EPSS information infrastructure comprised of user access devices, networks, developer skills, application policy, and financial support is a challenge to many organizations (Maughan, 2001). The provision of access terminals or nodes may vary from cabled bench-top computers to wearable wireless devices. Network capacity could range from delivering text-based information to full-motion video warehoused in multi-layered databases and connected to real-time process data. In most cases, the speed of data transfer is very high in order to accommodate multiple simultaneous users. This capability is best served in large organizations by their enterprise system. In such cases EPSS users must undergo training to be able to access the system at a level of proficiency necessary to acquire support for the tasks they perform. In addition, if voice interface is a feature of the EPSS, the user must teach the system to recognize his/her voice.

EPSS development generally requires a multidisciplinary team approach. The situation and degree of use of EPSS must be clarified through policy in order to optimize the potential symbiosis between the EPSS and the user, so that inappropriate application will not result in decreased efficiency in the work process. Structural changes in an organization may occur as trainers and teachers move from a linear paradigm of instruction (training followed by application to work), to a paradigm that includes the traditional linear model as well as models where employees or students also construct knowledge through experience or with the support of performance systems while doing work. Financial resources must be in place for the purchase, development, and maintenance of the system. Alternatives to fully integrated communication and information systems are available to most trainers and teachers. The most fundamental of these are hand held and desktop computers.

Knowledge management

Knowledge management is also a challenge to organizations moving towards the integration of EPSS. EPSS requires that relatively large amounts of knowledge be sorted and organized into smaller chunks and placed in the appropriate contexts of particular work processes. This can be difficult for trainers and teachers. Traditional industry and school curricula tend to treat content in an abstract or formal epistemological fashion independent of applications or work settings. Knowledge management in the support of task performance must be derived from the activity and involves identifying and capturing knowledge, indexing knowledge, and making knowledge available to users in flexible and useful ways (Siemens, 2004). Furthermore, it must be acknowledged that the practice of communicating knowledge across an organization depends on the varying communication patterns of workgroups, that in practice, also vary greatly from organization to organization.

Usability

Trainers and teachers tend to develop an unscientific assessment of the knowledge learners bring to the task of learning advanced or relatively new content. For any task, learners can be categorized in terms of possessing prerequisite knowledge as basic, intermediate, or advanced. This assessment can be verified with pre-test or screening instruments, although this is rarely done in education or industry environments. The task for developers of EPSS is to envision multiple access points within the process during which task support is offered – some at very basic levels, continuing in hierarchical fashion to very advanced levels of entry skills, knowledge and ability. In many cases this is not merely an investigation into a linear continuum of difficulty, but often requires the integration of related attributes and concepts fundamental to achieve success. Ideally, as workers or students perform iterative tasks, information corrections as well as new information needs should be provided to developers so that the support structures can be improved for the next execution cycle (Darling, Parry & Moore, 2005).

Presentation

Performance specialists frequently refer to “The Performance Zone” when developing EPSS (Dickelman, 1995; Degler & Battle, 2001). This zone is the center of a venn diagram that consists of three slightly overlapping circles. These three critical elements enable performance: information appropriate to the task, information appropriate to the person and information containing critical features of the world. By ensuring that each of these features are integrated through the means of a graphical user interface, an EPSS can optimize the efficiency of the support provided to workers or learners. EPSS developers must create a virtual world of work without omitting major human attributes (Dickelman, 1995). As sophisticated as a cleverly designed screen may look, the integrating of information needed to enable a worker to make a decision boils down to presenting the totality of the task, not just bits of information. In essence, the EPSS must process information based on the immediate task and the demands of the user.

Conclusions

Certainly the improvement of organization and individual performance requires a focus on the structure of work and workforce training. Because work task performance generally requires the application of specific skills and knowledge, training often focuses on this level of employee learning at the expense of developing a broader technological literacy. Some argue that this approach might limit decision-making and innovation. Improving human performance through the development of specific skills and knowledge, in addition to broader technological literacy has been a major goal of practioners and researchers. Furthermore, efforts to understand the relationship between support structures for the development of specific skills and knowledge to perform tasks and the development of high cognition levels are on-going. The many disparate attempts to characterize learning organizations and high performance workplaces illustrate this point.

Traditional approaches to developing technological literacy through formal education and training programs must continue and expand. However, EPSS can provide alternative learning opportunities to supplement traditional classroom or training strategies. Today’s students may benefit from educational settings and strategies that they will use in the future. In using EPSS to nurture the development of technological literacy, workers and students can achieve higher level cognition skills while they perform tasks. Although there are unique challenges to the development and use of EPSS, efforts to overcome these challenges are becoming more widespread. Additional research in this area could provide trainers and educators with new strategies and tools for performance enhancement.

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Computer Assisted Fluid Power Instruction: A Comparison of Hands-On and Computer-Simulated Laboratory Experiences for Post-Secondary Students.

Scott B. Wilson

Introduction

Despite demand from industry, there has been a general lack of emphasis placed upon course content in fluid power by post-secondary educational institutions in this country. The cost of development for the required laboratory facilities is often cited as a major obstacle to fluid power content development.

There is considerable recent research on the use of computer assisted instruction and computer simulation for technical training. Some of the areas that have been studied include the teaching of subjects such as: Electricity and magnetism (Chou, 1998), electrical operational amplifiers (Dobson & Hill, 1995), basic electronics (Moslehpour, 1993), engineering fluid mechanics (Engel et al., 1996), basic thermodynamics (Buttles, 1992), chemistry (Grosso, 1994), engineering physics (Chien, 1997), military pilot training (Andrews et al., 1996).

Much of this research has also been tied to individual differences in cognitive learning styles. In a 1994 review of literature, Moldafsky and Kown reported that cognitive learning style can be responsible for a person's lack of ability to process information from computers, along with their attitude and anxiety towards computers. Additional studies found that individuals with certain cognitive styles could significantly out perform others when asked to recall material presented using computer-based instruction (Hsu, Federick & Chung, 1994; Burger, 1985). There has also been considerable research to link cognitive learning style to a student's choice of a major and achievement within that major (Witkin, 1973; Witkin et al.,1977a; Gregorc, 1979; Garger & Guild, 1984; Torres & Canno, 1994; Garton et al., 1999).

The fluid power industry has had difficulty in achieving the professionalism and formal educational system found in many other engineering and technical fields. The high cost of training equipment may contribute to this problem (Luzerne County Community College, 1987). The small amount of available literature pertaining to fluid power education is a strong indication of the lack of emphasis that this subject area has historically received.

The literature review also indicated that a selection of fluid power computerized design and simulation software is now available. Various software programs can be used to perform computer aided design and testing of circuitry, or even complex engineering analysis of dynamic systems and component selection. Computerized simulations used for instruction can assist the student in developing mental models of many different types of complex systems (Mayer, 1989; Mayer & Sims, 1994; Munro & Towne, 1992; Perkins & Unger, 1994). There is a gap in the literature in terms of the application of computerized simulation to train people for the fluid power industry, which could result in a large reduction in the implementation costs of such a program. The certification levels offered by the Fluid Power Society (FPS) have brought the industry some much needed industry recognition. It is time for the educational community to focus on the need to offer courses in fluid power on a more consistent basis.

Purpose

The primary purpose of this study was to examine the effectiveness of utilizing a combination of lecture and computer resources to train personnel to assume roles as hydraulic system technicians and specialists in the fluid power industry. This study compared computer simulated laboratory instruction to traditional hands-on laboratory instruction, in terms of effectiveness.

Method

This study used a within-subjects repeated measures design to determine the relationship between two methods of teaching fluid power laboratory experiences and student achievement on a cognitive written instrument, as well as a performance (psychomotor) instrument. As secondary research areas, the study examined the relationship of cognitive learning style (field-dependant or field-independent), as well as the sequencing of the laboratory assignments, to the level of student achievement on a performance (psychomotor) instrument.

Four sections of the same college course, with a total of 70 subjects, participated in this study. After receiving the same lecture at the same time, the subjects in each course were randomly split into two treatment groups. Group B completed the first two laboratory assignments using the traditional hands-on fluid power trainers, while Group A completed the first two laboratory assignments using the computerized fluid power simulation program. Upon completion of the first two laboratory assignments, the performance instrument was individually administered to each student.

The performance (psychomotor) evaluations were given using a criterion- referenced instrument at the completion of the first two laboratory assignments and prior to switching to the other type of trainer. The student could receive a score of zero to three points on the performance evaluation, with one point awarded for each of the three required tasks which were completed correctly within the 15 minute time limit.

Upon completion of the mid-lab performance test, each of the groups switched to the other type of laboratory trainer so that all of the students experienced both the hands-on trainers and the computerized simulation program. Upon completion of both treatments, the performance (psychomotor) test was re-administered to each subject individually. At the completion of the course, the Group Embedded Figures Test (GEFT) was administered to all of the students to determine the cognitive learning styles (field-dependant or field-independent) of each subject.

Separate t-test procedures were used to determine differences in actual student performance between the two treatments, as well as to examine the relationship between learning styles (high or low GEFT scores) and performance scores between the treatment types. Additional t-tests were conducted to determine if the sequencing of the treatments resulted in differentiated student performance as well as to determine if there was a relationship between student final performance scores and learning styles (high or low GEFT scores). A paired t-test was conducted to determine if there was a significant difference between mid and post performance test scores and the sequencing of the treatment types. The last statistical analysis involved using another t-test to determine if there was a significant difference between the sum of the two unit exam scores and the sequencing of the treatments.

Findings

The findings of the study which are of value to educators are as follows;

1. There was not a statistically significant difference between the performance of the two treatment groups on the psychomotor instrument after the completion of the first two laboratory assignments.
2. The subjects classified as field-independent learners scored statistically significantly higher on the mid-lab psychomotor performance test than did the field-dependent learners.
3. There was not a statistically significant difference in student performance on the post-lab psychomotor performance evaluation as a result of the sequencing of the treatment types between the two groups.
4. The subjects classified as field-independent learners scored statistically significantly higher on the end-of-lab psychomotor performance test than did the field-dependent learners.
5. The difference between the mid- and post- psychomotor test scores within each group as a result of the two different methods of treatment sequencing was not statistically significant.

Table 1: The Research Design

	Treatments:	
Groups:	**1st & 2nd Lab Assignments:**	**3rd & 4th Lab Assignments:**
Group A	Treatment I: Computer-Simulation Labs	Treatment II: Hands-on Trainer Labs
Group B	Treatment II: Hands-on Trainer Labs	Treatment I: Computer Simulation Labs

6. There was a statistically significant difference in the sum of the cognitive unit exam scores between the subjects in the two different treatment groups. Treatment Group B, which completed the hands-on exercises before completing the computer simulation exercises, had a higher mean score.

Conclusions

The conclusions from this study may be generalized to the population from which the sample was drawn. This study examined the use of computerized simulation for teaching basic fluid power circuitry, and not its use as a tool for engineering analysis of hydraulic or pneumatic systems. Specific conclusions of value to educators are as follows;

1. Similar results can be achieved on a psychomotor performance evaluation whether the instruction is given using a computerized simulation program or a traditional hands-on trainer to teach basic fluid power circuitry.
2. Where both computerized simulation and hands-on trainers are used for fluid power instruction, the sequencing of the two types of laboratory instruction results in similar student psychomotor performance.
3. Students classified as field-independent learners perform better on psychomotor performance tests on basic fluid power circuitry than those classified as field-dependent learners.

Discussion

The finding that similar results can be obtained on a hands-on psychomotor evaluation using computerized as compared to hands-on laboratory instruction is contrary to conventional educational practice in the specific field of fluid power. While computerized laboratory instruction may never replace traditional hands-on laboratory instruction, it could offer similar student performance results where financial or physical constraints prevent the purchase and use of hands-on fluid power trainers. The potential impact of this finding could include an increase in the number of colleges and universities who are able to afford to develop and offer courses in basic fluid power by utilizing existing computer laboratories. In addition, the greater portability of lap-top computers when compared to hands-on fluid power trainers (which often weigh several hundred pounds and cost several thousand dollars each), could encourage more on-site fluid power courses to be offered away from the main campus. Through the use of a server to allow student access to the simulation program, it may be practical to offer a fluid power course in a distance-leaning format.

The lack of difference in performance on the end-of-lab psychomotor test of the two groups indicates there is no difference in the sequencing of the hands-on and computerized stimulation laboratory instruction. However, this study only examined a 50% to 50% split of the two types of laboratory instruction.

Subjects classified as field-independent (FI) learners did achieve a statistically significant higher score on the mid- and post-psychomotor test than did the field-dependent (FD) learners. An earlier study found that field independent (FI) learners were better able to mentally restructure information than field dependent (FD) learners (Wilkin et al., 1977). In addition, FI learners were found to be better able to recall material presented using computer based instruction (Hsu et al., 1994; Burger, 1985). This finding may also have implications for the level of degree that a technical student is seeking. A 1995 study by Hansen determined that the learning styles of four-year post-secondary technology students were more field independent than their two-year counterparts.

This study also found that treatment Group B, which completed the hands-on exercises before the computer simulation, attained a higher mean score on the sum of the unit exams as well as each unit exam separately. However, as the first unit exam was given before the treatments began and the second unit exam was given after the treatments were finished, the impact of the significant difference of the sequencing of laboratory assignments on the outcome of this study is minimal.

Applications for two and four year post-secondary technical programs

While traditional-hands on training will likely still continue to be the preferred method of conducting fluid power instruction, this study has shown that satisfactory results can be achieved using a computerized simulation program. It should be pointed out that unlike a computer-aided design program, a simulation program allows the student to see the system operate, and thus verify, the control logic of the circuit. This study utilized the Automation Studio software package from FAMIC Technologies, (www.automationstudio.com). In addition, supporting fluid power training material can be extremely helpful when explaining fluid power operational principles. A partial listing of sources of fluid power training materials includes: the International Fluid Power Society (www.ifps.org), National Fluid Power Association (www.nfpa.com), Eaton-Vickers Corporation (https://web.fluidpower.eaton.com), Rexroth Hydraulics (www.boschrexroth.com) and Parker-Hannifin (www.parker.com/training).

Basic fluid power trainers can cost from $10,000 for a Vickers unit to almost $15,000 for a Parker unit. Typically two students can use one of these trainers at the same time, producing an equipment cost of $5,000 to $7,500 per student. The cost of developing a computerized simulation lab for fluid power instruction is normally much lower. A six copy package of the Automation Studio software is priced at approximately $650 per copy, which combined with an average price of $1000 to $1200 for a computer package yields a cost of approximately $1600 to $1800 per work station. If two students are paired up on each computer station the equipment and software costs can drop to $800 to $900 per student. Thus, developing a fluid power instructional laboratory can be accomplished at approximately 1/3 to 1/6 of the per student cost of developing a similar sized lab using traditional hands-on fluid power trainers.

While professionals in the fluid power field often express a concern for the loss of hands-on skills when computers are used to teach laboratory applications, a blend of hands-on and computerized-simulation based training for fluid power instruction seems to be the best alternative. When available, a basic hands-on fluid power trainer can be a very valuable tool to teach the basic circuitry and troubleshooting. Complex fluid power circuitry can often be more easily taught using a simulation program. While the Automation Studio package does include detailed drawings of hydraulic components, actual cutaways of the various valves, pumps and motors prove to be an excellent teaching tool as well. Fluid power component cutaways are available from the training departments of the corporations listed above. In situations where the funds for a full complement of hands-on fluid power trainers are not available, computerized simulation packages can provide a low-cost alternative while still being able to offer this important educational opportunity to our students.

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Books Briefly Noted

Allen, M.T. & Hecht, G. (2001). *Technologies of power: Essays in honor of Thomas Parke Hughes and Agatha Chipley Hughes*. Cambridge, MA: The MIT Press. ISBN: 0-262-51124-X, $30.00.

This collection explores how technologies became forms of power, how people embed their authority in technological systems, and how the machines and the knowledge that make up technical systems strengthen or reshape social, political, and cultural power. The authors suggest ways in which a more nuanced investigation of technology's complex history can enrich our understanding of the changing meanings of modernity. They consider the relationship among the state, expertise, and authority; the construction of national identity; changes in the structure and distribution of labor; political ideology and industrial development; and political practices during the Cold War. The essays show how insight into the technological aspects of such broad processes can help synthesize material and cultural methods of inquiry and how reframing technology's past in broader historical terms can suggest new directions for science and technology studies.

Angel, S. (2004). *The tale of the scale: An odyssey of invention*. New York, NY: Oxford University Press. ISBN: 0-19-515868-7, $28.00.

"Either things go according to plan, or there is a story." So begins *The Tale of the Scale*, a rare first-person account of the process of invention and design as it unfolds in the remaking of a familiar bathroom scale. It is rare because inventors seldom have the inclination or the ability to articulate their thoughts and to recount their experiences in great detail. Angel, an urban planner by profession and internationally recognized authority on housing policy in developing countries, had no mechanical skills as he embarked on his journey. This book records his transformation, over the course of a decade, from an amateur to an expert on a thin scale, a travel scale. Readers know as much about scales – or about invention for that matter – as Angel does at the beginning of the journey.

The pursuit of the small scale took Angel to fascinating places – from Bangkok to Rolling Hills, California, from Groningen in the Netherlands to Murrhardt in Germany, and from New York to Tokyo. For Angel, these places became realms of knowledge inhabited by people with diverse yet complimentary outlooks on the invention process – engineers, designers, lawyers, product development specialists, corporate functionaries, and friends who philosophize on the deeper meanings of one's life pursuits.

For anyone who has ever strolled down the aisles of IKEA and dreamt that they too could invent a superb object for domestic use, *The Tale of the Scale* will provide advice, humor, caution, inspiration, and above all, a good story.

Berner, G. (2004). *Management in 20XX: A holistic view of what the future holds*. Erlangen, Germany: Publicis Corporate Publishing. ISBN: 3-89578-241-6.

The whole world is witnessing radical economic changes. Traditional markets are stagnating; global markets are emerging. Business processes are becoming more mobile, more flexible, and much more streamlined. The boom companies of yesterday have disappeared from the scene. Such an environment calls for innovative ideas - for new ways of doing business, for new products and services, and for a totally new world.

To survive, companies will have to be resilient and yet adaptable. To turn their visions into reality, they will have to act as well as react. Growth will come to only those companies that can identify demand and apply the right technological know-how to create tangible customer benefit. Development, marketing, and sales departments must arrive at the right strategies, just as corporate organization, production, and logistics managers must devise and implement the best possible processes.

The book lays out some remarkable scenarios and ambitious visions for the future. It helps readers to formulate ideas and plot new directions for their business and points out the changes needed to meet challenges that lie ahead. The new role people will play in the evolving world of business also receives attention in this book that is at once informative and inspiring.

Bizup, J. (2003). *Manufacturing culture: Vindications of early Victorian industry*. Charlottesville, VA: University of Virginia Press. ISBN: 0-8139-2246-1, $39.50.

From Robert Southey to William Morris, British social critics in the Romantic tradition consistently stigmatized industry as a threat to aesthetic or humanistic "culture." Joseph Bizup, Associate Professor of English and Comparative Literature at Columbia University, argues that early Victorian advocates of industry sought to resist the power inherent in this opposition by portraying automatic manufacture itself as a culture force or agent. He traces the contours of this new proindustrial rhetoric as it coalesced in two mutually reinforcing discourses: The contentious debate over the factory system and its social consequences that raged throughout the 1830s and 1840s, and the extensive discussions of the social and commercial benefits of good design that culminated in the Great Exhibition of 1851.

Through careful readings of a diverse array of texts, including treatises on factories and machinery, medical studies of the working classes, theoretical discussions of the decorative arts, and lectures on the Great Exhibition, Bizup shows that liberal proponents of industry such as Andrew Ure, Charles Babbage, James Phillips Kay, and Henry Cole aestheticized manufacture by interpreting its concrete agents and products – whether they be factory operatives, systems of machinery, mass-produced copies, or elaborately crafted "art manufactures" – as emblems of a prior conceptual unity or beauty. They thus allied industry with culture by portraying industry as one realization of the organic ideal central to the idea of culture. Bizup concludes with an examination of John Ruskin's and William Morris's efforts to counter this sort of rhetorical maneuvering by treating cultured manliness as a figure for the cooperative impulse they both hoped would replace competitive self-interest as a society's organizing value.

By showing that culture could not be opposed to industry in any pure or absolute sense, *Manufacturing Culture* both enriches our understanding of the Victorian debates over industrialization and contributes greatly to the ongoing scholarly exploration of the complex genealogy of our modern concept of culture.

Bowden, M.E., Crow, A.B. & Sullivan, T. (2003). *Pharmaceutical achievers: The human face of pharmaceutical research*. Philadelphia, PA: Chemical Heritage Press. ISBN: 0-941901-30-0, $30.00.

Teachers today want to present the human face of scientific and industrial research, to point to the real people who had the insights and made the major advances that students are asked to understand. This collection of photographs and biographical information makes it easy for teachers to show the human side of pharmaceutical research. The format and special binding of the book allow for easy conversion to overhead transparencies and other media.

Brantingham, P.J., Kuhn, S.L. & Kerry, K.W. (2004). *The early upper Paleolithic beyond western Europe*. Los Angeles, CA: University of California Press. ISBN: 0-520-23851-6, $75.00.

This volume brings together the research of prominent archaeologists working in areas outside western Europe to present the most recent evidence for the origins of the early Upper Paleolithic and its relationship to the origin of modern humans. With a wealth of primary data from archaeological sites that have never before been published and discussions of materials from difficult-to-find sources, the collection urges readers to reconsider the origins of modern human behavior.

Archaeological evidence continues to play a critical role in debates over the origins of anatomically modern humans. The appearance of novel Upper Paleolithic technologies, new patterns of land use, expanded social networks, and the emergence of complex forms of symbolic communication point to a behavioral revolution beginning around 45,000 years ago. Until recently, most of the evidence for this revolution derived from western European archaeological contexts that suggested an abrupt replacement of Mousterian Middle Paleolithic with Aurignacian Upper Paleolithic adaptations. In the absence of fossil association, the behavioral transition was thought to reflect the biological replacement of archaic hominid populations by intrusive modern humans.

The contributors, both of whom are Assistant Professors in Archaeology, present new archaeological evidence that tells a very different story: the Middle-Upper Paleolithic transitions in areas as diverse as the Levant, eastern-central Europe, and central and eastern Asia are characterized both by substantial behavioral continuity over the period 45,000-25,000 years ago and a mosaic-like pattern of shifting adaptations. Together these essays will enliven and enrich the discussion of the shift from archaic to modern behavioral adaptations.

Brodhead, R.H. (2004). *The good of this place: Values and challenges in college education*. New Haven, CT: Yale University Press. ISBN: 0-300-10600-9, $25.00.

Richard H. Brodhead, the popular Dean of Yale College from 1993 to 2004, was involved in every aspect of undergraduate education – curriculum, faculty appointments, and student life – and occupied a unique position from which to ponder the ways that college can prepare young people to live fulfilling lives.

As Dean Brodhead prepares to leave his position at Yale as Professor of English and American Studies and Dean of the College to begin a new chapter of his life as president of Duke University, Yale University Press is pleased to publish The Good of this Place: Values and Challenges in College Education. This eloquent collection of essays and speeches by Dean Brodhead addresses issues of importance to institutions of higher learning and to those who participate in them.

One of Dean Brodhead's responsibilities at Yale was to welcome new students at the annual Freshman Assembly, and this book presents his engaging remarks as he simultaneously reassured and challenged them. The later sections of the book range through various concerns of the contemporary university, from free speech and diversity issues to sexual harassment policy, residential education, the assessment of academic programs, and the complex and competing goals of college admissions.

At once reflective, witty, and wise, this book speaks to students and educators alike, to all who hope to become – or shape others to become – thoughtful and constructive members of society.

Butz, W.P., Kelly, T.K., Adamson, D.M., Bloom, G.A., Fossum, D. & Gross, M.E. (2004). *Will the scientific and technology workforce meet the requirement of the federal government?* Arlington, VA: RAND Science and Technology. ISBN: 0-8330-3529-0, $20.00.

The size and adequacy of the federal workforce for carrying out scientific, technical, engineering and mathematics (STEM) activities are ongoing concerns in many policy circles. Experts both inside and outside of government have voiced fears that this workforce is aging and may soon face a dwindling labor pool, a problem that could be compounded by skill shortages in key areas and growing numbers of non-US citizens obtaining STEM degrees in the United States. The authors asses the condition of this workforce, based on the best available data, while focusing on three main areas: trends in the US STEM workforce overall that might affect the federal STEM workforce, workforce-shaping activities in the federal STEM workforce, and legislative and programmatic mechanisms for influencing that workforce.

Table of Contents

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Providing a Virtual Initiation for Epsilon Pi Tau

Craig S. Sanders and Kathryn M. Griffin

Introduction

One of the requirements of the Epsilon Pi Tau (EPT) initiation is the apprentice has to physically be at the initiation (EPT, 2004). Since the majority of nontraditional students and working professionals are physically removed from an initiation site, they have missed the opportunity to join EPT.

Distance education in technological fields is continuing to grow to meet the needs of students and working professionals that are unable to attend traditional, on campus classes. Just as instructors can reach out to distance education students through the use of multimedia technology, so must organizations reach out to those same students. A key question, how societies can reach out and embrace nontraditional students, can be answered through the use of multimedia tools. By using the multimedia tools from the classroom in the initiation, nontraditional students and working professionals are now able to have the opportunity to participate in a live ceremony and experience the common social bond that develops in an interactive environment

The initiation itself consists of lessons with members of a ceremonial team playing the role of teachers/advisors. The lessons teach the apprentices about the organization, its fundamental beginning, basic beliefs and values, and the value and strength of the three precepts of EPT: technology, skill, and professional ideals. Therefore, it is very appropriate that one multimedia tool, streaming video, which is used in the classroom should also be used to teach the lessons of EPT.

On 8 April, 2005, the Beta Mu Chapter of The International Honor Society for Professions in Technology at East Carolina University (ECU) performed the first virtual initiation for the honorary in technology. Members of the ECU initiation team performed a face-to-face initiation for eight new apprentices while simultaneously initiating twenty more apprentices through the Internet using streaming video and an Internet relay chat client (mIRC). When the apprentices were required to respond to questions during the ceremony, the face-to-face group did so verbally while the students watching and listening on the Internet responded with a real-time, typed and transmitted text message.

This paper shows the benefits that schools and EPT Chapters can realize using a common and affordable Internet technology application to increase student participation and achievement, and provide EPT membership to deserving individuals who are geographically separated from traditional initiation sites.

The Value of Streaming Video

Streaming media technology distributes a real-time or on-demand combination of audio, video and multimedia via the Internet. Streaming media provides a simultaneous transfer of digital media so that it is received as a continuous real-time stream. Streaming video can deliver live or archived instructional presentations to all types of students, regardless of their available bandwidth. It is a series of compressed images that is sent in a continuous data stream over the Internet to a user's computer; the user can then view the images, or video, with only a short, few-seconds delay of buffer time. Streaming video replaces the downloaded video file, which can absorb massive amounts of computer memory and take a long time to download. Streaming video allows the user to start watching the video at almost the exact moment the data arrives on his or her computer (Waggoner, 2000). The great advantage streaming video has over other types of archived movies is that it does not leave behind a physical file on the viewer's machine; therefore, the speed or bandwidth of the Internet provider is less of a factor.

Streaming video has other benefits; it can be retrieved using broadband or dialup, is fairly easy to use, and is becoming less expensive each year (Cofield, 2004). Video streaming in the workplace is quite common now, covering issues such as diversity, safety, stress and time management, employee development and training, and total quality management. More people are realizing the benefits of streaming video in that it can bridge the gap between theory and practice. Traditional students, online students, and working professionals can now all have access to videos showing real-world problems, laboratory simulations, and lectures.

Overcoming Obstacles

While there are currently many obstacles to overcome regarding the adoption of video technology, there are also ways around these obstacles. Bandwidth refers to the amount of data that can be transmitted over the Internet in a fixed amount of time. For computing purposes, bandwidth is usually expressed in bits or bytes per second. Internet connection speeds include dial-up modems at 56 Kilobits per second (Kbps), DSL, which can range from 128 Kbps to 8 Megabits per second (Mbps), and T-1 lines at 1.544 Mbps. Generally speaking, the broader the bandwidth, the better the quality of the streaming video and audio. Many schools and students currently do not have sufficient bandwidth to support dependable downloaded video files, though the technology is coming.

According to one study, students who received instruction incorporating the video-on-demand application showed dramatic improvement in achievement (Boster, Meyer, Roberto, & Inge, 2002).

Potential advantages to multimedia are numerous. Claims ranging from reduced learning time to cost-effectiveness abound. Few of those advantages have been evaluated using formal experimentation, just as have the actual specific multimedia tools. One such tool, streaming video, has yet to be fully analyzed as a new instructional tool for both online and on campus classes; streaming video has the potential to bridge the divide between all types of students, and enhance material retention of said students.

Social Belongingness

Unfortunately, distance education does have its disadvantages, one of which is the lack of face-to-face social interaction. Online students are often cut off from campus activities and camaraderie with fellow students; the only form of interaction is through multimedia devices, which may enable visual interaction, but not physical interaction. Technology that is being used today in education has decreased face-to-face interaction and communication (Hagan, 1999). Online students often find themselves lacking in social presence, those qualities present when people are communicating and interacting in close physical proximity (Saenz, 2002).

This lack of physical interaction, or depersonalization, goes against human nature. Humans have basic needs, one of which is the need to belong. Maslow's hierarchy of needs show that one of the most fundamental biological needs is that of love and belongingness (1954). People seek relationships with and their places in formal, informal, and social groups. Numerous studies have been in agreement with Maslow's idea of belongingness (Mioduser, Nachmias, Lahav, & Oren, 2000; Ladyshewsky, 2004; Nohria, Lawrence, & Wilson, 2001; Ryan & Deci, 2000; and Thompson, Grace, & Cohen, 2001). Belonging to a group or a social set provides people with information and purpose, and gives them a foundation of social identity, including values, attitudes, and behavioral intentions (Haythornthwaite, 2002). Hence, many who are online are turning to virtual organizations and/or groups to satisfy their need to belong. The virtual groups give individuals a sense of affiliation and social satisfaction (Watson-Manheim, Crowston, & Chudoba, 2002; Dholakia, Bagozzi, & Pearo, 2004).

While Epsilon Pi Tau (EPT) is not necessarily categorized as a virtual organization, it does provide a means of emotional support, social support, companionship, and a sense of belongingness to its individuals. However, the organization has not been able to reach many distance education students because of students' location, work schedule, and other various issues.

Intitiation Methods

Two emails were sent out to East Carolina University distance education (DE) and on campus (OC) students nominated for membership into EPT. DE students are defined as nontraditional students who usually attend classes through the Internet, and typically have an age range of 25 to 65 years. OC students are defined as those students who usually attend on campus classes, and typically have an age range of 18 to 24 years.

For those students who accepted the nomination, a second email was sent with instructions concerning the initiation. The OC students received the traditional instructions, including the time and location of the initiation. The DE students received different instructions, which included the time of the initiation, instructions concerning the set up of mIRC, location and access to the streaming video website, and instructions on responding to the pledge statement. Both sets of instructions were also posted on the College of Technology and Computer Science website.

The initiation was held at ECU, and the following multimedia components were used: a 64-inch screen television, a web camera with remote movement capabilities, five microphones, a computer with a video capture card, software, a high bandwidth internet connection, video compression, mIRC, and Microsoft software.

The ritual itself was divided into an 84-slide PowerPoint presentation; a chapter member controlled the speed of the presentation by a remote mouse. The PowerPoint presentation was displayed upon the television, which acted as a teleprompter. The webcam was placed above the television so that when the presentation was read aloud, it appeared as if the initiation team members were looking straight into the camera, connecting with their audience. Three technicians controlled the broadcast, camera movements, audio and visual components, and the mIRC chatroom.

DE students were instructed to view the live streaming video broadcast through the Global Classroom website and, at the same time, be logged into a specific mIRC chat room, which kept logs of the conversation and the students who were in the chat room. An ECU moderator controlled the mIRC chat room. The moderator gave instructions at the beginning of the ceremony concerning chat room etiquette and the proper response during the pledge statement. During the pledge, DE students were asked to repeat the pledge in real time, and then type their names into the mIRC chat room as verification of completing the pledge. OC students followed the normal initiation procedures.

Conclusion

The Beta Mu Chapter members and the Region 2 Director, Robert E. Wenig, who attended and participated in the initiation, considered the initiation a success. An informal survey of attendees and initiates showed a very favorable response. As of yet there has been no formal response from the Board of Directors of Epsilon Pi Tau, but informally they are considering the virtual initiation for adoption as a way to reach more deserving nominees.

After an exhaustive search, it appears that EPT is possibly the first organization to ever attempt an online initiation ceremony, and has proven that it is a viable alternative. Using distance education technology tools, EPT can now extend membership to individuals who were once geographically incapable of physically attending an initiation, increasing interest and participation in EPT activities and membership.

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An Exploration of Middle and High School Students' Perceptions of Deviant Behavior When Using Computers and the Internet

Annie J. Daniel

Abstract

If the current trend continues, the use of computer technologies and the Internet will increase for teaching and education. It is urgent that researchers study computer and Internet deviance. The purpose of this study was to explore middle and high school students' perceptions of deviant behavior when using computers and the Internet.

The target population for this study was middle and high school students. The accessible population included all students who attended a middle or high school in the East Baton Rouge Parish School, which has computers that are capable of accessing the Internet (1,150 students - 575 middle school students and 575 high school students).

Professor San-Yi Li of Taiwan designed the instrument used in this study. This instrument contained 66 questions and a scantron was used to record participants' responses. From the instrument, variables were selected from five sections - 1) students demographic characteristics 2) computer-related activities 3) students perceptions of deviant behavior when using computers and the Internet 4) students perception of their peers deviant behavior when using computers and the Internet 5) students ability to use computers and the Internet.

Results showed that the majority of students indicated they perceive their behavior as being not deviant when using computers and the Internet. Contrarily, the students indicated they perceive the behavior of their peers to be more deviant when using computers and the Internet. When the means of the Students Behavior Score and the Peers Behavior Score were compared, there was a significant different between the two scores. The Peers Behavior Score for deviance was much higher than the Students Behavior Score.

Introduction

"Any technology tends to create a new human environment."

-Marshall McLuhan

Marshall McLuhan declared this quote over forty years ago. Indeed, today's technology has created many new human environments and behaviors. Deviant behaviors on the computer and the Internet are rising as technology use increases (Hollinger, 1996b; Power, 2000; Vatis, 2000). This is evident in the enormous number of computer viruses that have been released recently causing businesses, educational institutions and personal computer users to become skeptical about performing familiar daily tasks (e.g., opening email messages).

For the purpose of this paper, deviant behavior for technology will include these activities: using computers and the Internet for illegal activities that violate local, state, and/or federal laws, inappropriate use; such as, a violation of the intended use of the Internet or computer, and/or its intended purpose and goal, obscene activities; defined as entering a pornography website or selling pornography goods on the Internet; using the Internet or computer to violate copyrights laws or other contracts such as institutional or third party copyright, license agreements and other contracts, intentionally disrupting the Internet traffic by spreading a computer virus, spreading rumors about another person on the Internet, intimidating and frightening another person on the Internet.

Deviant behaviors are a genuine concern since our society is rapidly moving from a typographic culture to a post-typographic culture (Provenzo, Brett & McCloskey, 1999). According to Provenzo, et al., "typographic culture is defined as a culture or society based around the technology of printing and post-typographic culture is defined as an electronic non-text-oriented culture." (p. i) With this movement, our culture and society is being transformed. People are communicating more by electronic mail and computers than by text or letter writing. Culturally, we are becoming more dependent on computers and computer-based technologies (Provenzo, et al.).

For example, students are no longer learning to type with typewriters, but with word processor software. Those schools that are using typewriters are rapidly moving into the post-typographical era. Graphing calculators are required in math courses. Digital cameras are being used in art courses. In addition, art teachers are integrating computers with computer aided drawing software to teach computer drawing or graphic design to students.

Moreover, computer technologies are used to enhance various everyday classroom activities. Students may engage their time by playing computer-generated video games, simulations, drills and practice exercises, or tutorials. When students make class presentations, often the presentations will be integrated with interactive multimedia technology. Integrating technology is well thought-out type of school reform that is used to improve the learning of all students; schools are moving rapidly to integrate computers and the Internet into their curriculum (Glennan & Melmed, 1996). Computers are considered a tool that when effectively used, will increase efficiency and productivity in a curriculum (Hunter, 1984). Researchers have designated the Internet as an equalizer of knowledge, because it allows the same knowledge to be accessible to all (Kearsley, 2000; Kent & McNergney, 1999; Milken Family Foundation, 1997; Papert, 1993). The cost of purchasing a computer has drastically declined in recent years. This decline in costs is allowing the Internet and computers to be more accessible to all by being available in public libraries and schools. In addition, this decrease in the cost of computers allows more of the United States' population to own personal computers.

Brief Overview of Technology Deviance

For the past ten years, the Internet and computers have radically changed the way schools interrelate with the world. The information super highway has become a reality. Students can use the Internet from home or school to travel vicariously all over the world, to gather information and new knowledge. As more travel on this electronic highway increases, maps to find information and rules to keep the journey safe is becoming vital to successfully completing the journey.

In Understanding Media, Marshall McLuhan (1964) stated the following:

> Any technology tends to create a new human environment. Script and papyrus created the social environment we think of in connection with the empires of the ancient world. The stirrup and the wheel created unique environments of enormous scope. Technology environments are not merely passive containers of people but are active processes that reshapes people and other technologies alike. In our time, the sudden shift from the mechanical technology to the electric circuitry represents one of the major shifts of historical time. (p. iv)

Marshall McLuhan predicted in 1962 a coming "Global Village." This global village is now reality, in the form of the Internet. His words are so prophetic, "Technology environments are not merely passive containers of people but are active processes that reshape people and other technologies alike" (p. 2). Due to the evolution of the Internet and computers, this very quotation is now reality. Computers and the Internet have "reshaped people and other technologies alike" (p. 2).

As our society is being transformed, computers and the Internet are being incorporated into almost every activity including education, communication, shopping, buying and selling goods, and business. In business, having a website and electronic address in order to show that your company is on the cutting edge of technology is important. Large corporations and small locally owned companies are on-line. Being on the Internet is a new way of attracting potential business. The education system has the same views about technology, having technology in the schools shows willingness for reform or improvement. With change and improvement, usually there are advantages and disadvantages that should be considered. One major disadvantage is that computers and the Internet are vulnerable to attacks and sabotage.

Voss (2000) referred to the Internet as "cyberworld," which is very much like our earthly world. It has highways (the World Wide Web), businesses (e-commerce), homes (homepages), schools, colleges, universities (distance learning), and it has people that travel in this world (by way of the Internet). Among these people, there are those that are deviant and commit deviant acts on the superhighway and in cyberworld, but there are no police, highway patrol officers, and administrators of discipline or cybercops to stop these people from committing their deviant acts, although authorities are beginning to pursue actively such criminals (Power, 2000). This research will focus on what young people (middle and high school students) perceive to be a deviant act when using a computer or the Internet. After all, some of these students have been using computers since the age of two (National Public Radio, 2000).

The Internet is the electronic highway that provides a means of instantly accessing people, institutions, and an overwhelming amount of information from around the world.

Basically, the Internet is the world's largest computer network linking millions of people in more than 50 countries, on every continent of the globe. Most of the services are provided free by organizations that support host computers on the network. These typically include universities, corporations, governments, and small businesses that use mainframes and mini- computers to maintain and manipulate databases.

Due to the easy access of information on the Internet; the opportunity for misuse increases. Ethical behaviors by students, teachers, employees, and employers have become a major topic of concern. With the frequency of technology use, cyberattacks are also on the rise (Hollinger, 1996b; Power, 2000), as well as the question of ethical behavior by students and employees. A recent report on Cybercrime by Michael A. Vatis (2000) Director, National Infrastructure Protection Center, Federal Bureau of Investigation, indicated that cybercrime is on the rise:

> As Internet use continues to soar, cybercrime is also increasing exponentially. Our caseload reflects this growth. In FY 1998, we opened 547 computer intrusion cases; in FY 1999, that number jumped to 1154. Similarly, the number of pending cases increased from 206 at the end of FY 1997, to 601 at the end of FY 1998, to 834 at the end of FY 99, and to over 900 currently. These statistics include only computer intrusion cases, and do not account for computer-facilitated crimes such as Internet fraud, child pornography, or e-mail extortion efforts. In these cases, the NIPC and NIPCI squads often provide technical assistance to traditional investigative programs responsible for these categories of crime. (p. 12)

Secondary and college faculty have reported an increase in students cheating by computer (Benning, 1998). According to a George Mason University instructor, cheating is more easily done by using computers and the Internet. Anne Marchant (a college instructor) refers to these types of cheaters as "patchwork plagiarists." She says, "The students who copy and paste together passages from various articles they have found on the Internet, then turn in the work as their own." (p. 1). She teaches computer science and catches at least one such student every semester and this includes students using plagiarism in her computer ethics course. Marchant says she has no problem identifying the cheater, because "It's usually deadly obvious. The introduction will be written in broken English; then it will have this flawlessly written, almost doctoral-quality body; and then a conclusion that goes back to broken English." (p. 1) Students have access to dozens of web sites that aid them in cheating (on-line paper mills sell term papers) and students share tests and course materials via email or diskette (Benning, 1998).

In addition to using computers and the Internet to cheat, a few studies have been conducted to determine the types of on-line activities at colleges. Perry, Wilkinson, and Perry (1998) surveyed 509 college students to determine how many students engaged in seven online activities. There was only one question that addressed deviant behavior (Do you use the Internet to access adult material?); fifty (23%) of the 218 responded "yes" to this question.

Cost of Computer and Internet Deviance

The business industry is more susceptible and vulnerable to attacks (Power, 2000). Harrison (1999) reported that for the last three years, the Computer Security Institute statistics on cyberattacks showed a financial loss of more than $100 million a year. In Harrison's report, 521 security managers in the study reported breaches by outside crackers or hackers, and 30% of the respondents reported intrusions; which was up from 24% from the previous year. The Internet connection had the highest point of attack, 57% of the respondents. While 20% of the respondents had detected unauthorized

Table 1: Computer Crimes and Financial Loss

Types of Computer Crime	1997	1998	1999	2000
Theft of proprietary information	$20,048,000	$33,545,000	$42,496,000	$66,708,000
Financial fraud	$24,892,000	$11,239,000	$39,706,000	$55,996,000
Virus	$12,498,150	$7,874,000	$5,274,000	$29,171,700
Insider abuse of Net access	$1,006,750	$3,720,000	$7,576,000	$27,984,740
Sabotage of data or networks	$4,285,850	$2,142,000	$4,421,000	$27,148,000
Unauthorized insider access	$3,991,605	$50,565,000	$3,567,000	$22,554,500
Laptop theft	$6,132,200	$5,250,000	$13,038,000	$10,404,300
Denial of service	N/A	$2,787,000	$3,255,000	$8,247,500
System penetration by outsider	$2,911,700	$1,637,000	$2,885,000	$7,104,000
Active wiretapping	N/A	$245,000	$20,000	$5,000,000
Telecom fraud	$22,660,300	$17,256,000	$773,000	$4,028,000
Telecom eavesdropping	$1,181,000	$562,000	$765,000	$991,200
Spoofing	$512,000	N/A	N/A	N/A
Total Annual Losses:	$100,119,555	$136,822,000	$123,779,000	$265,586,240
Grand Total of Losses Reported (1997-2000): $626,306,795				

Source: Computer Security Institute - 2000; 643 Respondents for 2000

access or misuse of their websites in the past year from outsiders, 55% of the respondents reported attacks from the inside had increased by 10% from the previous year (Harrison, 1999).

For the past five years, the FBI and the Computer Security Institute have conducted a study of computer crime by administering the "Computer Crime and Security Survey" to information security professionals at corporations, financial institutions, government agencies, and universities across the United States.

The table shows the types of computer crime and amount of financial loss incurred over a period of four years by types of computer crimes. For several of the crimes, the financial losses have increased over the years of the study. The highest loss occurred in the 2000 survey (see Table 1) by theft of proprietary information ($66,708,000) and the lowest was telecom eavesdropping ($991,200).

A Review of Related Research on Students' Computer Usage

This review on related research was compiled from research of students in the United States. Researchers in the studies are from public and private institutions.

Where Students Use the Internet

According to a survey by the National School Boards Foundation (2000), "both school and home are important points of Internet access for children" and "by the time they are teenagers, nearly three out of four children are online." (p. 1)

Twenty-eight percent of the children surveyed by the National School Board Foundation (2001) reported that they access the Internet from home. However, when parents were surveyed, 69 percent of the parents reported their children have access to computers at home and are able to log onto the Internet.

Overall, 23 percent of all children surveyed are accessing the Internet from school. Fifty-six percent of parents whose children have access to the Internet at home reported that their children also log onto the Internet at schools or preschools. (p. 1)

Reasons Students Use Computers and the Internet

Researchers at the National Center for Educational Statistics (2000) revealed that the main reason families buy computers and connect to the Internet is for educational purposes.

> About two thirds (64 percent) of family households surveyed have a home computer. The most common reasons parents cite for buying home computers is children's education (36 percent) and business use (27 percent). Likewise, the most common motivation parents cite for their child to use the Internet from home is their education (45 percent). Education is the single most frequently cited motivation (39 percent) for parents who anticipate obtaining home Internet access as well, followed by email (17 percent) (p. 1).

Additionally, student ages 13 to 17, in the National School Board Foundation (2001) study, cited education and schoolwork (32 percent) as the main reasons for usage. This study also reports that students use the Internet at least once a week for schoolwork and general learning activities not connected to school.

Frequency of Computers and the Internet Use

The National Center for Education Statistics (1997) reported the frequency of computer and Internet use by students. This report disclosed information pertaining to students in the fourth, eighth and eleventh grades for five years (1984 to 1994). The categories for frequency of use were never, less than once a week, once a week, 2 or 3 times a week and every day.

Results of this study showed that in 1984 the majority of students in each grade level responded that they had never used a computer (4th grade-61.2%, 8th grade-66.7%, 11th grade-55.0%). However, by 1994, the majority of the students in all grades reported using a computer less than once a week, once a week, 2 or 3 times a week, or every day (4th grade-83.5%, 8th grade-72.4%, 11th grade-73.9%).

Computer use by students has increased over the years. Students are using computers at home and at school and using them for learning activities and pleasure (chatrooms, emails, playing games, listening to and recording music, etc.). (National Center for Education Statistics, 1997)

Computer Usage by Gender

In general, girls use computers and the Internet as much as boys, but in different ways (National School Boards Foundation, 2000). When it comes to competency, girls are as competent as boys. Girls are more likely to use the Internet to e-mail friends and family than boys. Girls are also more likely to use the Internet for schoolwork and chatrooms than boys. Boys reported using the Internet more for entertainment and games.

> According to their parents, 48 percent of 9- to 12-year-old boys and girls are online, while 71 percent of 13- to 17-year-old boys and girls are online. Both younger and older girls seem just as likely to use the Internet as their male counterparts; 50 percent of 9-to 12-year-old girls use the Internet, compared to 46 percent of boys. In the 13- to a 17-year-old age bracket, 73 percent of girls use the Internet, compared to 70 percent of boys. (National School Boards Foundation, 2000, p. 6)

Computer and Internet Use by Race and Income

"Schools have the opportunity to help narrow the gap between the haves and have-nots with Internet access." (National School Boards Foundation, 2000 p. 7) "Parents with an income of $70,000 or more reported that one or more of their children use the Internet, compared to 35 percent of parents with incomes of less than $40,000. Fifty-seven percent of white parents report that their children use the Internet, compared to 23 percent of African-American parents." (National School Boards Foundation, 2000, p. 7)

Among students with parents who have an income of $40,000 or less, 76 percent of 9-to 17-years-old use the Internet at school; while 68 percent of children of wealthy families and 54 percent of children in middle class families use the Internet at school. Schools are the main source of Internet use for children that are from low-income families (National Center for Education Statistics, 1999 & National Center for Education Statistics, 1998).

Eighty percent of African-American families with children age 9 to 17-years-old use the Internet at school. This is compared to only 16 percent who reported they log on from home (National School Boards Foundation, 2000 & National Center for Education Statistics, 1999).

This report is consistent with findings from a study by the National Public Radio (2000). Results of this study revealed a "digital divide" between those with lower incomes and less education. "Americans with lower incomes are less than half as likely as those with higher incomes to have an Internet connection at home" (p. 1). Furthermore, "there is a gap of 11 percentage points between blacks and whites using computers at work (46% vs. 57%); but there is a larger, 22 point gap between blacks and whites who have a computer at home (51% vs. 73%). Similarly, a gap of 8 points exists between blacks and whites using the Internet at work (21% vs. 29%) compared with a larger 19 point gap in access to the Internet or e-mail at home (38% vs. 57%). There is a 17 percentage point gap in home-computer ownership between low-income blacks and low-income whites" (p. 5).

The Study

If the current trend continues, the use of computer technologies and the Internet will increase for teaching and education. It is urgent that researchers study computer and Internet deviance that may occur in the educational environment. Although a limited amount of research has been performed to determine the types of deviant behavior students use on the Internet and on computers, the opportunity to perform deviant acts increases with the integration of technology in education.

Methodology

Population and Sample - The target population for this study was defined as middle and high school students. The accessible population included all students who attended a middle or high school in the East Baton Rouge Parish School System (EBRPSS) with computers that are capable of accessing the Internet. A convenience sample of approximately 1,150 students was surveyed (575 middle and 575 high school students). Principals at these schools were notified of the study and asked to identify teachers with Internet access in their classrooms. The school principals decided which teachers would participate in the study, which determined the students to survey.

Purpose and Objectives of the Study-The primary purpose of this study was to explore middle and high school students' perceptions of deviant behavior when using computers and the Internet. In order to answer the research problem, the following six objectives were used to guide the researcher:

1. Describe the middle and high school students on the following selected demographic characteristics: a) Gender, b) Age, c) Ethnicity, d) Grade in School, e) Type of School (middle or high school), f) Academic Achievement as Perceived by the Students, g) Religious Affiliation, h) Students' Interaction with Teachers, i) Students' Interaction with Other Students
2. Describe the middle and high school Students' Behavior Score.
3. Describe the middle and high school Students' Peers' Behavior Score.
4. Compare the Students' Behavior Score of middle and high school students on selected demographic characteristics and perceptions of computer-related activities.
5. Compare the Students' Behavior Score and the Peers' Behavior Score.
6. Determine if a relationship exists between the Students' Behavior Score and the Peers' Behavior Score on selected demographic characteristics and perceptions of computer-related activities.

Instrumentation and Procedure for Data Collection-The instrument for this study was developed by Professor San-Yi Li in Taiwan (who gave the researcher permission to use his instrument for this study) and revised by the researcher. Several key demographic questions were added to the survey, which were: "What is your race or ethnicity?," "Is there a working computer in the home where you live?," "If there is a working computer in the home where you live, is it connected to the Internet?," and "What type of school do you attend?" The original survey had 62 questions. After the revisions, the number of questions increased to 66. Not all of the questions were used for this study. Questions that addressed the objectives of the study were selected as variables to be used in the study. The selected variables were systematically copied into a file. The primary variables studied were categorized as: 1) students' demographic characteristics, 2) computer-related activities, 3) students' perceptions of deviant behavior when using computers and the Internet, 4) students' perception of their peers' deviant behavior when using computers and the Internet, and 5) students' ability to use computers and the Internet.

Data were collected during the spring semester of 2000. The procedure for collecting the data was as follows:

1. The EBRPSS Director of Academic Accountability was contacted to obtain approval to conduct a research survey in the middle and high schools in the system.
2. The parish Director of Technology (was contacted by telephone and visited in person by the researcher to obtain the list of schools) identified the seven middle and seven high schools with computers that had access to the Internet.
3. Principals of the schools identified were then contacted by faxed letter and telephone and a request was made to survey students with computer and Internet usage experience.
4. Those teachers and students selected by the school principals were informed of the general objectives of the research by the principal and the researcher. Students were asked to participate in the study voluntarily.

Once the subjects agreed to participate in the research, they were informed that this project required them to complete a survey that consisting of 66 questions. Students were given a pencil and scantron sheet to record responses and an additional sheet with open-ended questions to respond to. Students were allowed about 45 minutes to complete the survey, but additional time was allowed for those students needing it. Five hundred seventy five middle school students and 575 high school students responded to the survey.

Summary of Findings

For the first objective of the study, participants were asked several questions that pertained to demographics, (e.g., age, ethnicity, grade level). Participants' ages ranged from 13 to 17 years old. As for ethnicity, the majority of the students responding reported their ethnicity as African American, with the next largest group of respondents being White. The grade level of the students ranged from 7th to 12th grade, with the 11th or 12th graders having the largest number of respondents. Students in the study were either in middle or in high school, and most of them rated their academic achievement as good with a strong religious affiliation. Additionally, a large portion of the students interacted with their classmates and teacher regularly.

Objective two was to describe the middle and high school Students' Deviant Behavior Score, which indicates how often a student perceives he/she is using deviant behavior when using the computer or Internet. According to the Students' Deviant Behavior Score, the majority, 869 (79.6%), of the responding students indicated that they displayed no deviance or some deviant behavior while using the Internet. Only a small percentage of students indicated deviance.

In addition to the students' score, students were asked to describe their peers' level of deviance. This data was collected by using the Peers' Behavior Score, which indicates how often a student perceives his/her classmate to be displaying deviant behavior when using the computer or Internet. The results of this score indicated that the majority (1,016, 81.5%) of the students perceived their classmates to be displaying deviant behavior often or very often when using the Internet and computers. The researcher believes that if the students' peers are engaging in this type of behavior than a larger number of students may be engaging as well, but are not disclosing this information. Apparently, students feel more comfortable disclosing what others are doing, rather than what they are doing.

Objective four compared the Students' Behavior Score on selected demographic characteristics and perceptions of computer-related activities, by using a Chi-square procedure to determine if a relationship existed. When comparing the Students' Behavior Score, the following findings were discovered about gender: males indicated displaying more deviance than females when using the Internet and computers. Results indicated a statistically significant relationship between gender and perceived deviance. It appears that males are more likely to display deviance when using the Internet and computers than females. The overall results showed that 27.9% of the males and 12.6% of the females reported deviance. There were twice as many males as females that reported deviance when using the Internet and computers.

When considering deviance and age, two age groups showed the lowest percentage of deviance while using computers and the Internet, the 13 and 17 year olds. Students ages 14, 15 and 16 had the largest percentage of deviance reported. Furthermore, in all of the age groups the majority of the students indicated that they did not display any deviance.

Additionally, the ethnic group indicating the largest percentage of deviance when using the Internet and computers were the Spanish/Hispanic students. The second largest percentage of students indicating some deviance was Asian students. This is comparable to a study by Hollinger (1996b) of college students. He researches crime by computer as it correlates with software piracy and unauthorized account access of college students. He reported that Asian and Hispanic students indicated the highest levels of piracy.

When reporting academic achievement, the majority of students reported their academic achievement as being good, and most of the students perceived themselves as displaying no deviance or some deviance when online. This test resulted in a significant relationship between academic achievement and Student Behavior Score. Students indicating poor or fair academic achievement reported the highest percentage of deviance. Of the students that reported "poor" achievement, 38.1% indicated deviance, and the students that reported "fair" achievement had 25.7% to indicate deviance compared to those students that indicated "good" (17%) or "excellent" (17.4) achievement.

For religious affiliation, those students that indicated a strong or very strong religious affiliation also had the largest percentage of students that did not display deviance when using computers and the Internet. Religious affiliation did not result in a statistically significant relationship with Student Behavior Score. When comparing the no religious affiliation with strong religious affiliation (the group that is closest in numbers), there is no significant difference. The researcher believes these students are either just honest because of their religious affiliation, or religious affiliation for some is not as effective as for others in developing ethics. After all, the students with no religious affiliations were able to admit what they are doing online.

With regard to students' interaction with teachers, most of the students indicated that they interacted with their teachers. Interacting with teachers did not have a significant relationship with the Student Behavior Score. Although there was not a significant difference between level of interaction with teachers and Students' Behavior Score, students that reported no interaction with teachers reported deviance at 26.3%. This is compared to the students who reported they interacted with their teachers "some" (15.9%), "often" (20.1%) and "very often" (22.5).

The students that interacted with other students reported the least amount of deviance when using computers and the Internet. The majority of the students indicated that they interacted with their classmates. Furthermore, there was a significant relationship between the Student Behavior Score and the level of interaction students have with their classmates. Students that reported no interaction with classmates had the highest overall percentage of deviance (35.2%). This is compared to the other levels of interaction that gets lower as the level of reported interaction get larger ["some" (21.8%), "often" (18%) and "very often" (17.4)]. Consequently, students that alienate themselves from others are engaging in more deviant activity when using computers and the Internet.

A high proportion of the students indicated that they spend "much" time online and display very little deviance when using the Internet and computers. This analysis was interesting because some of the students indicated that they do not spend any time online, but they displayed deviant behavior when online (time spent online "none," 28.6% of the students indicated deviance online). Students evidently misunderstood the question. Students' time spent online have a significant relationship with Students' Behavior Score. Students that reported spending more time online has the highest overall percentage of deviance -"very much" (22.2%) and "much" (21.2%). This is compared to the other students that reported spending less time online, "little" (15.5%).

As related to hours per day spent on the Internet, when asked specifically how many hours per day they spent on the Internet, students could relate to this question and responded more accurately. Hours spent online are highly related to Student Behavior Score. Students that reported spending the least amount of time online reported the lowest percentage of deviance (2 hours, 15.3%). This is compared to the other amounts of time spent online, in which the percentage of deviance increases as more time is spent online (3-4 hours, 19.1%; 5-6 hours, 37.2%; 7-8 hours, 44.7%; 9 hours, 46.7%). It is highly recommended that students' time online is supervised and coupled with a program that will monitor or control their online activity.

When asked whether there was a working computer in the home, the majority of the students indicated that they had a working computer in the home. However, a smaller number of students indicated that they did not have a computer in the home. A working computer in the home was shown to be significantly related to the Student Behavior Score. The percentages for deviance were higher for those students not having a computer in the home. This relationship could mean that students do not need a computer in the home to engage in deviant acts on computers and the Internet.

Kevin Mitnick (one of the most famous computer hackers) did not own a computer, but he had been engaging in deviant acts with computer since he was a juvenile. Students with a working computer in the home may be more familiar with computers. Students may not realize or not have been taught that certain behaviors are deviant, therefore they may not be reporting their behaviors accurately. The significance may be how students with computers in the home view what is actually deviant behavior verses those without a computer in the home. Coldwell (1996) concluded that students from machine-based disciplines (computer environments) are less able to predict the social consequences of computer crime than those from people-based disciplines (no computers).

Due to the fact that students are being introduced to computers and the Internet at an earlier age, technology ethics needs to be introduced at all levels of education starting when computers are first introduced to the student. Having a computer in the home allows more chances of deviance to occur, despite the fact that a student may not realize what is happening. Therefore, supervision and ethics teaching become a necessity at home and away from home.

Objective five compared the Student Behavior Score and the Peers' Behavior Score. From the comparison of the means of the Peers' Behavior Score and the Students' Behavior Score, students' perceptions of themselves and their classmates are very different. Students perceive their peers are displaying deviant behavior "often" and "very often" on computers and the Internet. However, students perceive that they are not engaging in "deviance" or "some deviant" behavior.

The researcher believes that if the students' peers are engaging in this type of behavior, then a larger number of students is engaging as well, but is not disclosing this information. Students may feel more comfortable disclosing what others are doing. Students may not want to admit displaying deviance, but it is easier to be more open when discussing someone else's behavior. Therefore, the two scores can be used to gauge the amount of actual deviance being displayed.

The final objective examined whether or not a relationship existed between the Student Behavior Score and the Peers' Behavior Score on selected demographic and perceptual characteristics and computer-related activities. This analyses indicate that relationships are statistically significant between gender, hours spent on the computer, access to a computer with Internet, ethnicity and the ability to use the Internet for how students' perceive their peers' deviant behavior when using the computer and Internet. Likewise, results indicate that relationships exist between gender; hours per day spent online, access to a computer with Internet, ethnicity and a working computer in the home when examining how students perceive their behavior when using the computer and the Internet.

In both analyses, gender was the best predictor for how students may perceive deviance scores; hours spent on the computer is the next best predictor for both scores. The more time students spend online is likely to influence how deviance is perceived. Spending more time on computers and the Internet may lead students to perceive that their deviant behaviors are not deviant, especially if the students are committing deviance and nothing is happening. There may be no one to supervise students' online behavior. Consequently, students feel the behavior is not deviant.

Conclusion

The primary purpose of this study was to explore what middle and high school students perceive as deviant behavior when using the computer and the Internet. Based on the findings, it can be concluded that students do not perceive most of their behaviors on the Internet and computers as deviant. More specifically, the Peers' Behavior Score mean is higher than the Students' Behavior Score. Therefore, students do not perceive their behaviors as being as deviant as their peers. This attitude can be correlated to a theory known as the third person effect (Perloff, 1989). Cohen, Mutz, Price, and Gunther, (1988) defined the third person effect as how people represent themselves in relation to others. The students' image of themselves is more ethical than the students' image of their friends. Hence, their classmates are the ones that visit the pornography websites, access other people's websites without permission and perform other deviant acts when using the Internet and computers.

Additionally, this study will add to the small, but growing body of knowledge concerning students' perceptions of deviance when using the Internet and computers. We have gained an image of how students use the Internet and computers; how students spend some of their time online and how much time they spend using computers and the Internet. From this information, the following profile is generated of the possible characteristics of a student that may engage in computer or Internet deviance:

Male, possibly Asian, Hispanic or Other; ages 14-16;

Poor to fair academic achievement;

No religious affiliation;

No interaction with classmates or teachers;

From 5 to 9 hours a day spent on the Internet and/or computer;

May or may not have a computer at home.

When analyzing the above profile, keep in mind what Bologna (1981) perceived. He indicated that younger computer abusers find it to be challenging to beat the system, establishment or institution. The motive is not always to harm others or for financial gain.

To conclude, the researcher recommends the following to avoid or decrease the chances of deviance when using computers and the Internet at school and home:

- Decrease the size of computer classes to 18-22. One teacher can better manage this number.
- Teachers and parents should encourage students to talk about what they are doing on the computer and the Internet.
- Find out whom they are talking to in chatrooms and via instant messaging, as well as the types of websites they are visiting.
- Supervise their online activity. Students should not be alone for lengthy periods of time. When supervision is not possible, use software or hardware that will help to limit online activity.
- Schools that offer computer classes and access to the Internet should include information on appropriate computer and Internet behavior and ethics in their curriculum. Awareness is the first step to prevention and reducing the potential of abuse.

With the integration of computers and the Internet into the curriculum, there must also be responsibility. If deviance is to be avoided or decreased, all participants must take responsibility, which includes users and the suppliers. Educators and parents must be vigilant in their effort to discourage computer and Internet deviance.

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A Historical Chronology of the Plight of African Americans Gaining Recognition in Engineering and Technology

Keith V. Johnson and Elwood D. Watson

Africans and African Americans have contributed significantly to the evolution of many of the engineering technologies that we can identify with today in areas such as manufacturing, construction, electronics, design graphics, transportation. Due to past history, many African Americans' inventions have been obscured from the public eye. Further, the inventions of African slaves in America automatically belonged to their owners. It wasn't until after slavery that African Americans were given credit for their inventions when they were patented. But even when some patents were sold to Whites, African Americans did not receive proper credit. Therefore, it is virtually impossible to show all of the significant contributions of African Americans in our society.

Science is a pervasive and dominating force in American society. It is a primary source of the understanding of the worlds—physical, biological, behavioral, and social—in which we live; directly or indirectly, it shapes the boundaries and directions of all phases of American life. As a major institutional component of our society, the scientific community inevitably reflects the values of American society at large in its own social structures, beliefs, and attitudes. And, like American society in general, American science reflects the dominance of Whites (Bechtel, 1989). The Black scientist in America is historically an anomaly and currently a statistical rarity. In 1984 Blacks accounted for only 2.3%, or 90,500, of the 3,995,000 employed scientists and engineers (Kusmer, 1991) Even now, in the 21st century, Blacks were 11.3% of the labor force, but only 4.2% of natural scientists, 7.6% of math and computer scientists, and 4.6% of engineers.

In very simple terms, the source of the problem is obvious: There are few Black scientists because there are few Blacks in graduate science programs; there are few Blacks in graduate programs because there are few Blacks who are encouraged to take the undergraduate sources required for successful scientific careers; there are few Black undergraduates who are prepared by their high schools or grade schools to choose such courses. And at every point along the pipeline to a scientific career, large numbers of the young Black men and women who could be scientists turn away. Where does this happen? Why does it happen? And what can be done about it? (Bechtel, 1989).

The shortage of Blacks among the ranks of scientists, engineers, and mathematicians is not the result of some recent misdirected social policy. Rather, it is one dimension of the larger story of Blacks in American society and needs to be understood by reviewing past ideologies, practices, policies, and expectations of Whites and Blacks (Bechtel, 1989). It is necessary to examine the sociohistorical links among attitudes about race, educational policies, and the social structure of science. All three have worked to prevent Blacks from entering science or from having their scientific contributions acknowledged and rewarded.

This article focuses on the contributions of African Americans to scientific and technological innovations. It was written not to disprove or discredit nonminorities who were given full credit for an invention or contribution to technological society but to recognize the contributions of Africans and African Americans who significantly helped mold and direct the evolution of technology. This article is also intended for technology education teachers to use as a tool to encourage African American youth to realize that they have a very brilliant heritage and wealthy history. This paper attempts to reveal a legacy of intelligence, and it serves to inspire future African Americans to keep the torch of technological innovation and invention aflame.

During the first half century of the nation's history, in New England and the mid-Atlantic states specifically, revolutionary spirit, growing abolitionist sentiment, and Christian missionary fervor favored the education of Blacks. The work of various religious groups, most notably the Quakers, to establish schools for Blacks is well documented. The efforts to provide instruction to Blacks during this period were generally local and unconnected, reflecting the interests of the diverse groups involved. Thus, some communities provided integrated public instruction while others had separate facilities. The growing intensity of antislavery sentiments in parts of the North prompted some communities to adopt policies that would allow more Blacks to attend public schools (Franklin, 1973; Frazier, 1949; Woodson, 1915).

The results of this movement were impressive as free Blacks took advantage of opportunities to get an education. Of the 2,000 Blacks in Boston in 1850, almost 1,500 were in school; and in the states and territories as a whole, 32,629 Blacks were in school in 1860. Blacks also began to move into higher education. In 1826 Edward Jones graduated from Amherst while John Russwurm was getting his degree from Bowdoin -the first Black to graduate from college in America. Blacks were attending Oberlin and other institutions of higher education well before the Civil War (Franklin, 1973; Pifer, 1973).

Although most of these educational efforts were provided and controlled by Whites, Blacks also played a role. A few schools were established by Blacks, and in such large cities as Philadelphia Blacks began to organize literary societies as early as the 1780s (Funke, 1920; Winston, 1971).

The social climate in the South during the slavery era effectively precluded educating Blacks. Interest in public education in general was low. Whites who wanted schooling were expected to rely on their families for financial support. There were a few isolated efforts to provide free Blacks with an education, and some progressive plantation owners felt morally bound to teach their slaves to read and write. Any possibility of these practices gaining widespread support quickly vanished with the abortive revolts by Prosser (1800) and Vesey (1822), and the Turner rebellion (1831). These actions by Blacks who had been educated so frightened the planters that laws were passed throughout the South making it illegal to instruct any slave or free Black (Franklin, 1973; Funke, 1920; Low & Cliff, 1981).

During the decade of Reconstruction following the Civil War, Blacks made temporary gains in their social and political conditions. Passage of the Thirteenth, Fourteenth, and Fifteenth Amendments to the Constitution and the Civil Rights Act of 1866 gave Blacks freedom and rights of citizenship and hindered restrictive legislation that attempted to reestablish antebellum social relationships (Bond, 1934; Brawley, 1970). Probably the most significant change came in the area of education. The emancipated slaves were eager to take advantage of their new status and felt that getting an education was of primary importance. And many individuals and organizations interested in aiding the freedmen were quick to offer their services (Woodson, 1969).

Even before the war ended, missionaries began to make their way into the Southern states to establish educational programs for those Blacks freed by the advancing Union troops. Immediately after the war, religious organizations, such as the American Missionary Association and the government-sponsored Freedmen's Bureau, established schools in the South. Blacks responded eagerly, and thousands were attending schools by the late 1860s (Bond, 1934; Cruden, 1969; Funke, 1920).

White Southerners, however, were unprepared for such a radical change and opposed efforts to provide education for Blacks, who were considered innately inferior—the idea of educating them was viewed as absurd. Providing educational opportunities to Blacks would have meant extending a privilege that had historically been restricted to the upper classes in the South; it would elevate the former slave to a status higher than that of most former slave owners. Conservative Southerners feared that the schools taught by Northerners would instill Republican ideals of equality and further undermine their political power. The hostile reaction by Southerners to Black education was a predictable part of their attempt to maintain the traditional antebellum social order in the face of massive social dislocation (Bechtel, 1989).

Nevertheless, some Southern Whites grasped an obvious fact: The Freedmen would have to be educated simply to survive and provide for their own basic needs. At the end of the Civil War, 95% of the Black population in America was illiterate. To most enlightened observers, the presence of this large number of "ignorant Black rabble was a menacing Trojan horse" (Winston, 1971, p. 681). White Southerners faced a serious dilemma that went beyond simple questions of educational philosophy. The way this problem was addressed would have a significant impact on important issues of political and economic relationships because once Whites chose to educate Blacks, they had to decide what type of education should be provided. And that decision ultimately depended upon the role that Whites saw for Blacks in the American social order.

From an egalitarian perspective, education is a means of raising those less fortunate up to a level on par with the rest of society. If such a goal had been paramount at the end of the Civil War, what sort of educational program could have been developed? Ballard (1973) described a possible scenario.

> First, there would have to be federally funded elementary schools in every village. Second, a federally funded group of highly trained teachers would have been sent to those villages. Centers of literacy would have to be established for adult education. This first thrust could have carried through for five to ten years, to be followed by the establishment of regional high schools with both vocational and academic curricula to serve as the funnel through which the most able Black youth would have gone on to federally subsidized colleges. Over a period of fifty or seventy-five years the educational level of the Africans would have risen to that of White Americans. (p. 11)

Ballard makes clear that it was unthinkable that Whites during Reconstruction would have allowed anything of the sort. If Blacks had to be educated, White Southerners felt that the education should be suited to their inferior mental capacities and to their proper, subservient place in society. With the goal decided upon, the two pillars of post-Reconstruction Black educational philosophy emerged: a system of separate and unequal schools for Blacks and industrial education.

During Reconstruction, the quality of education provided in the South had been generally poor for both Blacks and Whites, but it was administered on a fairly equal basis. After the end of Reconstruction and the reemergence of Southern conservatives in political power, the policies of Black social and political disenfranchisement extended to Black education as well. Through deception, blatant discrimination, and law, White schools were improved at the expense of Black schools. An examination of the data on school expenditures from the mid 1870s to 1930 clearly reveals the massive disparities between the education of Whites and Blacks in the South.

Data (Bond, 1934) for the state of Alabama indicate the changes that took place over the 55-year period from 1875 to 1930. During the 1875-1876 school term, Alabama spent an average of $1.30 per pupil for White teachers' salaries and $1.46 per pupil for Black teachers' salaries. This difference in favor of Black teachers reflects the impact of the Reconstruction administration. By 1885, however, Alabama was paying Black teachers 85% of what was paid to White teachers ($1.09 versus $1.28). And 25 years later, Black Alabama teachers still received only $1.10 per pupil whereas their White counterparts got nearly six times as much ($6.42).

Although the figures from Alabama show the dramatic decline over time in expenditures to Black teachers, the data from Tennessee reveal no change whatsoever over the 60-year period from 1870 to 1930. In 1870 Tennessee paid its White teachers $11.83 per pupil compared to $7.48 for Black teachers—63% of the White teachers' salary. By 1931 Tennessee was paying its White teachers $27.55 per pupil compared to $17.25 for Black teachers—again only 63% of the White teachers' salary (Bond, 1934).

Harlan (1968) noted that the regional differences in funding for White schools paled when compared to the economic disadvantages suffered by Black schools. In 1915 the North Central states spent an average of $28.00 per White child for education compared to only $14.00 per White child in South Carolina. But at the same time, South Carolina was spending only $1.13 per Black child for education.

Statistics revealed the degree of inferiority of funding of Black education compared to that of Whites in the South. Using Washington, DC, as a point of comparison, one finds that spending by the six Southern states on school expenses, school property, and teacher salaries falls far short of anything that could be remotely called "equal" education. The breadth of the discrimination against Black education is revealed in other areas as well. For example, during the 1933-1934 school year, 10 Southern states spent a total of $20 million on transporting rural school children. But, only 3% of this money was spent on Black children who constituted

34% of the total school population. In 1935-1936 over half (55%) of the 24,405 Black public elementary schools in the 18 states with separate schools were one-room schools. In terms of total property value, in 10 Southern states for which data were available, for every $1.00 invested in school property for each White student, only $0.19 was invested for each Black student (Frazier, 1949).

Factors other than direct discrimination in finances also undermined the ability of Blacks to acquire an adequate education. Black attendance remained relatively low because Black schools were often distant and so little transportation was provided. But because the number of Black teachers was also small, the typical teacher in a Black school would, on the average, have twice as many students as the typical teacher in a White school. Possibly most damaging was the practice of having shorter terms for the Black schools. In the 1929-1930 school year, for example, the average length of the term for the 18 Southern and border states, including Washington, was 164 days for Whites and 144 days for Blacks. However, in South Carolina the average school term was 173 days for Whites compared to only 114 days for Blacks (Work, 1931). After eight years of school, the typical Black student in South Carolina would have been in class 472 days less than the typical White student—in other words, he or she would be approximately four years behind. This policy, combined with the fact that few secondary schools were established for Blacks, goes far toward explaining why few Blacks during this period attained more than a sixth-grade education (Rice, 1971).

Much of this discussion of Black education has focused on the Southern states. One must not conclude that the educational experiences of Blacks in the North were any better. During the 18th and 19th centuries, Blacks were few in number in the North and West and did not arouse the fear and apprehension found in the South. Life was therefore different for those Blacks who lived in the various Northern states. They were not subject to the whims of a master, the restrictions on their activities were less severe, they could protest against injustices, and there were more opportunities for self-expression (such as churches and newspapers) and improvement in one's political and economic position (Litwack, 1961; Quarles, 1969).

Popular beliefs and attitudes about Blacks were not restricted to a particular region of the country, and the belief in Black inferiority was shared by most White Americans. Discrimination and racial segregation were facts of life for Blacks in both the North and South. And the justification for such practices was the same everywhere: Blacks constituted an inferior race suited only for the most menial of positions (Litwack, 1961).

Despite having comparatively greater freedom in the North, Blacks found that there was strong opposition to their receiving an education. Many Northern states were unwilling to spend money on schools for Blacks, fearing that more of them would move into their states or communities seeking education. Northerners seemed no more fond of Blacks than Southerners. Ohio, Illinois, and Oregon had laws forbidding the migration of free Blacks into their states. Although Northern states did not pass laws prohibiting the teaching of Blacks, there was an undercurrent of resentment toward educating Blacks that found expression in the forcible closing of schools, the intimidation and driving away of teachers, and the destruction of school buildings (Beale, 1975; Bond, 1934).

While some White schools in the North admitted Blacks, this occurred mostly during the early 1800s. By 1830 most Northern states had excluded Blacks from White schools and required them to attend separate all-Black schools. Reflecting the prevailing belief in the limited intellectual capability of Blacks, these separate schools were often as unequal as those in the South, with substandard teachers, inadequate facilities, and inferior curricula (Litwack, 1961).

Frazier (1949) remarked that the problems facing Blacks in the public schools of the North were similar to those faced by the large number of immigrants who settled in the major urban centers. As with the immigrants, Blacks had been forced to live in the poorest sections of the cities and their children had to attend old, inferior, and overcrowded schools. Nevertheless, Blacks suffered additional problems: Because of their color, they were restricted in their movement both socially and economically. Greer (1973) noted that with varying degrees of speed, foreign immigrants were able to become part of American society, whereas Blacks remained on the margin. Both groups were vulnerable because of their low social status, but it was the individual immigrant who suffered the consequences of economic change, whereas for Blacks the entire group was affected. Thus, caste through race added a significant dimension to the life of the lower class Black in the urban North.

Despite widespread animosity toward Blacks, they did receive more education in the North, although the quality of that education was inferior. Frazier (1949) reported figures for 1940 that show the proportion of Blacks with four years of high school in the South was only 25% of the total, whereas in the North it ranged from 50% to 75% of the total. The reality, however, is that North or South, Blacks in America received an inadequate and inferior education when compared to that available for more Whites.

The content of Black schooling adequately reflected White goals for Blacks in the social order. Industrial training was an effective way of ensuring that Blacks could not rise beyond what was seen as their natural sphere as laborers and servants.

Industrial education had its beginnings at Hampton Institute under the direction of General Samuel Armstrong, a Freedmen's Bureau administrator in Hampton, Virginia. A believer in the innate inferiority of Blacks, Armstrong thought that the best training for Blacks was one that would instill self-control and provide a check on what he believed was the natural tendency of Blacks toward rebellion. His program of education was intended to affect a change in the freedman's innately flawed character, to "civilize" the Black by instilling "habits of living and labor" (Spivey, 1978, p. 19). Armstrong believed that Blacks were ultimately destined to "form the working classes" and remain at the bottom of the economic hierarchy (Spivey, 1978). Having no faith in Blacks' intellectual capacity, Armstrong thought it was a waste of time to give them academic training, stating that courses involving "reading and elocution, geography and mathematics, history, the sciences . . . would, I think, make a curriculum that would exhaust the best powers of . . . those who would for years enter Hampton" (Spivey, 1978, p. 26). Thus, education at Hampton under Armstrong was designed to maintain the Southern status quo. Black students would be trained in the principles of agriculture, unskilled menial labor, and domestic service—activities that would not be a threat to White skilled workers and would keep Blacks in their proper place in the social and economic structure (Spivey, 1978). But while Armstrong was the originator of vocational education, it took a Black man to make industrial training a prominent feature of Black education.

The few Blacks who managed to overcome educational obstacles and enter careers in science and technology still faced bigotry in other aspects of their lives. This discrimination extended to the lack of public recognition of names and accomplishments of Black scientists, medical researchers, and inventors. Only recently have scholars begun to search out evidence of these Blacks' contributions and discover that, although Blacks are rare in the history of American science, they are by no means missing or negligible. It is worth noting that, for many of the same kinds of reasons, the presence and activities of women in science were long overlooked by historians and only recently have been reexamined (Rossiter, 1974).

It is appropriate to describe briefly the work of some of these Black American scientists and inventors and to examine the ways in which they surmounted the formidable barriers to intellectual achievement.

Before the Civil War, the United States was not known for its scientific accomplishments. It would not make sense to expect Blacks to be the exception to this rule. For most slaves and free Blacks, the main issue was gaining and keeping their freedom. Many Blacks with exceptional abilities directed their talents to devising ways to gain their own freedom and to interest others in supporting such efforts. Inevitably, preachers and orators outnumbered inventors among the Black community during the antebellum period (Baker, 1913/1969).

It is also true that Black inventors, especially in the South, were unrecognized by historians. Slaves who invented mechanical devices to relieve the physical burden of labor could not protect their rights to the inventions (Baker, 1913/1969). They were not recognized as citizens and therefore could not enter into contracts. The federal government refused to grant them patents or to allow them to transfer patent rights to their owners. This did not preclude the outright theft of inventions by the slave owners, who would claim them as their own. Given this situation, it can never be known how many inventions were originated by slaves (Haber, 1970). Among free Blacks, inventors preferred to have their race kept secret for fear that such information would impair the commercial success of their devices (Baker, 1913/1969).

Government restrictions on the granting of patents to slaves did not apply to free Blacks. For example, James Forten (1766-1842), a free Black Philadelphian, had no difficulty in getting a patent for his invention for handling sails or deriving a comfortable living from its manufacture. The same could be said of Norbert Rillieux. Born in New Orleans on March 17, 1806, Rillieux was the son of Vincent Rillieux, a wealthy plantation owner, and his slave Constance Vivant. Because of his father's position, the young Rillieux had the advantages of both freedom and wealth. He attended Catholic schools in New Orleans and studied engineering in France. At the age of 24, he became the youngest instructor in applied mechanics at L'Ecole Centrale in Paris and contributed papers on steam technology to engineering journals (Klein, 1971). His major accomplishment came in 1846 when he invented and patented a vacuum pan that transformed the process of refining sugar. The device yielded a superior product—granulated sugar—at a low price. The invention was a boon to the sugar industry in Louisiana and revolutionized the production of sugar worldwide (Baker, 1913/1969; Haber, 1970; Ploski & Williams, 1983; Toppin, 1971).

A discussion of early Black inventors cannot fail to mention the accomplishments of Benjamin Banneker. The son of a free Black mother and a slave she had purchased, Banneker was born in Baltimore County, Maryland, in 1731. Taught to read and write at home by his grandmother, Banneker also attended an integrated public school where he obtained the equivalent of an eighth grade education. In 1761, his curiosity about mechanical devices led him to construct a wooden striking clock so accurately made that it kept perfect time for over 20 years. His knowledge of astronomy and his mathematical ability enabled him to predict the solar eclipse of 1789. During the next 10 years he published an almanac of tables, eclipses, and medicinal formulas. His most notable contribution came as a surveyor with the team chosen by George Washington to develop the plans for the new national capital. Although publicly recognized in France and England for his scientific accomplishments, he received little official recognition in the United States—although in 1970, Banneker Circle in Washington, DC, was named in his honor (Haber, 1970; Ploski & Williams, 1983; Toppin, 1971).

During the second half of the 19th century, a number of Black inventors produced devices of considerable importance in the mechanical advance of American industry. Most noteworthy were Lewis Latimer, Granville T. Woods, Elijah McCoy, and Jan Earnst Matzeliger.

Jan Matzeliger was born in Dutch Guiana in 1852. He immigrated to Philadelphia at the age of 10 and went to work in a shoe factory. He realized that while the tops and bottoms of shoes were being manufactured by machines, the two parts had to be put together by hand—a time-consuming bottleneck in the production process. He spent long hours at great physical and financial cost to do the seemingly impossible—invent a machine that would sew the top and bottom halves of manufactured shoes together. After Matzeliger developed his lasting machine, it was possible for one factory to produce 150 to 700 pairs of shoes a day, compared to 50 pairs sewn by hand. The cost of shoes went down, and the American shoe industry grew dramatically. Matzeliger died in 1889 at the age of 37 and never realized any of the millions of dollars that eventually derived from his invention (Haber, 1970; Logan & Winston, 1982; Ploski & Williams, 1983).

Elijah McCoy was born in Canada in 1844 to runaway slaves. He attended grammar schools in Michigan and went to Scotland to apprentice as a mechanical engineer. Upon returning to America, McCoy found that because of his race it was impossible for him to find employment as an engineer. He eventually took a job as a fireman on the Michigan Central Railroad where his experiences with maintaining the locomotive engines inspired him to invent a device that solved a critical problem in the manufacturing industry. Heavy machinery constantly needed lubrication to prevent the metal parts from fusing together. In the late 19th century, factory workers had to stop the machines and lubricate the parts by hand, a time-consuming and costly procedure. McCoy invented the "lubricating cup," which provided continuous and automatic lubrication of moving parts. His inventions were significant in perfecting the overall lubrication system eventually used in all large industrial plants with heavy machinery. Over a period of 40 years, McCoy acquired more than 50 patents for his lubrication devices, yet he died poor, as his race made it difficult for him to realize any profit from the inventions that made millions for others. Although not documented, it is often claimed that the expression "It's the real McCoy" is associated with his devices (Haber, 1970; Ploski & Williams, 1983).

In the area of electrical engineering, Granville T. Woods and Lewis Latimer deserve special recognition. Born in Ohio in 1856, Granville T. Woods attended school until the age of 10. First employed in a machine shop, he continued to develop his mechanical aptitude working on the railroad and reading books on electricity in his spare time. He reportedly took a course in electrical and mechanical engineering but was essentially self-taught. He invented a telephone transmitter in 1884 but is best known for his development of the Synchronous Multiplex Railway Telegraph. This system enabled communication between stations and moving trains and greatly improved railway safety. In the 20-year period from 1879 to 1899, 23 separate inventions bore his name, including the overhead conduction system for electric railways and the "third rail" used in most subway systems. Known as the "Black Edison," he held over 60 patents, many of which were assigned to General Electric, Westinghouse, and Bell Telephone (Haber, 1970; Logan & Winston, 1982; Ploski & Williams, 1983; Toppin, 1971).

Lewis Howard Latimer was born in Massachusetts in 1848. At the age of 10, Latimer was forced to quit school and help support his family. After serving in the United States Naval Service during the Civil War, he was employed as an office boy with Crosby & Gould, Patent Solicitors. Demonstrating his superior skill after reluctantly being given the chance to try his hand at drafting, Latimer ultimately was named chief draftsman. Needing a skilled draftsman to help prepare his patent application, Alexander Graham Bell asked Latimer to prepare the drawings and descriptions for the telephone patent issued in 1876. Latimer eventually began to work on his own inventions, and in 1881, he developed a method of making carbon filaments that were longer lasting than previous filaments, greatly improving Edison's incandescent lamps. He supervised the installation of electric lights in New York, Philadelphia, Montreal, and London. In 1884, Latimer joined the Edison Company, where he was instrumental in defending Edison's patents in court (Haber, 1970; Logan & Winston, 1982; Ploski & Williams, 1983).

Most of the Black scientists and inventors of the 19th century were very gifted, self-taught individuals who lacked academic or professional training in the physical sciences. This should not be surprising since the description would apply equally to White American scientists and inventors at the same time. In fact, it was only in 1861 that the first doctorate was granted in a science—physics—at Yale University. Probably the most noteworthy accomplishment in the history of Blacks in science occurred just 15 years later. In 1876, Edward Alexander Bouchet, a 24-year-old Black man was awarded a PhD in physics from Yale University for a dissertation in geometrical optics entitled *On Measuring Refracting Indices*. Bouchet was the first Black to receive a doctorate from an American university and only the sixth person in the United States to be awarded a PhD in physics. Yet, other than an occasional footnote in the history of Black education, Bouchet and his accomplishments remain virtually unknown to the world of science and literally unheard of by the world in general. What happened to Bouchet provides a glimpse into the adversity facing educated Blacks in post-Civil War America.

Edward Bouchet was born in 1852 to free parents in New Haven, Connecticut, where he attended a public "colored school." Like most of the schools for Blacks in the city, it was small, ungraded, and had only one teacher. In 1868, Bouchet was the first Black to be accepted into Hopkins Grammar School, a preparatory school for the classical and scientific departments at Yale College. During his two years at Hopkins, he studied Latin and Greek grammar, geometry, algebra, and Greek history. He graduated first in his class in 1870 and was chosen valedictorian (Bechtel, 1989).

Bouchet entered Yale University in the fall of 1870 and continued to excel. When he graduated in 1874, his grade-point average was 3.22 on a 4.0-point scale, the sixth highest in a class of 124. In 1875, Bouchet returned to Yale to pursue graduate work in physics. During his two years in the graduate school, he paid special attention to chemistry, mineralogy, and experimental physics. Under the direction of Arthur Wright, he successfully completed his dissertation (Bechtel, 1989).

Bouchet's graduate education was encouraged and financed by Alfred Cope, a member of the board of managers of a Friends school for Blacks in Philadelphia, the Institute for Colored Youth (ICY). Firm believers in the value of liberal education and the unlimited capabilities of Blacks, Cope and the other managers offered at ICY a curriculum that included ancient history, geography, Greek and Latin classics, algebra, geometry, and chemistry. In an effort to expand the school's offerings, Cope established a Scientific Fund to promote learning in the principles of applied science. It was the establishment of the Scientific Fund that led Cope to invite Bouchet to head the new science program (Perkins, 1978).

Bouchet arrived in Philadelphia in the fall of 1876 and taught at the ICY for the next 26 years. However, as with all American Blacks during the last two decades of the 19th century, Bouchet's life took a turn for the worse. By the mid-1890s, many Philadelphia Quakers were becoming disillusioned with the Black community as they now questioned the ability of Blacks to respond to the efforts being made on their behalf. In 1894, a study made of the institute's curriculum suggested that it be simplified, stating that the courses were "pitched too high." By the end of the century, the new managers had become openly hostile to classical and academic education and receptive to Booker T. Washington's educational philosophy. In their efforts to redirect the ICY along the line of industrial training at Hampton and Tuskegee, the managers proceeded to fire all the teachers, including Bouchet, and replaced them with instructors favorable to industrial education (Bechtel, 1989; Perkins, 1978).

No White college would have considered him seriously for a position on its faculty even with his superior qualifications. But barriers other than race had an impact on Bouchet's career. The ascendance of vocational-industrial instruction during the latter half of the 19th century, and the overwhelming acceptance of the Hampton-Tuskegee model for Blacks in particular, served to limit Bouchet's opportunities. His academic education and his training in the natural sciences made him increasingly unattractive as a candidate at Black colleges that had adopted the industrial-education philosophy. As noted by DuBois (1973), the debate between academic and industrial education was a bitter one. "The disputants came to rival organizations, to severe social pressure, to anger and even to blows. . . . Employment and promotion depended often on a Negro's attitude toward industrial education. . . . Men were labeled and earmarked by the allegiance to one school of thought or to the other" (p. 65).

The difficulties that the industrial-education movement created for Bouchet were tragic not only for him but also for the future generations of students he might have trained in science. The movement stopped students from striving for professional careers, it perpetuated stereotypes about Black intellectual inferiority, and it kept Blacks in economically inferior jobs. Even on its own terms, it misjudged the demand for Blacks in the trades, arousing the hostility of White workers. It failed to see that the rise of large corporations would put many tradesmen and craftsmen out of business (DuBois, 1973; Franklin, 1973).

Although Whites enthusiastically endorsed industrial training for Blacks and helped to implement it through contributions to Black schools, it is noteworthy that some Blacks resisted. W. E. B. DuBois led this movement against industrial education, while leaders at some Black colleges refused to change their curriculum in the direction of Tuskegee and Hampton. An important change occurred at the beginning of the 20th century as a small number of men and women began to move into the fields of science and engineering. Consider, for example, three Blacks who made scientific contributions to biology and medicine: E. E. Just, Percy Julian, and Charles Drew (Bechtel, 1989).

Born in Charleston, South Carolina, in 1883, Ernest Just received his bachelor's degree with honors from Dartmouth. In college he developed an interest in biology, especially cell structure and development. After graduating from Dartmouth, he taught biology at Howard University and began a 20-year period of summer research at the Marine Biological Laboratories at Woods Hole, Massachusetts. In 1916, he received his PhD in biology from the University of Chicago. During his career, he published two books and over 60 papers in scholarly journals. His ideas on cell-membrane activity completely changed the scientific opinion of his time as he successfully demonstrated that the cells' cytoplasm and ectoplasm are equally important as the nucleus in heredity. As with most of the Black scientists of the period, Just never received proper recognition in the United States, although he was respected and honored in the scientific capitals of Europe (Haber, 1970; Manning, 1983; Ploski & Williams, 1983; Toppin, 1971).

Born in Alabama in 1899, Percy Julian attended DePauw University, where he was valedictorian and Phi Beta Kappa. He taught at Fisk, Howard, and West Virginia State College before attending Harvard and the University of Vienna. A specialist in derivative and synthetic drugs, Julian discovered cortisone, a cheap and effective treatment for arthritis derived from soybean oil. In 1935, Julian was the first to synthesize physostigmine, important in the treatment of glaucoma. He was also the first to synthesize hormones, greatly reducing the cost of these drugs and making them available to thousands of people who were unable to afford the expensive natural drugs. He was offered the post of chief chemist and director of research for the Glidden Company in Chicago, the first Black scientist to obtain such a prestigious position. This was a turning point in the struggle of Black scientists to gain access to America's research facilities (Haber, 1970; Ploski & Williams, 1983; Toppin, 1971).

Charles Drew, medical doctor and researcher, was educated at Amherst College in Massachusetts and took his medical degree from McGill University in Canada. Early in his career, he became interested in the problems associated with the transfusion and storage of blood. He took a teaching position at Howard University and while working on his doctor of science degree at Columbia wrote a dissertation on banked blood. He soon became an expert on separating and storing blood, and his research on blood plasma is credited with saving many lives during World War II. In 1941, he was called to England to help with the problems of blood storage and set up the first blood bank in England. Drew was one of the first Blacks to become a diplomat in surgery and the first Black to be appointed an examiner by the American Board of Surgery (Haber, 1970; Ploski & Williams, 1983; Toppin, 1971).

To this discussion of unrecognized scientists must be added several others. One is Charles H. Turner, who received his doctorate from the University of Chicago in 1907. He published many papers in the area of animal behavior, and the phenomenon of insect activity referred to as "Turner's circling" is named for him. William A. Hinton was an authority on venereal disease and responsible for developing the Hinton Test for detecting syphilis. In 1949, he became the first Black professor of medicine at Harvard. Lloyd A. Hall was chief chemist and director of research for Griffith Laboratories in Chicago. He transformed the meatpacking industry with his development of curing salts for processing and preserving meats. Louis Tompkins Wright was a leading surgeon and medical researcher best known for his work in developing the intradermal method of smallpox vaccination. He also pioneered in drug therapy for cancer and was the first to use chlortetracycline on humans. A graduate of Harvard Medical School, Wright was the first Black to be elected to a fellowship in the American College of Surgeons (Haber, 1970; Logan & Winston, 1982; Ploski & Williams, 1983).

There is little doubt that White scientists of this caliber won recognition from the scientific world in the form of research grants, prestigious positions, and prizes. More important, they were urged to continue their research and their teaching of future scientists. In light of the racism and discrimination these Black scientists faced, their accomplishments are even more impressive, yet their names and deeds remain obscure. Students quickly learn the importance of such men as Benjamin Franklin, Eli Whitney, Thomas Edison, Alexander Graham Bell, and Jonas Salk. These individuals are held up as great scientists and inventors whose work was instrumental in the transformation of American society. Students rarely learn the names Benjamin Banneker, Norbert Rillieux, Granville T. Woods, Lewis Latimer, or Percy Julian, or their equally important contributions to the transformation of American science and industry.

The achievements of Black intellectuals and scientists in White America have been largely obscured, ignored, or diminished in importance. The world of science and research was the private domain of White males. Society provided Blacks with more appropriate arenas for gaining success and notoriety, arenas more fitting for their place in the American social order. The roles of gladiator and jester have long been traditional among powerless people and are often seen by the dominant group as more appropriate than that of scholar or scientist (Lewis, 1972). According to the stereotype, Blacks were to perform, produce, or entertain, not invent, design, or create. The former activities require only simple innate abilities; the latter intelligence and creativity—characteristics not thought to be present in Blacks.

From the perspective of White America at the turn of the century, educated and intellectual Blacks presented a grave problem. They were not supposed to exist, and the fact that they did exist challenged the very foundation of the White belief in Black intellectual and social inferiority (Winston, 1971). Therefore, such individuals had to be explained away (they were called freaks), minimized (they were accused of stealing their ideas from Whites), hidden (they were not acknowledged), or destroyed (they suffered discrimination and violence). The lives of early Black scientists were filled not only with the challenge and elation of scientific discovery, but with the specter of racism and discrimination as well.

During his brief tenure at St. Paul's College in Lawrenceville, Virginia, Edward Bouchet was respected and admired in the community. Nevertheless, he was assaulted by a White lawyer he accidently bumped into as they came around a corner (Bechtel, 1989). Percy Julian was denied appointment as head of DePauw's chemistry department because he was Black, and he would not go to Appleton, Wisconsin, for a job interview because of a city statute prohibiting Blacks from staying overnight. During his tenure at Glidden, his house in Oakbrook was set afire and bombed in several acts of racial violence. Ernest Just, despite his scientific discoveries, was never offered an appointment at a major American research center or university and was urged by Whites to teach at Black universities in order to help his race (Haber, 1970; Logan & Winston, 1982; Manning, 1983).

More important than these acts of racism toward individuals are the patterns of institutional discrimination that created an almost insurmountable obstacle to the Black scientist. Segregation produced isolation: Black PhDs in science were forced to teach in Black colleges and high schools, which were often unsympathetic to the needs of a research scientist. Edward Bouchet and Charles Turner spent most of their careers in high schools with limited resources and poorly equipped labs. Those who were fortunate enough to find positions in Black colleges (like Just or Julian) often taught students from the inner city or rural areas, who lacked advanced training in mathematics and English. These teachers seldom had the scientist's pleasure of training students to surpass their mentors. Black colleges had little money available for scientific equipment or libraries. In the South, where most Black colleges were located, Black scholars were denied use of public libraries and White university laboratories and were barred from local chapters of learned societies (Julian, 1969; Winston, 1971).

To this can be added Jim Crow laws designed to restrict the social and political actions of Blacks, the constant threat of violence reinforced by numerous lynchings every year, and the exclusion from the community of science in general. In this type of restricted and fearful environment, the PhD degree was a farce (Julian, 1969). Excluded because of their race from full participation in the American scientific community, these scientists languished in obscurity.

Under such historical conditions, it is no wonder that so few Blacks chose to study science. Ernest Just's motive in discouraging his students from pursuing careers in science grew out of his own bitter recognition of the reality they faced (Manning, 1983; Winston, 1971). For Blacks at the turn of the century, education had to provide marketable skills, a point of view that continues to direct scientifically talented students into careers in education, medicine, or law rather than biology, physics, or chemistry. For any Black who knew about Just, Julian, or Turner, the lesson was clear: Even those with the highest level of education and degrees from America's most prestigious universities were denied the recognition and respect befitting their qualifications and scientific accomplishments. In the fields of medicine, teaching, and law, one could find jobs and prosper, albeit while restricted to serving a Black clientele. Under the rules made by Whites concerning the roles Blacks were to play in American society, the pragmatic Black decided it was better to be an employed teacher or lawyer than an underemployed scientist.

Specific evidence supports this argument. Edwards (1959), in a survey of 300 Black professionals, found that half of the respondents had given serious consideration to careers other than the one they presently had. Many expressed a primary interest in becoming engineers, architects, or research scientists but felt that Blacks could not earn a decent living in these occupations. One of Edwards's respondents, a physicist now working as a teacher, had wanted to enter the field of engineering. He changed his mind when it became clear that despite his ranking near the top of the class, White classmates who were far below him could get jobs as student laboratory technicians while he could not.

The Black scientist is both rare and relatively unknown: rare because of an educational philosophy that produced laborers not scholars, and unknown because White society has often refused to recognize the contributions of those able to overcome the obstacles placed before them. In part, this failure to recognize the Black scientist stems from beliefs about Black inferiority. To acknowledge these individuals would be to demonstrate the fallacy of those beliefs and the effort of the policies that deprived Blacks of equal and quality education.

Separate, unequal, and discriminatory educational policies served to keep a generation of Blacks at the bottom socially, politically, and economically. And while a few (such as Bouchet, Just, and Julian) were able to break through and acquire a quality education, being Black meant that in most instances the rewards were withheld. The rare Black scientist was faced with a lack of research facilities, funds, and recognition for achievements that by any standard were of superior quality and importance. Given the historical conditions, one can understand why Black scientists were treated in such a manner. But to understand is not to justify. Educational policies served to suppress and demoralize generations of Blacks in America, creating discredible castes within an ostensibly open society.

History is more than description and explanation; one can often use the past to examine the present. What has the past taught with regard to current educational policies directed toward Blacks? Several major themes can be identified. First are *interest* and *motivation*. Historical evidence shows that Blacks in America had a strong interest in and motivation for getting an education. This desire continues as large numbers of Blacks seek higher education. Second is *opportunity*. The evidence is just as clear that Blacks were denied the opportunity for a quality education by legal and extralegal means. Today, Blacks are able to take advantage of educational opportunities as many of the barriers of the past have been removed. And third, is the *reward* or *payoff*. Given the historical conditions, for most Blacks there was no payoff for getting an education. Today, the picture appears more positive as Blacks are found in all professions and at all levels of achievement (Betchtel, 1989).

Yet, below the surface a different image can be seen. Less than 2% of all doctoral scientists in America are Black, and few Black students take courses in the sciences or express a desire to pursue such careers. For those who complete graduate school, the door to a science career is opened. The problem, as in the past, remains at the level of basic educational opportunity and experience. America has desegregated its White schools and has renounced its past practices as counterproductive and mean-spirited. But those practices remain, in effect, in the form of tracking, curriculum reform, and teacher expectations.

Eighty years ago, vocational education served to perpetuate Black social and economic inferiority, locking a generation of Blacks into low-paying, low-status jobs. Today, Black children are bused to excellent schools in an attempt to equalize educational opportunity. Yet once off the bus and in the school, they are tracked, counseled, or intimidated away from academic courses into less rigorous curricula. At the turn of the century, the typical student at Hampton or Tuskegee learned simple trades and domestic skills while American industry was going through a transformation that was making such skills obsolete. Today, the typical Black student studies a watered-down curriculum devoid of higher level math and science courses while we are living in a computer age that is transforming the world into a more complex and scientifically sophisticated arena (Bechtel, 1989).

To break the hold of the past, parents, educators, and policymakers need to move forward and address the educational deficiencies that continue to derail the scientific careers of Black students in America.

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Undergraduate Engineering and Psychology Students' Use of a Course Management System: A Factorial Invariance Study of User Characteristics and Attitudes

Stephen A. Sivo and Cheng-Chang "Sam" Pan

Implementing information systems (IS) is expensive and sometimes unsuccessful due to low levels of system user acceptance (Legris, Ingham, & Collerette, 2003). For this reason, IS research has focused, in part, on variables contributing to system user acceptance of technology. As a part of this effort, Davis (1989) theorized and tested the technology acceptance model (TAM) to describe how system user characteristics influence patterns in technology use. Since then, the TAM has survived empirical scrutiny in varied contexts (e.g., Davis, 1993; Lee, 2002; Legris et al., 2003; Pan, 2003; Pan, Gunter, Sivo, & Cornell, in press; Pan, Sivo, & Brophy, 2003; Venkatech, 2000; Wiedenbeck & Davis, 1997). The viability of the TAM has encouraged a continued investigation of its applicability as well as revisions and extensions. Many modifications considered have in common a focus on client side variables exogenous to the original model (e.g., Anandarajan, Igbaria, & Anakwe, 2000; Legris et al., 2003; Venkatech, 2000; Wiedenbeck & Davis, 1997; Wolski & Jackson, 1999).

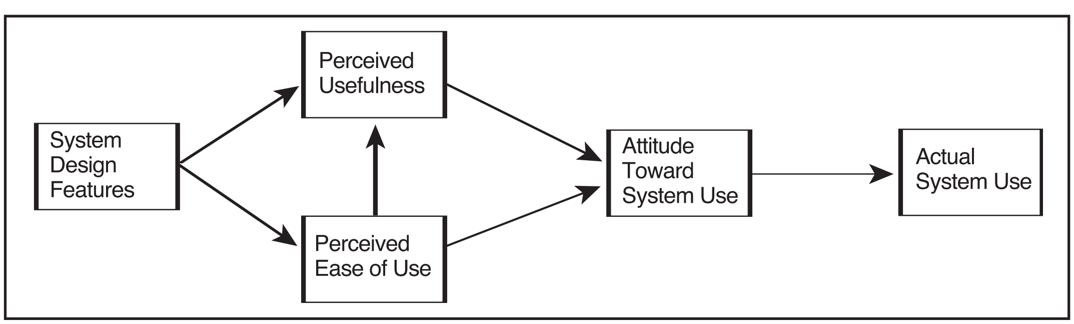
With respect to IS implementation in institutions of higher education, colleges and universities in the state of Florida and elsewhere are increasingly relying on the use of course management systems such as WebCT for the purpose of delivery of online courses. As a vendor's commercial product, WebCT is a Web-based course management system developed by the University of British Columbia (Goldberg, 1997). WebCT, a sophisticated learning management system, itself provides several features and functions that afford learning and teaching in a system-based environment by serving as a supplemental course tool/solution. In the present study, WebCT is conceptualized as an information system project and it is also considered a course management system.

Understanding student attitudes towards course management systems is important to study as student acceptance of this technology may conceivably have an impact on student use of the system in the completion of course requirements and therefore student grades. Indeed, research focused on how well psychology students respond to the use of WebCT in a Web-enhanced classroom has suggested that student grades are affected to some extent by student attitudes towards WebCT (Pan et al., 2003; Sivo, Pan, & Brophy, 2004). However, evidence of whether the relationships among factors involved in psychology student attitudes towards a course management system generalize to students of other majors has yet to be demonstrated. The assumption that student attitudes and related constructs are similar regardless of program major needs to be empirically evaluated because students in different majors arguably vary with respect to technological familiarity and expertise.

The Essential TAM

The TAM was designed to be a useful explanation of why people vary with respect to their success in using technology (Davis, 1989). According to Davis (1989), client side elements of this model include perceptions of a technology's usefulness, perceptions of a technology's ease of use, and attitudes toward the use of technology. The essential TAM proposes that these three variables work together to impact the actual use of technology in a given setting.

Figure 1. Original technology acceptance model



Specifically, a technology's perceived usefulness and ease of use jointly influence one's attitude towards the technology, which, in turn, affects a system's actual use (see Figure 1; Davis, 1993).

Previous structural equation modeling research has furnished evidence supporting the conclusion that the TAM is a parsimonious representation of how perceptions and attitudes affect actual system use (Bajaj & Nidumolu, 1998; Hu, Chau, Liu Sheng, & Yan Tam, 1999; Igbaria, Zinatelli, Cragg, & Cavaye, 1997; Mathieson, 1991; Subramanian, 1994). However, several researchers have increasingly entertained TAMs that exchange system design features with system user characteristics (Anandarajan et al., 2000; Legris et al., 2003; Pan et al., 2003; Venkatech, 2000; Wiedenbeck & Davis, 1997; Wolski & Jackson, 1999).

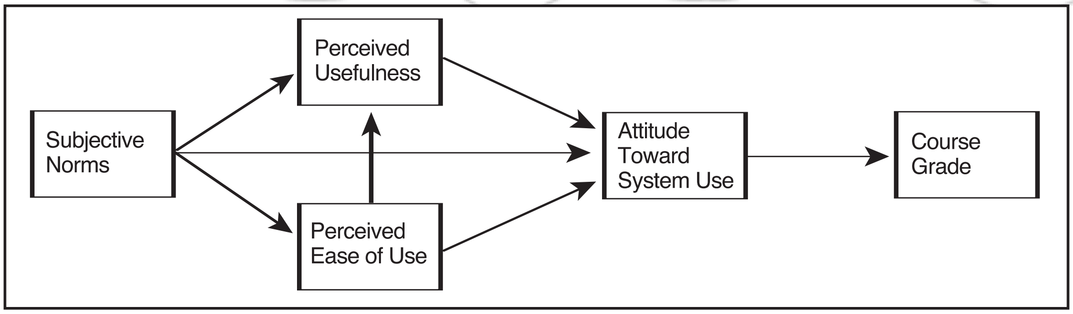
This transition in focus from system design variables to psychological variables is consistent with the nature of other variables in the model, which also focus on psychological aspects of the system user. For example, Wolski and Jackson (1999) found that within educational institutions, faculty and peer expectations are a prominent combined force in determining technology acceptance. It is not altogether surprising to find such normative influences (i.e., social pressure) at work particularly given the context in which technology acceptance is assessed. Developmentally, typical undergraduate students in the U.S. ages 18 to 22 are very susceptible to peer influence (Erikson, 1968) and, within the context of postsecondary education, students are, as well, shaped by their instructors. Indeed, the inclusion of perceived subjective norms as a psychological factor exogenous to the essential TAM continues to be a germane feature worthy of consideration (e.g., Anandarajan et al., 2000; Pan et al., 2003; Venkatech & Davis, 2000).

Pan et al. (2003) successfully replicated the TAM by identifying a causal relationship existing among students' perceived ease of use of WebCT, perceived usefulness of WebCT, their attitude toward WebCT, and their actual use of the course management system. They also succeeded in expanding the original TAM by adding subjective norms in addition to computer self-efficacy. These studies were conducted using students in a course on psychology. One of the two primary purposes of this study was to not only replicate this study with students in another psychology course, but to also contrast the TAM model results with results obtained from students in an engineering course. Factors affecting student use of a course management system (i.e., WebCT) in two large-sized, Web-enhanced, hybrid undergraduate courses was investigated. Other than the fundamental difference (i.e., course content), the two entry-level courses are compared and contrasted in Table 1.

Table 1: Comparison of Target Population by Characteristics

Characteristics	Psychology Class	Engineering Class
Textbook use	Yes	Yes
Office hours (primary)	Yes (TAs)	Yes (instructor)
Teaching assistants used	2	2
Extra credit offered	Yes	Yes
WebCT tool uses:		
Online grade	Yes	Yes
Online quizzes	Yes	Yes
WebCT mail	Yes	No
Online chatroom	Yes	Yes
Discussion forum	Yes (185 postings)	Yes (501 postings)
Content modules	Yes	Yes
WebCT calendar	Yes	No
Notes in WebCT	Yes (discussion)	Yes (PowerPoint files)
WebCT syllabus	No	Yes
Required WWW search	Yes	Yes
eCommunity use	Yes	Yes

Figure 2. The academic technology acceptance model



The outcome of interest in this case was attitudes towards system use and, secondarily, the impact of student attitudes on academic performance, operationally defined as a student's end of the course grade. This study was conducted with the permission of the psychology and engineering course instructors who supported the study by providing the grades they assigned to students at the end of the semester. The academic TAM fitted to the data is specified in Figure 2.

This model allows a direct path from the exogenous psychological variable, in this case subjective norms, to student attitude towards system use (i.e., the use of technology) because theoretically social pressure from peers and professors would have a direct effect on student attitude. In addition to subjective norms, perceptions of usefulness and ease of use are specified to jointly affect student attitudes, as these specifications are consistent with the original TAM defined by Davis (1985). For the same reason, user perception of how easy a technology is to use is specified to affect perceptions regarding the usefulness of the technology. In other words, the more strongly a student perceives a technology to be easy to use, the more strongly that student will regard the technology as useful.

The second purpose of this study was to determine whether this model is as applicable to psychology students as to engineering students. The assumption that the configuration of relationships among factors is the same for students in engineering and psychology needs to be evaluated. It is possible that the field of engineering, which has at its very heart the application of technology, draws students who, as a group, are more homogenous with respect to their comfort with technology. Though some students of psychology are likely to be comfortable with technology, it is not unreasonable to suppose that students in this major are more variable with respect to technological comfort levels relative to their peers in engineering. The academic TAM was fitted to engineering and psychology student data for the purpose of comparing the covariance structure across the two groups. The research question answered in this study was: Is the covariance structure of the academic TAM invariant (the same) across the psychology and engineering student data?

Method

Participants

This study included 460 students in both psychology (*n* = 230) and engineering[1] (*n* = 230) classes using WebCT for a Web-enhanced course. Each student completed an online questionnaire at two occasions in the spring semester of 2003. Permission to conduct this study at the University of Central Florida was provided by the engineering and psychology professors teaching the courses evaluated and the university's Institutional Review Board.

Measures

To measure subjective norms, a four-item scale that Wolski and Jackson (1999) developed was used. A sample question in the instrument included, "The instructor thinks that I should use WebCT for my course work." Furthermore, five items assessing system user attitudes toward technology were obtained from Davis (1989, 1993). A sample question in the instrument was, "All things considered, my using WebCT in my course work is: negative or positive?" Higher scores on the attitudinal scale suggested an overall more positive attitude. Results of reliability testing indicated that the alpha value for each factor was greater than .6, which suggested that adapted scales were deemed reliable (see Table 2).

[1] Initially, 237 students of the engineering class fully participated in the study. In order to have an equal number of the participants in both classes, 230 were randomly selected.

Table 2: Reliability Testing of the Scales

Scale	# of items	α
Attitude toward WebCT	5	.93
Subjective norms	4	.60
Perceived usefulness	6	.91
Perceived ease of use	6	.94

Table 3: Instruments

Attitude Toward WebCT Instrument (on a 7-point bipolar semantics scale)
Question: All things considered, my using WebCT in my course work is: 1. Bad ↔ Good. 2. Foolish ↔ Wise. 3. Unfavorable ↔ Favorable. 4. Harmful ↔ Beneficial. 5. Negative ↔ Positive.
Subjective Norms Instrument (on a 7-point Likert scale)
1. The instructor thinks that I should use WebCT for my course work. 2. My peers think that I should use WebCT for my course work. 3. Generally speaking, I would do what my instructor thinks I should do. 4. Overall, I would do what my peers think I should.
Perceived Ease of Use Instrument (on a 7-point Likert scale)
1. Learning to use WebCT would be easy for me. 2. I would find it easy to get WebCT to do what I want it to do. 3. My interaction with WebCT would be clear. 4. I would find WebCT to be flexible to interact with. 5. It would be easy for me to become skillful at using WebCT. 6. I would find WebCT easy to use.
Perceived Ease of Use Instrument (on a 7-point Likert scale)
1. Using WebCT in my class would enable me to accomplish tasks more quickly. 2. Using WebCT would improve my job performance. 3. Using WebCT in my class would increase my productivity. 4. Using WebCT would enhance my effectiveness in my course work. 5. Using WebCT would make it easier to do my course work. 6. I would find WebCT useful in my course work.

These results, while favorable, must be treated with some degree of caution given that the errors associated with linked items may be correlated and thereby overestimate the reliability estimates (Gessaroli & Folske, 2002). For more details, see Table 3.

Data Collection and Analysis Procedures

Using Dreamweaver 4, Coldfusion, and MS Access, two online questionnaires were created and administered across two time occasions: at the beginning and end of the semester. Student informed consent was used. Two weeks before each administration, a friendly reminder (prenotice) was sent via e-mail to make sure intended participants were informed of the incoming questionnaire. WebCT's Tip feature was also used for announcement making. Additionally, teaching assistants of the course made an announcement in front of the class every time the survey was being administrated. Student participants were given a week to finish each questionnaire on a voluntary basis. Data sets from both time occasions were housed in a password-protected server.

The overall response rates (across the two occasions) for both psychology and engineering classes were 51.7% and 30.4%, respectively. Responses of students who failed to complete the questionnaire at both occasions were not considered for further analysis. Overall, female students accounted for 55.44% of the study participants and 68.44% were freshman; 68.44% were novice WebCT users. More than 70% had used the computer for more than four years.

We downloaded the data sets from the high-secured server in MS Access. The engineering and psychology professors accordingly provided to us the final course grades assigned to the students under study. The data were imported to Notepad as a text file for filtering. Then, the final copy of data was imported to LISREL for further analysis. The results were evaluated in terms of their propriety, fit, and parsimony. With this in mind, three criteria were investigated: (a) the maximum likelihood estimator should converge for properly fitting models, (b) the estimated covariance matrix should be positive definite, with no negative eigenvalues and no collinearities, and (c) the standard errors should be within proper bounds.

Specifically, the following fit indices were examined: the goodness of fit index (GFI), comparative fit index (CFI), non-normed fit index (NNFI), and the standardized root mean square residual estimate (SRMR). These indices were chosen because of their relative merits. The GFI is a stand-alone index that has a long history in SEM research. The CFI and NNFI are both incremental fit indices that indicate how much the fit of a model improves upon the nested null model. These indices are more sensitive to misspecification between latent and manifest variables relationship misspecifications (Hu & Bentler, 1999). The SRMR is more sensitive to latent-latent variable relationship misspecifications (Hu & Bentler, 1999).

An assessment of adequate fit in structural equation modeling is not without standard cutoff criteria. In part, the cutoff criteria chosen were the result of Hu and Bentler's (1999) Monte Carlo simulation findings. The GFI, CFI, and NNFI were all expected to exceed .95 if the model was to be deemed as fitting well. The SRMR was expected to attain values no higher than .05.

Results and Discussion

Is the covariance structure of the academic TAM the same across the psychology and engineering student data? A multisample analysis was conducted using LISREL. The multisample analysis using LISREL constrains the parameters of both covariances to be equal and determines whether the fit assuming these constraints is very good.

The covariances and means analyzed in this study are presented in Tables 4 and 5. Upon gross inspection, the covariances and means appear to be somewhat dissimilar, but similarities are recognizable as well. The purpose of this analysis was to determine whether the differences were of a sufficiently large magnitude to preclude a comparable fit with respect to the model.

Table 4: Covariances and Means of the Psychology Students

	PU	PEU	AT	Grades	SN
PU	53.11				
PEU	34.40	54.26			
AT	18.47	10.54	23.88		
Grades	0.11	-0.09	0.45	0.33	
SN	10.08	10.11	4.39	-0.03	13.64
Means	32.47	35.11	30.00	4.78	22.06

Note: PU = perceived usefulness; PEU = perceived ease of use; AT = attitude toward technology; SN = subjective norms.

Table 5: Covariances and Means of the Engineering Students

	PU	PEU	AT	Grades	SN
PU	57.93				
PEU	29.66	54.54			
AT	30.52	15.61	36.03		
Grades	0.67	0.67	0.74	0.44	
SN	18.60	14.88	11.96	0.14	16.32
Means	29.02	34.06	27.23	4.78	20.39

Note: PU = perceived usefulness; PEU = perceived ease of use; AT = attitude toward technology; SN = subjective norms.

Table 6: Results for the Goodness of Fit Indices

Fit Index	Value
Degrees of freedom (*df*)	6
Minimum fit function chi-square	4.75 (p = 0.58)
Goodness of fit index (GFI)	0.99
Comparative fit index (CFI)	1.00
Non-normed fit index (NNFI)	1.01
Standardized RMR (SRMR)	0.021

The maximum likelihood procedure converged to a proper solution in five iterations. The results suggest that the covariance in the responses of psychology students was very much like the covariance in the responses of the engineering students. All of the fit indices consulted suggested both models fit well and equivalently (see Table 6).

The GFI, CFI, and NNFI all exceeded .95, and the SRMR was less than .05. All fit criteria were exceeded, suggesting a magnificent fit. These results suggest that the same model is viable for both groups.

A review of the standardized path coefficients (regression weights) suggests many paths were indeed similar in value; however, notable differences could be observed as well (see Figures 3 and 4).

Both figures represent the configuration of relationships estimated for each group. A review of the parameters suggested that most of the paths specified were viable, though perceptions of how easy WebCT is to use had a negligible direct effect on attitudes toward WebCT for either groups (-.08 for psychology students; -.04, for engineering students). Furthermore, the effect of student attitudes towards WebCT on student course grades was statistically significant for either group, though small ($.02 \leq r^2 \leq .04$%). This result suggests that regardless of whether students are in psychology or engineering, their attitudes towards WebCT plays only a minor role in their final grade. Although this result is not reassuring for this aspect of the model, it does imply that institutional concerns about how student attitudes may affect student grades may not be needed. With respect to utility of the academic TAM, perhaps outcome(s) variables other than course grades

Figure 3. Psychology student data

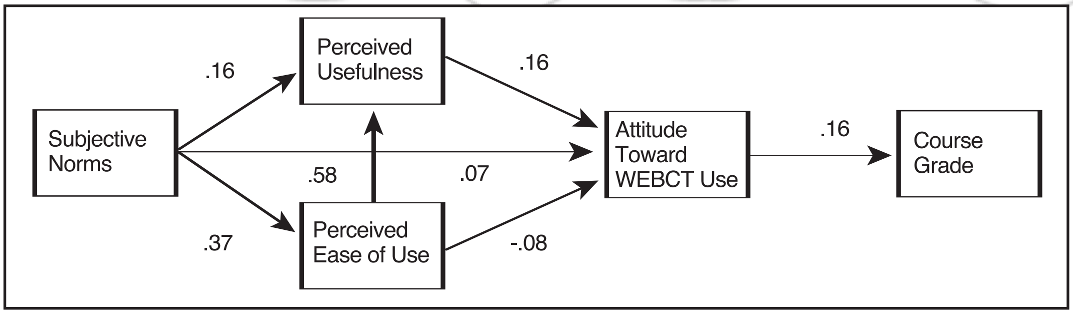
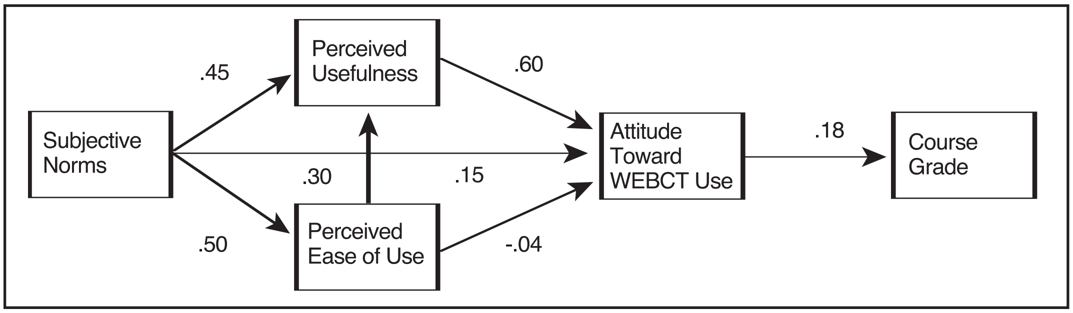


Figure 4. Engineering student data



should be considered such as frequency of technology use or the duration of technology use. Just how much do students' attitudes affect their exploitation of the technological resources made available to them and at what price?

To facilitate a further comparison of these paths, corresponding coefficients across the two path models are juxtaposed in Table 7.

A comparison of the differential effects of variables revealed that the influence of peer pressure and professorial expectations (subjective norms) were stronger for engineering students than for psychology students. For instance, the effect of subjective norms on student perceptions of how easy WebCT is to use was notably greater for engineering students (_ = .50) than psychology students (_ = .37). Subjective norms also had a stronger impact for engineering students on perceptions of how useful WebCT is as a course management system (_= .45) than for psychology students (_= .16). Similarly, subjective norms influenced engineering student attitudes towards WebCT (_= .15) more than psychology student attitudes (_= .07), although the coefficients were smaller. These results may be due to the engineering professor tending to hold his office hours primarily by himself and therefore having relatively more opportunities than the psychology professor to exert his influence in student perception of the WebCT use and student attitude toward the technology use. Conversely, psychology student perceptions of how easy WebCT is to use had a stronger effect on their perceptions of how useful WebCT is (_= .58) than engineering student perceptions (_= .30). These results may be due because of the limited social influence (or pressure) by the instructor, the psychology students behaved more like regular end users of a technology system, where they believed that WebCT had to be easy to use before they started to feel it is useful to their coursework (and then favored WebCT). Overall, these results suggest that although the same path model is viable for engineering and psychology students, differences in the two groups exist in the strength of certain effects.

The ultimate goal of this study was to assist the University of Central Florida in offering an alternative educational medium and a nontraditional paradigm to tailor customized instruction for the purpose of better suiting the wide variety of University of Central Florida students. Though the response rate of the engineering class was not noticeably high, the significance of this study may provide administrators from similar settings with insights into users' perception about the system employed from two different disciplines, which may mediate the acceptance of such technology.

Table 6: Academic TAM Path Values for Psychology and Engineering Students

	Standardized Paths (_s)	
	Psychology	Engineering
Subjective norms → Perceived usefulness	.16	.45
Subjective norms → Perceived ease of use	.37	.50
Subjective norms → Attitudes towards WebCT use	.07	.15
Perceived ease of use → Perceived usefulness	.58	.30
Perceived ease of use → Attitudes towards WebCT use	-.08	-.04
Perceived usefulness → Attitudes towards WebCT use	.55	.60
Attitudes towards WebCT use → Course grades	.16	.18

These results suggest that the academic TAM is as applicable to engineering students as it is to psychology students with respect to WebCT as a course management system, although perceptions of peer pressure and professor expectations play a more prominent role for engineering students and perceptions of WebCT ease of use has a greater impact on psychology students. If it is the goal of an institution to build student acceptance of a course management system, if for no other reason than to secure student satisfaction, then these results suggest that interventions should vary by the course sequence students are designated to take. Programmatically, this is useful because the relative strength of variable relationships at play in determining student attitudes towards technology is not the same. Specific recommendations of what programmatic strategies might be considered are not possible at this point, though this study does further develop our understanding of some of the dynamics. It is important to note that interventions designed to increase student attitudes towards technology should consider how a change in attitude would benefit students in academic ways beyond course grades. This research suggests that attitudes towards technology only play a minor role in affecting final grades.

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Books Briefly Noted

Cathcart, B. (2004). *The fly in the cathedral: How a small group of Cambridge scientists won the race to split the atom*. London, UK: Viking Press. ISBN: 0-670-88321-2, CAN $34.00 (Not available in US).

The book in your hand is mostly empty space. Each of the billions of atoms that make it up is hollow, its true mass concentrated in a tiny core which, if the atom were a cathedral, it would be no bigger than a fly.

Three quarters of a century ago no one could describe the atomic nucleus. Discovering its existence was Lord Rutherford's greatest scientific achievement but even he caught only a glimpse. Incapable of stopping there, he ached to know more – to catch the fly, examine it, dissect it and illuminate its mystery.

For a time all efforts to crack it open were stalled. No theory was possible until it could be tamed experimentally and no experiment seemed feasible since it guarded its secrets so fiercely. Then, just at the point of despair, John Cockcroft and Ernest Walton, two young researchers in a grubby basement room at the Cavendish Laboratory in Cambridge, came under Rutherford's guidance. And, with paper-and-pencil calculations, hand-made apparatus and the odd lump of plasticine, they changed everything.

Recreating the frustrations, excitements and obsessions of 1932, the 'miracle year' of British physicists, *The Fly in the Cathedral* reveals the astonishing story behind the splitting of the atom – the most celebrated scientific experiment of its time. Involving intense international competition, a cast of Nobel prize-winners, a few silly experiments and some revolutionary physics, Brian Cathcart's lucid, learned, high-voltage narrative is inspired by the dreams and endeavor that led the last true gentlemen scientists to the very essence of the universe: the heart of matter.

Cornish, E. (2004). *Futuring: The exploration of the future*. Bethesda, MD: World Future Society. ISBN: 0-930242-57-2, $29.95 (Hardcover).

This comprehensive guide to the study of the future, written by Edward Cornish, president of the World Future Society and editor of *The Futurist* magazine, is an essential and indispensable tool for anyone interested in the future.

Futuring is an authoritative introduction to scientific thinking about the future. Written in a clear, readable style, *Futuring* explains what we know about the future and what we can't, some of the techniques used by futurists, and the role that forward-looking people can play in creating a better tomorrow.

Cornish describes specific methods for anticipating future events so that readers can prepare to seize emerging opportunities and avoid unnecessary problems. *Futuring* can help readers make better decisions, develop worthwhile goals, and find the means to achieve them. *Futuring* is a powerful tool for achieving a better future.

Futuring also explains how serious thinking about the future has changed through the years, including the development of the idea of progress in the 17th century, the disillusionment with progress in the 20th century, and recent developments in thinking creatively and practically about the future. Readers will learn how far-sighted business trend watchers, military planners, and think-tank scholars now have a growing number of ways to think scientifically about the future so that leaders in government and business can prepare for opportunities and risks ahead. Cornish explains how these new methods are being used and how you too can use many of these methods in simplified but useful forms.

Davis, L.J. (2003). *Fleet fire: Thomas Edison and the pioneers of the electronic revolution*. New York, NY: Arcade Publishing. ISBN: 1-55970-655-4, $27.95.

The electric revolution, which eclipsed the Industrial Revolution by the end of the nineteenth century and continues to this day, changed our world forever. *Fleet Fire* tells us how it all began. In this entertaining narrative, science writer L.J. Davis introduces us to the men behind both the stunning successes and forgotten failures. Among them are Benjamin Franklin, whose kite first ignited the spark of curiosity; Alessandro Volta, who invented the storage battery; Joseph Henry, who gave us the electromagnet; Thomas Davenport, the electric motor; Samuel Morse, the electromagnetic telegraph; Cyrus Field, the transatlantic cable; Thomas Edison, the phonograph and electric light; and Nikola Tesla and Guglielmo Marconi, who raced frantically against each other to create the radio. Though in retrospect these devices may seem simple, they revolutionized the way we work and, more important, the way we view the world by redefining our concept of time and space.

Thoroughly researched and engagingly written, *Fleet Fire* shines a bright new light on the formative years of the electric revolution, capturing one of the most creative periods of experimentation and discovery, an inventive epoch unmatched in history.

Dean, T. (2004). *Talking with computers: Explorations in the Science and Technology of computing*. NY: Cambridge University Press. ISBN: 0-521-54204-9, $30.00.

In this lively series of essays, Tom Dean, Professor of Computer Sciences at Brown University and a Fellow of AAAI, explores interesting fundamental topics in computer science with the aim of showing how computers and computer programs work and how the various subfields of computer science are connected. Along the way, he conveys his fascination with computers and enthusiasm for working in a field that has changed almost every aspect of our daily lives.

The essays touch on a wide range of topics, from digital logic and machine language to artificial intelligence and searching the World Wide Web, considering such questions as:

- How can a computer learn to recognize junk email?
- What happens when you click on a link in a browser?
- How can you program a robot to do two things at once?
- Are there limits on what computers can do?

The author invites readers to experiment with short programs written in several languages. Through these interactions he grounds the models and metaphors of computer science and makes the underlying computational ideas more concrete. The accompanying website www.cs.brown.edu/~tld/talk provides easy access to code fragments from the book, tips on finding and installing software, links to online resources, exercises, and sample lectures.

DeGregori, T.R. (2002). *Bountiful harvest: Technology, food safety and the environment*. Washington, DC: The Cato Institute. ISBN: 1-930865-31-7, $12.95.

Millions of lives have been saved from malaria and typhus - two of the world's greatest killers - by DDT, a chemical that anti-technology groups in the United States managed to get banned. Yet these same groups oppose regulation of products with proven toxicity-for example, organic foods and alternative medicines-but this contradiction does not seem to bother them. Bountiful Harvest debunks these myths about the dangers of technology.

Arguing that humans are inherently technological beings and that technology has supported immense human progress over the past century, author DeGregori, who is a professor of economics at the University of Houston, provides a resounding critique of the modern Greens, vegetarians, organic and natural food advocates, and critics of genetically modified foods.

Doeringer, P., Evans-Klock, C. & Terkla, D.G. (2002). *Start-up factories: High-performance management, job quality, and regional advantage*. NY: Oxford University Press and Kalamazoo, MI: W.E. Upjohn Institute for Employment Research. ISBN: 0-19-514747-2, $24.50.

Start-Up Factories charts the experience of start-up factories in adopting high performance management practices and provides insights into how U.S. manufacturing can improve labor productivity and job quality in the coming years. Based on an extensive study of 48 new branch plants – with both U.S. and Japanese parent companies – that began operating between 1978 and 1990, this book explains how best practice manufacturing companies are raising productivity and lowering unit costs by introducing innovative high performance management practices.

Start-Up Factories answers six key questions related to high performance management practices in the American workplace and provides criteria for evaluating certain strategies:

- To what extent do the newest and technologically most advanced manufacturing plants adopt high performance management practices?
- Are there complementarities among these practices?
- Is there a single "best practice" model of high performance management being used by top-performing plants?
- Do high performance management practices contribute to jobs of high quality?
- Are there unique regional characteristics that reinforce high performance workplace standards?
- How can factories that combine state-of-the-art technologies with comprehensive high performance management strategies generate a large competitive advantage?

This book demonstrates to economists, labor and management professionals, and policymakers that there is a set of principles about how to rebuild management systems in ways that simultaneously provide higher rates of growth in business productivity and a greater sharing of these productivity gains with workers.

Fuhrman, S.H. & Elmore, R.F. (2004). *Redesigning accountability systems for education*. NY: Teachers College Press. ISBN: 0-8077-4425-5, $45.00,

Now more than ever, policymakers face a number of difficult and technical questions in the design and implementation of new accountability approaches. This book gathers the emerging knowledge and lessons learned offered by leading scholars in the field to provide an invaluable resource for policymakers, educators, and anyone interested in the pressing issue of accountability and public schools.

Expert contributors examine and offer recommendations on crucial issues such as:

- The effect of accountability policies on the ability of schools to improve over time.
- The significant variation in the design and effect of accountability systems in different states.
- The validity of assessment measures, including the use of scores for high-stakes decisions about students and schools.
- The choice of accountability measures and the levels of progress to expect.
- How to avoid penalizing schools for socioeconomic problems and other factors out of their control.
- The use of multiple measures of student achievement.
- Inclusion of students with disabilities and limited English proficiency in accountability systems.
- Building teachers' capacity to use information provided by assessments to improve instruction.

Gordin, M.D. (2004). *A well-ordered thing: Dmitrii Mendeleev and the shadow of the periodic table*. New York, NY: Basic Books. ISBN: 0-465-02775-x, $30.00.

When a young Dmitrii Mendeleev drafted the Periodic Table of Elements as a guide for his chemistry students at St. Petersburg University, he already had dreams of building a unified scientific empire in his home of Russia, with a place for himself in the limelight.

That the Periodic Table predicted the existence of three unknown elements and became the framework for modern chemistry helped Mendeleev's cause; it gave him a platform for social change and sensationalism. When he battled the emergence of Spiritualism in Russia, playing the skeptical foil in the séances he attended, newspapers across St. Petersburg paid attention. When he ventured into the sky as the novice pilot of a hot-air balloon, it made meteorology noteworthy in Russia. His attempts to distill a pure "ether" from the earth's atmosphere were similarly brave, but that chemical prophecy turned out to be less inspired.

Mendeleev's relationship with the Russian establishment was equally turbulent. He was an advisor to the Tsar, vitriolic proponent of protectionism, and he later introduced the metric system to the Russian empire. But his dramatic rejection at the hands of the Russian Academy of Sciences sent him into a tailspin that saw him spend his later years clawing to hold onto the reputation he established in his youth, while trying to reinvent himself as a scientific legend, a

Siberian Isaac Newton. Mendeleev was a loyal subject of the Tsar, but he was also a maverick who thought that only an outsider could perfect a modern Russia. He wanted to remake Russia just as he had remade chemistry, and his successes – and failures – were significant.

And yet, Mendeleev may be the most important scientist about whom we have almost nothing in English – until now, that is. In *A Well-Ordered Thing*, historian and Princeton assistant professor Michael Gordin changes that, drawing a portrait of the man in three full dimensions. A clever and detailed portrait of a man who had nearly been lost to history, *A Well-Ordered Thing* is a fascinating journey into the world of Imperial Russia – and into the life of one of its most notorious minds.

Gusterson, H. (2004). *People of the bomb: Portraits of America's nuclear complex*. Minneapolis, MN: University of Minnesota Press. ISBN: 0-8166-3860-8, $19.95.

This book tells the story of how – like it or not, know it or not – we have become "the people of the bomb." Integrating fifteen years of field research at weapons laboratories across the United States with discussion of popular movies, political speeches, media coverage of war, and the literature of defense intellectuals. Hugh Gusterson, associate professor of anthropology and science studies at MIT, shows how the military-industrial complex has built consent for its programs and transformed our public culture and personal psychology since we entered the nuclear age.

Hakken, D. (2003). *The knowledge landscapes of cyberspace*. New York, NY: Routledge. ISBN: 0-415-94509-7, $24.95.

The Knowledge Landscapes of Cyberspace is a provocative and pioneering analysis of information technology from a humanistic perspective. David Hakken – a leading anthropologist of computer culture and Professor of Anthropology and Director of the Policy Center at the State University of New York Institute of Technology at Utica/Rome – examines some fundamental about the cultural impact of cyberspace: Is the character or social function of knowledge changed profoundly – so profoundly as to justify terms like "Knowledge Society"? How are knowledge technologies tied to various agendas and forms of power?

In this richly documented and powerfully argued work, Hakken outlines a fresh way of thinking about the dynamics of technology and offers a new anthropologically-informed method of studying cyberspace from a cultural perspective. He also investigates the political economy of knowledge in cyberspace, and responds to the many aesthetic, ethical and political questions posed by uses and abuses of information technology.

This book is essential reading for anyone seeking to understand the human implications of the so-called computer revolution.

Hart, J.F. (2003). *The changing scale of American agriculture*. Charlottesville, VA: University of Virginia Press. ISBN: 0-8139-2229-1, $37.50.

Few Americans know much about contemporary farming, which has evolved dramatically over the past few decades. In *The Changing Scale of American Agriculture*, the award-winning geographer and landscape historian John Fraser Hart describes the transformation of farming from mid-twentieth century, when small family farms were still viable, to the present, when a farm must sell at least $250,000 of farm products each year to provide an acceptable standard of living for a family.

The increased scale of agriculture has outmoded the Jeffersonian ideal of small, self-sufficient farms. In the past farmers kept a variety of livestock and grew several crops, but modern family farms have become highly specialized in producing a single type of livestock or one or two crops. As farms have become larger and more specialized, their number has declined.

Hart contends that modern family farms need to become integrated into tightly orchestrated food-supply chains in order to thrive, and these complex new organizations of large-scale production require managerial skills of the highest order. According to Hart, this trend is not only inevitable, but it is beneficial, because it produces the food American consumers want to buy at prices they can afford.

Although Hart provides the statistics and clear analysis such a study requires, his book focuses on interviews with farmers: those who have shifted from mixed crop-and-livestock farming to cash-grain farming in the Midwest agricultural heartland; beef, dairy, chicken, egg, turkey, and hog producers around the periphery of the heartland; and specialty crop producers on the East and West Coasts. The invaluable case studies bring the reader into personal contact with the entrepreneurs who are changing American agriculture. Hart believes that modern large-scale farmers have been criticized unfairly and *The Changing Scale of American Agriculture*, the result of decades of research, is his attempt to tell their side of the story.

Heilbrun, M. (2000). *Inventing the skyline: The architecture of Cass Gilbert*. New York, NY: Columbia University Press. ISBN: 0-231-11873-2, $20.00.

Designed by the architect of the Broadway Chambers Building, the US Custom House, the Minnesota State Capitol, the St. Louis Art Museum, and large-scale projects like the city plan for New Haven, Connecticut, Cass Gilbert's pioneering skyscrapers – "symbols of our national genius and unrestraint" – profoundly influenced architects during the first decades of the twentieth century and epitomize the Beaux Arts "City Beautiful" aesthetic he embraced throughout his career. Containing essays by major Gilbert scholars, this lavishly illustrated volume considers the full breadth of Gilbert's career. The book also documents fascinating details about the buildings: the color scheme of the main entrance of the Minnesota State Capitol, made to resemble the Byzantine tombs of Galla Placidia in Ravenna; the controversy that erupted over the use of female nudes on the relief of the Essex County Courthouse; and the ill-fated plans for the George Washington Bridge as a Beaux Arts monument with elaborate plazas, fountains, and sculptures.

Hocker, F.M. & Ward, C.A. (2004). *The philosophy of shipbuilding: Conceptual approaches to the study of wooden ships*. College Station, TX: Texas A&M University Press. ISBN: 1585443131, $75.00.

No boat or shipbuilder has ever started from scratch. Skilled craftsmen construct vessels based on a combination of their own skills and those of their predecessors, and these techniques tell how people of the past, from ancient Egypt's First Dynasty to North America's Golden Age of Navigation, perceived the physical world.

Edited by Frederick M. Hocker and Cheryl A. Ward, who both received their PhDs from Texas A&M University, *The Philosophy of Shipbuilding: Conceptual Approaches to the Study of Wooden Ships* explores the concepts underlying basic ship design and construction during various periods of history. Experts in the field study ancient boat models, present the latest research methodologies, and furnish information from nautical archaeology excavations.

"The study of ship remains begins with the recording of seemingly trivial details: the thickness of a plank, the numbers and sizes of nails, the direction of an adze stroke, the color and texture of stains in half-rotten bits of wood," Hocker writes. "Those tool marks and stains, grain patterns and botched repairs, are the voices of the people who owned, built, and sailed the vessels archaeologists excavate and ship specialists study. Their voices can tell us who they were and why they built their boats and ships the way they did."

The first essays explore the earliest plank-built ships of ancient Egypt and the evidence contained in Egyptian papyri, the mortise-and-tenon joined hulls of the ancient Mediterranean, and principles and methods of construction used in ancient naval architecture. Further chapters discuss Nordic clinker construction, bottom-based shipbuilding in northwestern Europe, and Nile skippers of the mid-third century B.C. A wide range of ships is examined, including those from the third millennium B.C., the Tantura wrecks, and Iberian ships from the fifteenth and sixteenth centuries. A final chapter examines the evolution of Lake Champlain's sailing merchant fleet.

Hood, Clifton (2004). *722 miles: The building of the subways and how they transformed New York centennial edition*. Baltimore, MD: Johns Hopkins University Press. ISBN 0-8018-8054-8, $18.95.

The 22 miles, from City Hall to 145th Street and Lenox Avenue, was once considered a remarkable engineering feat. By the 1940s, the New York City subway system grew to 722 miles, including the Independent Subway line. In the process, the subway system transformed New York. In this definitive history, Clifton Hood traces the complex and fascinating story of the New York City subway system, one of the urban engineering marvels of the twentieth century. For the subway's centennial the author supplies a new foreword explaining that now, after a century, "we can see more clearly than ever that this rapid transit system is among the twentieth century's greatest achievements."

Hosek, J.R., Mattock, M.G., Fair, C.F., Kavanagh, J., Sharp, J., Totten, M. (2004). *Attracting the best: How the military competes for information technology personnel*. Arlington, VA: RAND National Defense Research Institute. ISBN: 0-8330-3550-9, $27.50.

During the 1990s, the private-sector demand for information technology (IT) workers, escalating private-sector pay in IT, growing military dependence on IT, and faltering military recruiting led to a concern that the military capability was vulnerable to a shortfall in IT personnel. This report addresses that concern by use of a literature description, field interviews, data analysis, and a dynamic model that, taken together, offer some policy implications for military planners in terms of how to recruit and retain qualified IT personnel.

Hughes, T. P. (2004). Human-built world: How to think about technology and culture. Chicago, IL: The University of Chicago Press. ISBN: 0-226-35933-6, $22.50.

Technology surrounds us: Millions of homes have digital cable and wireless internet connections; telephones can also serve as cameras, music players, and personal organizers; and everything from stereos to computers grow more sophisticated every year. This, of course, is the technology that most of us encounter and even embrace. But lurking behind these gadgets is an arena in which the topic of technology raises troubling questions. Cosmetic surgery, chemical weapons, and cloning are just some of the more recent examples of the uneasy results of our technological progress, and they remind us that technology is Janus-faced – something capable of immeasurable good as well as a test of the limits of human morality and power.

Thomas P. Hughes, the eminent historian of technology and acclaimed author of *American Genesis*, a finalist for the Pulitzer Prize, wrote *Human-Built World* as a similar reminder, revealing the concept of technology as it was framed historically by thinkers who ran the gamut from horrified to euphoric. For just as Henry Ford's factories were revolutionizing the productive capacity of the American automobile industry, social critics were warning of the increasing "dehumanization" of machine-age culture. And just as Ralph Waldo Emerson was celebrating the transformative power of technology and its ability to express the ultimate creativity of the human race, the steam engine and coal production were beginning to ravage the nineteenth-century landscape.

Exploring such competing perspectives, *Human-Built World* is a concise intellectual biography of the tools of technology. Drawing on a vast body of work created over the centuries by philosophers and architects, social theorists and web designers, politicians and engineers, Hughes charts the multiple ways that technology has been viewed – sometimes with elation, sometimes with skepticism – by various thinkers. Technology, as he shows here, has not been a slow and steady march to the ever-increasing complexity and sophistication of objects; it has been the subject of debate for centuries about the human will to create, the inherent danger of progress for its own sake, and the Mephistophelean urge to alter everything from the natural landscape to the daily activities of millions. "In its variety," Hughes writes here, "technology is full of contradictions, laden with human folly, saved by occasional benign deeds, and rich with unintended consequences." Hughes' mission here is to restore to technology these contradictions and unintended consequences, and his *Human-Built World* is a necessary and original guide that recreates technology as the philosophical, moral, and social dilemma it rightfully is.

Jackson, W. J. (2004). *Heaven's fractal net: Retrieving lost visions in the humanities*. Bloomington: Indiana University Press. ISBN: 0-253-21620-6, $29.95.

"Fractal" is a term coined by mathematician Benoit B. Mandelbrot to denote geometry of nature, which traces inherent order in chaotic shapes and processes. Using lines so intricate they are more than one-dimensional and surfaces so rough they are more than two-dimensional, fractal geometry can articulate new ways of considering and describing nature. In the recursive patterns of religious music, in temple architecture in India, in cathedral structures in Europe and America, in the imagery of religious literature depicting infinity and abundance, and in poetic descriptions of the nature of consciousness, fractal-like configurations are pervasive. Fractal concepts are part of our emerging vocabulary and can describe patterns of human behavior, culture and history while enhancing our understanding of the nature of consciousness.

Karoly, L.A. & Panis, C.W.A. (2004). *The 21st century at work: Forces shaping the future workforce and workplace in the United States*. Arlington, VA: RAND Labor and Population. ISBN: 0-8330-3492-8, $30.00.

What are the forces that will continue to shape the US workforce and workplace over the next 10 to 15 years? With such inevitabilities as the proliferation and acceleration of technology worldwide, will more individuals work at home, will more businesses outsource their noncore functions – and with what consequences? Answering such questions can help stakeholders – workers, employers, educators, and policymakers – make informed decisions. With its eye on forming sound policy, the US Department of Labor asked the RAND Corporation to look at the future of work in the near-to-medium term. The authors analyzed shifting demographic patterns, the pace of technological change, and the path of economic globalization. They observe, for example, that the workforce will continue to grow – however, at a markedly declining pace – and that the ongoing education of employees will be paramount as new technologies, such as bio- and nanotechnologies, come onto the scene and develop. They also look at the trend of globalization and how it fares for the United States' economy and those of other countries. Overall, the authors provide for the reader expectations about the key forces in the economy today and their implications for the future workforce and workplace, including the size, composition, and skills of the workforce; the nature of work and workplace agreements; and worker compensation.

Kent, P. (2004). *Search engine optimization for dummies*. NY: Wiley Publishing, Inc. ISBN: 0-7645-6758-6, $24.99.

Find out how to make your site pop to the top when the search is on. Search engines, search directories, search systems – it's enough to make you search for antacids! Well, relax – this book not only tells you which is which, it gives you the inside track on which ones to impress. Find out about pay-per-click search engine advertising, what your site needs to lure search engines, how and where to register, and more.

Krebs, R.E. (2004). *Groundbreaking scientific experiments, inventions & discoveries of the Middle Ages and the Renaissance.* Westport, CT: Greenwood Press. ISBN: 0-313-32433-6, $65.00.

The Middle Ages and the Renaissance were a period of scientific and literary awakening. Scientific development and a renewed interest in classical science led to new discoveries, inventions, and technologies. Between 500 and 1600A.D., scientific explorers rediscovered ancient Greek and Eastern knowledge, which led to an eruption of fresh ideas. This reference work describes more than 75 experiments, inventions, and discoveries of the period, as well as the scientists, physicians, and scholars responsible for them. Individuals such as Leonardo da Vinci, Marco Polo, and Galileo are included, along with entries on reconstructive surgery, Stonehenge, eyeglasses, the microscope, and the discovery of smallpox.

Part of a unique series that ranges from ancient times to the 20th century, this exploration of scientific advancements during the Middle Ages and the Renaissance will be useful to high school and college students, teachers, and general readers seeking information about significant advances in scientific history.

Launius, R.D. & Daly Bednarek, J.R. (2003). *Reconsidering a century of flight*. Chapel Hill, NC: The University of North Carolina Press. ISBN: 0-8078-5488-3, $19.95.

On December 17, 1903, Orville and Wilbur Wright soared into history during a twelve-second flight on a secluded North Carolina beach. Commemorating the 100th anniversary of the first flight, these essays chart the central role that aviation played in twentieth-century history and capture the spirit of innovation and adventure that has characterized the history of flight.

The contributors, all leading aerospace historians, consider four broad themes relating to the development of flight technology: innovation and the technology of flight, civil aeronautics and government policy, aerial warfare, and aviation in the American imagination. Through their attention to the political, economic, military, and cultural history of flight, the authors establish that the Wrights' invention – and all that followed in both air and space – was one of the most significant technologies of the twentieth century, fundamentally reshaping our world.

Levick, S.E. (2004). *Clone being: Exploring the psychological and social dimensions*. NY: Rowman & Littlefield Publishers, Inc. ISBN: 0-7425-2990-8, $28.95.

Marshalling psychological and sociological theory and research, and drawing upon extensive clinical experience as a psychiatrist and psychotherapist, Levick explores the various dimensions of cloning. This book attempts to anticipate the possible consequences of cloning for a clone, his or her "parents" and family, and society. Levick, who is also a clinical assistant professor of psychiatry at the University of Pennsylvania School of Medicine, does this through models of situations that are relevant by analogy to various aspects of cloning. Psychotherapy case material enlivens and illustrates each model, and the reader is helped to identify "clone-like" aspects of his or her own experience and mental life, and also to see evidence of the clone-like around them. Through this process, the book comes to important conclusions about human nature, including the crucial roles of intimacy, sex and sexuality for society. The clinical and scientifically grounded insights of this book should help inform the reader's ethical judgments and attitudes about the reproductive cloning of human beings.

Lottman, H. (2004). *The Michelin men: Driving an empire*. New York, NY: I.B. Tauris. ISBN: 1-86064-896-7, $27.95.

Herbert Lottman is an American writer based in Paris and is the European correspondent for *Publishers Weekly.* In his new book, *The Michelin Men: Driving an Empire* he offers the previously untold account of the Michelin dynasty – one of the world's most successful and secretive companies – and the inside story of the Michelin hotel and restaurant guides, as well as their tires, both products that revolutionized the way people travel today.

Andre and Edouard were two brothers trying to rescue their family's family rubber plant in Clermont-Ferrand, France. After repairing a faulty tire as a favor, Edouard became determined to design a superior one. Deciding to pursue the business, Andre, who was based in Paris, began a public relations campaign. Trying to convince the public that riding on a cushion of air was the more comfortable way to travel, he came up with the phrase that the Michelin tire "swallows the obstacle." That slogan would give name to Bibendum, the endearing and immediately recognizable tire man. Back in the factory, Edouard's management style and focus on innovation kept the Michelin brand ahead of the competitors. At the same time Andre, defending the company in his weekly promotional articles, prepared a free travel guide touting Michelin tires, which would encourage motorists to explore the countryside. The free guides grew in popularity and the Paris travel office, which offered free route plans, began to become a business of its own.

The company grew from its success, but as competitors entered the fray, the Michelin men began protecting their empire. Whether a factory worker or a guide inspector, all staff were required not to reveal company secrets – with good reason, Lottman tells just how far some people would go to get the world-renowned three star designation for their restaurant. The Michelins were also protecting plans for a radial tire that would revolutionize the tire industry for the latter half of the twentieth century. They even managed to keep their plans secret from the Germans during the Occupation. However, the company faced another hurdle when Francois Michelin took the helm of the company in 1959. He stressed that the company needed to expand into the international marketplace to remain viable. Through intense criticism and economic ups and downs, he remained convinced of his long-term plan. In the end proving his critics wrong, Lottman describes how Francois made Michelin one of the most successful worldwide companies.

With Herbert Lottman's skillful narration, *The Michelin Men* tells how two brothers saved their family's company, created an international industry, and invented the world's best guidebooks to promote their tires. In the process, he gives readers a history of the automobile and travel industries, and how Michelin revolutionized them both.

Livingstone, D.N. (2003). *Putting science in its place: Geographies of scientific knowledge.* Chicago, IL: The University of Chicago Press. ISBN: 0-226-48722-9, $27.50.

As any fan of Patrick O'Brian's series devoted to the voyages of Captain Jack Aubrey and Stephen Maturin knows, part of the appeal of books is the vivid descriptions of Maturin's botanic and scientific labors and discoveries during the course of the series. The character of Maturin is based on the historical figure of the seafaring scientist, encountering new species, collecting specimens, and bringing his researches home to a fascinated public. But while we recognize Maturin as fictional, we forget that the work of the men he represents is conditioned by time and place as the recent "Master and Commander" movie demonstrated. Science, far from a universal pursuit, always has a setting, and this setting in turn affects the shapes of scientific discoveries.

David N. Livingstone's *Putting Science in Its Place* is an elegant, concise story of how science has been affected by its setting. As Livingstone, who is professor of geography and intellectual history at Queen's University in Belfast, points out, landmark discoveries have been made not only on boats but also in asylums, in royal gardens that served as the home of exotic animals, on living and dead bodies, and in sterile laboratories. All of these places – and more – have made their mark in determining the questions that scientists have been able to ask and answer. Livingstone's narrative charts the ways that place and space have organized science, bringing the latter fully into discussion with social and political history.

Livingstone, a fellow of the British Academy and member of the Royal Irish Academy, does not restrict himself solely to place. Measurement, for example, has a history, as does representation. The advent of photography, the invention of the metric system, even the relative wealth of nineteenth-century "gentleman scientists" are all connected to the scientific enterprise. *Putting Science in Its Place* fills out this necessary context for understanding the history of human discovery and invention. "Scientific knowledge", Livingstone writes, "is always the product of specific spaces. To claim otherwise is to displace science from the culture of which it is so profoundly a part."

Putting Science in Its Place is a fascinating view of how science is specific and local. While it may make claims to universality, Livingstone shows, science is as much a product of place and time as operas and politics, technology and travel. He reminds us in accessible language and through fascinating examples. This clear, thought-provoking book brings the scientific endeavor back from the lofty realm of the abstract and situates it solidly in the historical circumstances from which it emerged. In the process, a geography of science is born.

May, W.F. (2001). *Beleaguered rulers: The public obligation of the professional*. Louisville, KY: Westminster John Knox Press. ISBN: 0-664-22671-X,$19.95.

Professionals today wield an enormous public power. Collectively, their decisions affect the patient's plight, the client's fate, the student's future, the city's scape, the earth's sustainability, the worker's fair treatment, and the durability of institutions great and small. Yet professionals do not perceive themselves as power wielders. They feel beleaguered, marginal, insufficiently appreciated, often under siege. Thus they tend to obscure for themselves their obligations to the common good. This book explores eight professions as their struggle with their double identity – as a means to a livelihood and as a "common calling in the spirit of public service." An interpretation of American culture emerges from its pages, as social critic and Professor of Ethics at Southern Methodist University William May opens up the ways in which each profession answers to something deep in the American spirit.

Misa, T.J. (2004). *Leonardo to the internet: Technology & culture from the Renaissance to the present.* Baltimore, MD: The Johns Hopkins University Press. ISBN: 0-8018-7809-8, $19.95.

The image of the lone inventor transforming society from the outside has a strong hold on the public's imagination. In reality, though, technologies are products of ongoing social and cultural processes. In *Leonardo to the Internet*, historian and associate professor of history at the Illinois Institute of Technology Thomas J. Misa provides a sweeping comparative history of the interrelationship between technology and society since the Renaissance, revealing how technological innovations have been shaped by the cultures in which they arose and how such technologies have, in turn, shaped these cultures. From the careers and contributions of the Renaissance court inventors Johann Gutenberg and Leonardo da Vinci to beer brewing in industrial London to the telecommunication revolution of the late twentieth century, Misa uses carefully chosen and engagingly told case studies to develop his thesis.

Over eight thematic chapters, Misa provides detailed portraits of the inventors and users of technologies. Beginning his narrative at the dawn of the "modern" era, Misa surveys the intersections of technology, politics, and culture in the Renaissance court system of Western Europe; the role of technology in Holland's commercial expansion; the diverse "paths" to and through Britain's industrial revolution; the links among technology, imperialism, and trade in the nineteenth century; and the application of scientific discoveries in chemistry and physics to industry in Germany and the United States at the turn of the twentieth century. Misa then examines the introduction of mass-produced consumer goods and their impact on daily life and modernist sensibilities, the rise of the military-industrial complex during World War II, the technological innovations generated by the command-and-control economics of the Cold War, and the emergence of a technology-oriented global culture since the 1970s. The work concludes with a provocative essay laying out the technological choices we face today and considering their impact on the type of society we wish for the future.

A masterful analysis of the ways in which technology and culture have influenced each other over five centuries, *Leonardo to the Internet* encourages students and general readers alike to think both more widely and more deeply about the invention, development, transfer, and adaptation of technologies within Western civilization.

Mitchell, R. & Thurtle, P. (2004). *Data made flesh.* New York, NY: Routledge. ISBN: 0-415-96905-0, $24.60.

In an age of cloning, cyborgs, and biotechnology, the line between bodies and bytes seems to be disappearing. *Data Made Flesh* is the first collection to address the increasingly important links between information and embodiment, at a moment when we are routinely tempted, in the words of Donna Haraway, "to be raptured out of the bodies that matter in the lust for information," whether in the rush to complete the Human Genome Project or in the race to clone a human being. From cybernetics to genomics, this timely collection is essential reading for anyone interested in the fate of the body at the cutting edge of technology.

Mom, G. (2004). *The electric vehicle: Technology and expectations in the automobile Age.* Baltimore, MD: The Johns Hopkins University Press. ISBN: 0-8018-7138-7, $54.95.

Recent attention to hybrid cars that run on both gasoline and batteries has made the electric car an apparent alternative to the internal combustion engine and all of its attendant environmental costs and geopolitical implications. Yet few people realize that the electric car – neither a recent invention nor a historical curiosity – has a story as old as that of the gasoline-powered automobile. Indeed, at one time many in the nascent automobile industry believed battery-powered engines would become the dominant technology. Before World War II, in both Europe and America, electric cars and trucks succeeded in meeting the needs of a wide range of consumers. As many as 30,000 electric cars and more than 10,000 electric trucks then plied American roads; European cities were busy with electrically propelled fire engines, taxis, delivery vans, buses, heavy trucks, and private cars.

Even so, popular memory and automotive historiography have left the impression that it was an inferior technology, and that view has remained stubbornly in place. In *The Electric Vehicle*, Gjis Mom, who teaches the history of technology at the Technical University of Eindhoven, challenges this view, arguing that at the beginning of the automobile age neither the internal combustion engine nor the battery-powered vehicle enjoyed a clear advantage. He explores the technology and marketing/consumer-feedback relationship over four “generations” of electric-vehicle design, with separate chapters on privately owned passenger cars and commercial vehicles. He makes abundant comparisons among European countries and between Europe and America.

Professor Mom finds that the electric vehicle offered many advantages, among them greater reliability and control and less noise and pollution. He also argues that a nexus of factors – cultural (under-powered and less rugged, electric cars seems “feminine” at a time when most car buyers were men), structural (the shortcomings of battery technology at the time), and systemic (the infrastructural problems of changing large numbers of batteries) – ultimately gave an edge to the internal combustion engine. As a new generation of electric vehicles becomes a reality, *The Electric Vehicle* offers a long-overdue reassessment of the place of this technology in the history of street transportation.

Murmann, J.P. (2003). *Knowledge and competitive advantage: The coevolution of firms, technology, and national institutions*. NY: Cambridge University Press. ISBN: 0-521-81329-8, $60.00.

Entrepreneurs, managers, and policy makers must make decisions about a future that is inherently uncertain. Since the only rational guide for the future is the past, analysis of previous episodes in industrial development can shape informed decisions about what the future will hold. Historical scholarship that seeks to uncover systematically the causal processes transforming industries is thus of vital importance to the executives and managers shaping business policy today. With this in mind, John Peter Murmann, who is an Assistant Professor of Management and Organizations at the Kellogg School of Management at Northwestern University, compares the development of the synthetic dye industry in Great Britain, Germany, and the United States through the lens of evolutionary theory. The rise of this industry constitutes an important chapter in business, economic, and technological history because synthetic dyes, invented in 1856, were the first scientific discovery to quickly give rise to a new industry. Just as with contemporary high-tech industries, the synthetic dye business faced considerable uncertainty that led to many surprises for the agents involved. After the discovery of synthetic dyes, British firms led the industry for the first eight years, but German firms came to dominate the industry for decades; American firms, in contrast, played only a minor role in this important development. Murmann identifies differences in educational institutions and patent laws as the key reasons for German leadership in the industry. Successful firms developed strong ties to the centers of organic chemistry knowledge. As Murmann demonstrates, a complex coevolutionary process linking firms, technology, and national institutions resulted in very different degrees of industrial success among the dye firms in the three countries.

Nichols, F.D. & Griswold, R.E. (1978). *Thomas Jefferson, Landscape architect*. Charlottesville, VA: University of Virginia Press. ISBN: 0-8139-0899-X, $13.96.

Collaboration with the greatest botanists of his time, an instinctive humanitarianism, and a natural ingenuity in landscape design combined to make Thomas Jefferson a pioneer in American landscape architecture. Frederick D. Nichols and Ralph E. Griswold, in this close study of Jefferson’s many notes, letters, and sketches, present a clear and detailed interpretation of his extraordinary accomplishments in the field.

Thomas Jefferson, Landscape Architect investigates the many influences on--and of--the Jeffersonian legacy in architecture. Jefferson’s personality, friendships, and convictions, complemented by his extensive reading and travels, clearly influenced his architectural work. His fresh approach to incorporating foreign elements into domestic designs, his revolutionary approach to relating the house to the surrounding land, and his profound influences on the architectural character of the District of Columbia are just a few of Jefferson’s contributions to the American landscape. Eighteenth- and nineteenth-century maps, plans, and drawings, as well as pictures of the species of trees that Jefferson used for his designs, generously illustrate the engaging narrative in *Thomas Jefferson, Landscape Architect*.

Oudshoorn, N. *The male pill: A biography of a technology in the making*. Durham, NC: Duke University Press. ISBN: 0-8223-3195-0, $21.95.

Why, forty years after the introduction of the contraceptive pill for women, is there still no equivalent for men? Nelly Oudshoorn seeks an answer in her new book *The Male Pill: A Biography of a Technology in the Making.*

Oudshoorn, who is a Professor of Gender and Technology at Twente University and an author of several books on gender and reproduction, explains why it is that, although the technical feasibility of male contraceptives was demonstrated as early as the late 1970s, there is, to date, no male pill. Ever since the idea of hormonal contraceptives for men was introduced, Oudshoorn stresses, scientists, feminists, journalists and pharmaceutical entrepreneurs have questioned whether men and women would even accept a new male contraceptive if one were available. *The Male Pill* provides a detailed examination of the cultural, policy, and scientific work around the male pill from the 1960s through the 1990s.

Oudshoorn emphasizes that the introduction of contraceptives for men depends to a great extent on changing ideas about reproductive responsibility. Initial interest in the male pill, she shows, came from outside the scientific community: from the governments of China and India, which were interested in population control, and from Western feminists, who wanted the responsibilities and health risks associated with contraception shared more equally between the sexes. She documents how in the 1970s, the World Health Organization took the lead in investigating male contraceptives by coordinating an unprecedented, worldwide research network.

Oudshoorn chronicles how the search for a male pill required significant reorganization of drug-testing standards and protocols and of the family-planning infrastructure – including founding special clinics for men, creating separate spaces for men within existing clinics, enrolling new professionals, and defining new categories of patients. *The Male Pill* is ultimately a story as much about the history of masculinity in the last decades of the twentieth century as it is about the development of safe and effective technologies.

Overly, Esq., M., & Kalyvas, Esq., James R. (2004). *Software agreements line by line: A detailed look at software agreements & how to change them to fit your needs*. Aspatore Books. ISBN: 1-58762-369-2, $49.95.

Today's business climate demands the ability to leverage essential technologies, as well as a heightened understanding of how the Software Agreement underlying such essential technologies may adversely affect your business. There has long been a disconnect between the interests of the end user and the objectives of the vendor in developing, drafting, and executing such agreements. *Software Agreements Line* by Line serves to bridge this gap. Taking a standard "vendor oriented" software agreement and breaking it down clause by clause, explaining the nuances of the language, and the business implications inherent therein, leading technology lawyers Michael Overly and James Kalvyas, both of whom are partners in the Los Angeles law firm Foley & Lardner specializing in technology, present a penetrating insight into the Software Agreement. The authors detail why such agreements should be modified, how to modify them, and offer practical solutions to promote your ability to successfully implement critical technologies in your business. A never before offered glimpse into the often daunting world of these highly technical agreements, *Software Agreements Line* by Line highlights the often overlooked, unnoticed and even hidden aspects of procuring and implementing business systems. The ability to understand and develop user-friendly software agreements offers great advantages for any company making investments in, and developing strategies around, software. This book will provide any reader the tools to become an informed user, a more strategic thinker, and above all, an empowered consumer.

Peskin, L.A. (2003). *Manufacturing revolution: The intellectual origins of early American industry*. Baltimore, MD: The Johns Hopkins University Press. ISBN: 0-8018-7324-x, $49.95.

"While much has been written about the industrial revolution", writes Lawrence A. Peskin, "we rarely read about industrial revolutionaries." This absence, he illustrates, reflects the preoccupation of both classical and Marxist economics with impersonal forces rather than individuals. In

Manufacturing Revolution Peskin, who is an assistant professor of history at Morgan State University, deviates from both dominant paradigms by closely examining the words and deeds of individual Americans who made things in their own shops, who met in small groups to promote industrialization, and who, on the local level, strove for economic independence.

In speeches, petitions, books, newspaper articles, club meetings, and coffeehouse conversations, they fervently discussed the need for large-scale American manufacturing a half-century before the Boston Associates built their first factory. Peskin shows how these economic pioneers launched a discourse that continued for decades, linking industrialization to the cause of independence and guiding the new nation along the path of economic ambition. Based upon extensive research in both manuscript and printed sources from the period between 1760 and 1830, this book will be of interest to historians of the early republic and economic historians as well as to students of technology, business and industry.

Porter, T. M. (2004). *Karl Pearson: The scientific life in a statistical age*. Princeton, NJ: Princeton University Press. ISBN: 0-691-11445-5, $35.00.

Karl Pearson, founder of modern statistics, came to this field by way of passionate early studies of philosophy and cultural history as well as ether physics and graphical geometry. His faith in science grew out of a deeply moral quest, reflected also in his socialism and his efforts to find a new basis for relations between men and women. This biography recounts Pearson's extraordinary intellectual adventure and sheds new light on the inner life of science.

Theodore Porter's intensely personal portrait of Pearson extends from religious crisis and sexual tensions to metaphysical and even mathematical anxieties. Pearson sought to reconcile reason with enthusiasm and to achieve the impersonal perspective of science without sacrificing complex individuality. Even as he longed to experience nature directly and intimately, he identified science with renunciation and positivistic detachment. Porter, who is Professor of History at UCLA, finds a turning point in Pearson's career, where his humanistic interests gave way to his statistical ones, in his *Grammar of Science* (1892), in which he attempted to establish scientific method as the moral educational basis for a refashioned culture. In this original and engaging book, a leading historian of modern science investigates the interior experience of one man's scientific life while placing it in a rich tapestry of social, political, and intellectual movements.

Rabinovitz, L. & Geil, A. (2004). *Memory bytes: History, technology, and digital culture*. Durham, NC: Duke University Press. ISBN: 0-8223-3241-8, $22.95.

Digital culture is often characterized as radically breaking with past technologies, practices, and ideologies, rather than as reflecting or incorporating them. *Memory Bytes* seeks to counter such ahistoricism, arguing for the need to understand digital culture – and its social, political, and ethical ramifications – in historical and philosophical context. Looking at a broad range of technologies, including photography, print and digital media, heat engines, stereographs, and medical imaging, the contributors present a number of different perspectives from which to reflect on the nature of media change. While foregrounding the challenges of drawing comparisons across varied media and eras, *Memory Bytes* explores how technologies have been integrated into society at different moments in time.

These essays from scholars in the social sciences and humanities cover topics related to science and medicine, politics and war, mass communication, philosophy, film, photography, and art. Whether describing how the cultural and legal conflicts over player piano rolls prefigured controversies over the intellectual property status of digital technologies such as MP3 files, comparing the experiences of watching QuickTime movies to Joseph Cornell's "boxed relic" sculptures of the 1930s and 1940s, or calling for a critical history of electricity from the Enlightenment to the present, *Memory Bytes* is a lively, enlightening examination of the interplay of technology and culture.

Riggs, K.E. (2004). *Granny @ work: Aging and new technology on the job in America*. New York: Routledge. ISBN: 0-415-96583-7, $19.75.

The advancing age of baby boomers, who are living longer and retiring later, has generated an unprecedented number of older workers in America. The Bureau of Labor Statistics predicts that the population of workers 55 and over will practically double from 18 million in 2000 to more than 33 million by 2025.

In *Granny @ Work*, Karen Riggs- a renowned expert on aging and Associate Professor of Communication and Director of the School of Telecommunications at Ohio University – examines how this older workforce is coping with radical technological changes being introduced to the workplace – from e-mail to automation. Drawing on extensive interviews, she brings to light what employers, software engineers, and public policy makers seem to be thinking behind the scenes about the roles older adults might play in the workplace of the future – and asks whether those on the front lines of corporate life are actually looking out for the interests of a graying workforce. Riggs also challenges dominant beliefs about aging and technology as they are disseminated in popular culture, offering incisive analysis of a wide range of material from films focused on older characters such as *Cocoon* and *Space Cowboys* to specialty websites and magazines aimed at older workers.

Granny @ Work is an impassioned comment on aging, work, and technology in American culture. As Riggs challenges popular assumptions with surprising research – for example, people over the age of 60 sped more time on the Internet than people of any other age group – and trenchant cultural critique, she also forces us to confront the deeply entrenched ageism in today's technology-driven workplace.

Scarlett, M. (2004). *The great rip-off in American education: Undergrads underserved*. Amherst, NY: Prometheus Books. ISBN: 1-59102-031-x, $22.00.

Is a bachelor's degree from an American university really worth the ever-rising cost of obtaining one? According to former university president Dr. Mel Scarlett, who is currently president emeritus of Middle Tennessee State University, unless major changes are made to the American system of higher education, the disparity between the quality and the price of education is only going to get worse. The rise in tuition has substantially outpaced inflation over the last few decades, while the resources of larger "research" universities have shifted dramatically to feed the insatiable appetite of today's faculties, whose "publish or perish" culture has eclipsed any real concern for innovative teaching and sparking young minds to think independently. The undergraduate student is left in the cold: huge classes, an uninspiring lecture format, and perhaps worst of all, inexperienced teaching assistants whose English is often highly suspect. Scarlett spares no sacred cows when identifying the obstacles that prevent efforts to improve post-secondary education throughout the country. He offers a variety of "Radical Recommendations" to steer undergraduate education in a direction that will inspire and invigorate the learning experience. Be prepared to question everything you know about higher learning in America.

Schneier, B. (2003). *Beyond fear: Thinking sensibly about security in an uncertain world*. NY: Copernicus Books. ISBN: 0-387-02620-7, $25.00.

Searching kids and grandmas actually improves airport security, but arming pilots makes us all less secure; shopping with a credit card is just as secure as using it over the phone or by mail. These, and the dozens of other surprising insights in this book, will help you develop a keen sense of what today's most talked-about security measures can and cannot do.

Security is not mysterious, Bruce Schneier tells us, and contrary to popular belief, it is not hard. What is hard is separating the hype from what really matters. You already make security choices every day, from what side of the street you walk on to whether you park your car under a streetlight. You do it naturally. This book guides you, step by step, through the process of making all your security choices just as natural.

Schneier, a security expert for policy makers and business leaders, invites us all to move beyond fear and to start thinking sensibly about security. He tells us why security is much more than cameras, guards, and photo Ids, and why expensive gadgets and technological cure-alls often obscure the real security issues. Using anecdotes from history, science, sports, movies, and the evening news, *Beyond Fear* explains basic rules of thought and action that anyone can understand and, most important of all, anyone can use.

The benefits of Schneier's non-alarmist, common-sense approach to analyzing security will be immediate. You'll have more confidence about the security decisions you make, and new insights into security decisions that others can make on your behalf. Whether your goal is to enhance security at home, at the office, and on the road, or to participate more knowledgeably and confidently in the current debates about security in our communities and the nation at large, this book will change the way you think about security for the rest of your life.

Shagena, J. L. (2004). *Who really invented the steamboat? Fulton's Clermont coup.* Amherst, NY: Humanity Books (Prometheus). ISBN 1-59102-206-1, $35.

Contrary to accounts found in school textbooks, and the claims of Robert Fulton himself, he did not invent the steamboat. This is the first work to chronicle the entire story of the steamboat and to place Fulton's contribution in perspective. Jack L. Shagena, a retired professional engineer, clarifies the nature of invention, examines various individuals who contributed to the steamboat's development, and identifies a more credible candidate for the title of its inventor. He also shows how the Fulton myth evolved.

Silberglitt, R.,Howell, D.R. & Sherry, L. (2003). *Research priorities of the Supporting Industries Program: Linking industrial R&D needs.* Arlington, VA: RAND Science and Technology. ISBN: 0-8330-3490-1, $20.00.

This documented briefing summarizes the results of an independent analysis of the vision statements and other documents relevant to the Industries of the Future initiative of the US Department of Energy (DOE) Industrial Technologies (IT) program. The RAND Corporation analyzed this information to identify links between the DOE/IT Supporting Industries program and other DOE/IT programs, which could potentially form the basis for alliances to facilitate the achievement of research goals.

Smith, J.E. (2004). *Biotechnology: Fourth edition*. Cambridge, UK: Cambridge University Press. ISBN: 0-521-54077-1, $26.99.

Biotechnology will undoubtedly be the major technology of the twenty-first century. It concerns the practical application of biological organisms or their various components to the benefit of humankind, and spans a multitude of modern and traditional industries. The rise of genetic engineering, genomics, proteomics, and the creation of transgenic crops and animals has revolutionized activities as varied as brewing beer and the treatment of sewage and wastewater, to drug development and agriculture.

In this expanded fourth edition of his popular textbook, Emeritus Professor of Applied Microbiology at the University of Strathclyde in Glasgow, John Smith once again demystifies biotechnology, and especially genetic manipulation, clearly and accessibly explaining the history, techniques and applications of modern biotechnology for students and the general reader. All aspects of biotechnology are covered and a positive stance is taken concerning the potential benefits to human society. In this edition, greater emphasis is given to the public perception of biotechnology and the ethical and safety questions raised.

Spitz, P.H. (2003). *The chemical industry at the millennium: Maturity, restructuring, and globalization*. Philadelphia, PA: Chemical Heritage Press. ISBN: 0-941901-34-3, $45.00.

The global chemistry industry is big business and growing every year. But impressive growth has not recently impressed investors, and increasingly both individuals and money managers have turned to other areas of the economy for better returns. A 4 percent growth rate throughout the 1990s was not enough to keep US chemical companies from seeking opportunities in more rapidly growing regions with low-cost feedstock, and the US trade balance in chemicals turned downward in the late nineties; by 2001 chemical imports exceeded exports.

Why has an industry that provides so many of the essentials of modern life been so severely challenged? In The Chemical Industry at the Millennium, Peter Spitz, who is a renowned expert on the evolution of the global chemical industry, and a team of industry experts look at this complex and fascinating industry. Concentrating on basic and specialty chemicals, chapter authors examine many of the trends and market factors that have affected the chemical industry in the recent past. The book offers an insider's view of the restructuring and reengineering crazes and the improvements and roadblocks offered by information technology and the Internet. Other factors that came into play include the impact of environmental regulations and globalization and the financial community's demand for greater shareholder value. The Chemical Industry at the Millennium is a must read for industry professionals and anyone else interested in the changes and challenges facing a great and essential industry.

Squier, S.M. (2003). *Communities of the air: Radio century, radio culture*. Durham, NC: Duke University Press. ISBN: 0-8223-3095-4, $21.95 (Paperback).

A pioneering analysis of radio as both a cultural and material production, *Communities of the Air* explores radio's powerful role in shaping Anglo-American culture and society since the early twentieth century. Scholars and radio writers, producers, and critics look at the many ways radio generates multiple communities over the air – from elite to popular, dominant to resistant, canonical to transgressive.

Drawing on the perspectives on literary and cultural studies, science studies and feminist theory, radio history, and the new field of radio studies, these essays consider the development of radio as technology: how it was modeled on the telephone, early conflicts between for-profit and public uses of radio, and amateur radio (HAMS), local programming, and low-power radio. Some pieces discuss how radio gives voice to different cultural groups, focusing on the BBC and poetry programming in the West Indies, black radio, the history of alternative radio since the 1970s, and science and contemporary arts programming. Others look at radio's influence on gender (and gender's influence on radio) through examinations of Queen Elizabeth's broadcasts, Gracie Allen's comedy, and programming geared toward women. Together the contributors demonstrate how attention to the variety of ways radio is used and understood reveals the dynamic emergence and transformation of communities within the larger society.

Steiner, G. (2004). *Descartes as a moral thinker: Christianity, technology, and Nihilism*. Amherst, NY: Humanity Books. ISBN: 1-59102-212-6, $59.00

Although commentary on Descartes is extensive, the importance of morality in his thought has been all but overlooked in contemporary English-language scholarship. Considered to be the first modern philosopher, Descartes is often interpreted as a wholly secular thinker who acknowledged no authority above the human will. In this important reassessment of the great French philosopher, Gary Steiner, who is an associate professor of philosophy at Bucknell University, shows the influence of Christian thought on the moral foundations of Descartes' philosophy.

Steiner provides a close analysis of all of Descartes' texts and correspondence bearing on morality. By placing his work in historical context, Steiner demonstrates Descartes' indebtedness not only to Galileo and Bacon in developing his conception of autonomous human reason, but also to Augustine and Aquinas in conceptualizing the human condition and the role of belief in God. Providing a detailed survey of German, French, and English scholarship on Descartes, Steiner concludes with an in-depth examination of contemporary debates about secularization, nihilism, and modernity in such thinkers as Nietzsche, Heidegger, Hans Blumenberg, and Karl Lowith. Steiner shows how Descartes' own ambivalence about the relation between faith and reason can shed light on contemporary controversies regarding what Blumenberg calls "the legitimacy of the modern age."

Sterne, J. (2003). *The audible past: Cultural origins of sound reproduction*. Durham, NC: Duke University Press. ISBN: 0-8223-3013-x, $22.95 (Paperback).

We take our noisy world, full of artificial sounds, for granted today. Jonathan Sterne, who teaches in the Department of Communication and the Program for Cultural Studies at the University of Pittsburgh and writes about media, technology and the politics of culture, takes us back to the cultural origins of sounds reproduction. He describes a distinctive sound culture that gave birth to the sound recording and transmission devices so ubiquitous in modern life. With an ear for the unexpected, scholar and musician Sterne uses the technological and cultural precursors of telephony, phonography, and radio as an entry point into a history of sound in its own right.

Blending cultural studies and the history of communication technology, Sterne follows modern sound technologies back through a historical labyrinth. Along the way, he encounters capitalists and inventors, musicians and philosophers, embalmers and grave robbers, doctors and patients, deaf children and their teachers, professionals and hobbyists, folklorists and tribal singers. *The Audible Past* tracks the connections between the history of sound and the defining features of modernity: from developments in medicine, physics, and philosophy to the tumultuous shifts of industrial capitalism, colonialism, urbanization, modern technology, and the rise of a new middle class.

A provocative history of sound, *The Audible Past* asserts that sound is not a natural category and that what we hear and how we hear it has its cultural origins in the nineteenth and twentieth centuries. With its truly interdisciplinary approach, the book will fascinate those interested in the history of technology, cultural studies, communication, and music.

Stoltzenberg, D. (2004). *Fritz Haber: Chemist, Nobel Laureate, German, Jew*. Philadelphia, PA: Chemical Heritage Press. ISBN: 0-941901-24-6, $40.00.

The long-awaited biography of Fritz Haber, now abridged by the author and translated into English, illuminates the life of one of the most gifted yet controversial figures of the twentieth century.

Haber, a brilliant physical chemist, carried out pioneering research in electrochemistry and thermodynamics and won the Nobel Prize for his synthesis of ammonia, a process essential for synthetic fertilizer – and for the explosives Germany needed in World War I.

An ardent patriot, Haber also developed chemical weapons. Believing them to be no worse than other types of warfare, he directed the first true gas attack in military history from the front lines in Flanders. His nationalism also spurred his failed attempt to extract gold from seawater, in hopes of paying off Germany's huge war reparations.

Yet Haber, a Jew by birth, was exiled from his homeland in 1933 by the Nazi party. He died the following year, never knowing the full dire effects of his work, as Zyklon B, a gas studied in his institute around 1920, was used to murder prisoners in concentration camps, including members of Haber's own family.

With the help of previously unpublished documents and sources, Dietrich Stoltzenberg explores Haber's personal life, including the breakdown of his two marriages, his efforts to develop industrial and political support for scientific study in Germany, his directorship of the Kaiser Wilhelm (now Max Planck) Institute, his ethical struggles in times of war, and much more. A detailed and fascinating portrait of a brilliant scientist who is both revered and reviled, this book is a must read for historians and scientists, as well as those with an interest in the history of Germany in the early twentieth century.

Sturken, M., Thomas, D. & Ball-Rokeach, S.J. (2004). *Technological visions: the hopes and fears that shape new technologies*. Philadelphia, PA: Temple University Press. ISBN: 1-59213-226-X, $23.95.

For as long as people have developed new technologies, there has been a debate over the purposes, shape, and potential for their use. A range of contributors, including Sherry Turkle, Lynn Spigel, John Perry Barlow, Langdon Winner, David Nye, and Lord Asa Briggs, discuss the visions that have shaped "new" technologies and the cultural implications of technological adaptation. Focusing on issues such as the nature of prediction, community, citizenship, consumption, and the nation, as well as the metaphors that have shaped public debates about technology, the authors examine innovations past and present, from the telegraph and the portable television to the Internet, to better understand how our visions and imagination have shaped the meaning and use of technology.

Van Dulken, S. (2004). *American inventions: A history of curious, extraordinary, & just plain useful patents*. Washington Square, NY: New York University Press. ISBN: 0-8147-8813-0, $26.95.

An American, Thomas Alva Edison, invented the light bulb, but who invented the pregnancy test? Or the air bag? Who patented the first computer? Stephen van Dulken, an expert curator in the Patents Information Services of the British Library, examines the way inventions and patents such as these have helped to create the American Dream.

Between 1911 and 1999, the number of registered US patents rose from 1 million to 6 million. Showcasing dozens of those original patent drawing from the US Patent and Trademark Office, *American Inventions* shows how trends in the history of the United States are reflected in the patent records. For example, the invention of the Frisbee dates back to 1920 when a Yale University student recalled throwing around the lids from the pie cans of the nearby Frisbie Baking Company, but it was not until 1948 that Fred Morrison and Warren Francioni capitalized on Americans' new-found fascination with flying saucers by applying for a patent on a flying plastic disk. Van Dulken surveys the inventions and patents of the workplace, the home, the kitchen, the open road, and the beauty parlor, to name a few, to find the compelling stories and eureka moments in American history. From bobby pins to in-line skates, from the jukebox to the fax machine, *American Inventions* is a captivating catalog of the famous and not-so-famous contraptions that have shaped the American way of life.

Vicente, K. (2004). *The human factor: Revolutionizing the way people live with technology*. New York, NY: Routledge. ISBN: 0-415-97064-4, $27.95.

Technological innovation is progressing at such a rapid pace that we have fallen behind in our ability to manage it. Our world is filled with objects that invite human error, from VCRs to stoves. But the negative impact of technology on contemporary society goes well beyond the frustrations caused by these everyday items, often affecting areas as significant as hospital administration, airplane cockpits, and nuclear power plants. Problems – some potentially catastrophic- continuously arise when designs are developed without human nature in mind. Our reaction to this dilemma has been to create more sophisticated and ultimately confusing technology, perpetuating a vicious cycle as we struggle to keep up.

Now, in *The Human Factor*, McLean Award winning author and former Hunsaker Distinguished Visiting Professor of Aeronautics and Astronautics at MIT Kim Vicente makes vividly clear how people can bridge the widening gap between human beings and technology. He investigates every level of human activity – from simple matters such as hand-eye coordination to complex human system such as government regulatory agencies, and why businesses would benefit from making consumer goods easier to use. He shows readers why we all have a vital stake in reforming the aviation industry, the health industry, and the way we live day-to-day with technology.

Our traditional ways of thinking have ignored – and virtually made invisible – the relationship between people and technology. In *The Human Factor*, Vicente defines his theory of mechanistic versus humanistic schools of thought and how these two disparate ideologies – essentially technological tunnel vision versus the purely human/emotional mode of thinking – would be best served if they were more complimentary, or, as he defines it, more "human-tech."

With "human-tech," the author seeks to reconcile two heretofore incompatible elements and provide examples and suggestions of how ever-advancing technology can better serve, rather than rule, mankind. Vicente discusses everything from the "human-tech" successes of such items as the Reach toothbrush and the Fender Stratocaster electric guitar to the "human-tech" shortcomings of the medical and nuclear power industries. Citing historical events such as the disaster at Chernobyl and the Space Shuttle *Challenger* accident, among others, Professor Vicente demonstrates how this lack of "human-tech" thinking helped lead to these most likely preventable calamities.

Human beings are capable of many remarkable things, but if we become alienated from technology, our full capacities won't be realized. This incessantly readable and ultimately hopeful, groundbreaking work offers solutions that have enormous implications for human life. As accessible and entertaining as it is provocative, *The Human Factor* is certain to create vigorous public debate.

The 2004 Paul T. Hiser Exemplary Publication Award Recipients

Robert E. Wenig

"Leadership Knowledge and Skill: An Enabler for Success as a Technology Education Teacher–Leader"

The Board of Editors of The Journal of Technology Studies and the Board of Directors are pleased to announce the recipients of the Paul T. Hiser Exemplary Publication Award for Volume XXX, 2004.

The Board of Directors established this award for deserving scholars. In recognition for his exemplary service to the profession and to the honorary as a Trustee and Director, the award bears Dr. Hiser's name. It is given to the author or authors of articles judged to be the best of those published each year in this journal.

Selection Process

Each member of the Editorial Board recommends the manuscript that he or she considers the best of those reviewed during the year. The editor forwards copies of nominated manuscripts to the members of the board for their evaluation against the criteria.

A majority vote of the editors is required for the award to be made. The honor society's Board of Directors renders final approval of the process and the award.

Criteria

1. The subject matter of the manuscript must be clearly in the domain of one or more of the professions in technology.

2. The article should be exemplary in one or more of the following ways:
    - Ground-breaking philosophical thought.
    - Historical consequence in that it contains significant lessons for the present and the future.
    - Innovative research methodology and design.
    - Trends or issues that currently influence the field or are likely to affect it.
    - Unique yet probable solutions to current or future problems.

A $300 award recognizes the recipient(s) for the year and is presented during an Epsilon Pi Tau program at an annual professional association conference.

GUIDELINES FOR
The Journal of Technology Studies

A refereed publication of Epsilon Pi Tau the international honor society for professions in technology.

The Journal of Technology Studies (JOTS) is the flagship, peer-reviewed journal of Epsilon Pi Tau, an international honor society for technology professions. Two print issues per year are mailed to all members of the society as well as to academic and general libraries around the globe. These printed issues, plus additional issues available only in electronic format as well as past issues, are available free on-line at scholar.lib.vt.edu/ejournals/jots.

SUBJECT FOCUS

The JOTS welcomes *original* manuscripts from scholars worldwide focused on the depth and breadth of technology as practiced and understood past, present, and future. Epsilon Pi Tau, as perhaps the most comprehensive honor society among technology professions, seeks to provide upto-date and insightful information to its increasingly diverse membership as well as the broader public. Authors need not be members of the society in order to submit manuscripts for consideration. Contributions from both academics and practitioners are equally welcome.

A general guide to the breadth of topics of potential interest to our readers can be gained by consideration of the 17 subclasses within "Technology" of the classification scheme of the Library of Congress, USA <lcweb.loc.gov.catdir/cpso/lcco/lcco_t.pdf>. This includes engineering and allied disciplines, informatics in its many manifestations, industrial technology, and education in and about technology. Authors are strongly urged to peruse this list as they consider developing articles for journal consideration. In addition, JOTS is interested in manuscripts that provide:

- brief biographical portraits of leaders in technology that highlight the difference these individuals made in distinct fields of technology or its wider appreciation within society,
- thoughtful reflections about technology practice,
- insights about personal transitions in technology from formal education to the work environment or vice versa,
- history, philosophy, sociology, economics, and anthropology of technology,
- technology within society and its relationship to other disciplines,
- technology policy at local, national, and international levels,
- comparative studies of technology development, implementation, and/or education,
- industrial research and development,
- new and emerging technologies and technology's role in shaping the future.

Within this immense diversity of technology, its applications and import, authors must communicate clearly, concisely, informatively, and only semi-technically to readers from a diverse set of backgrounds. Authors may assume some technical background on the part of the reader but not in-depth knowledge of the particular technology that is the focus of the article. Highly technical articles on any field of technology are not within the purview of the journal. Articles whose subject focus has been extensively explored in prior issues of the journal are only of potential interest if they: 1) open up entirely new vistas on the topic, 2) provide significant new information or data that overturns or modifies prior conceptions, or 3) engage substantially one or more previously published articles in a debate that is likely to interest and inform readers. Syntheses of developments within a given field of technology are welcome as are metanalyses of research regarding a particular technology, its applications, or the process of technical education and/or skill acquisition. Research studies should employ methodological procedures appropriate to the problem being addressed and must evince suitable design, execution, analysis, and conclusions. Surveys, for example, that exhibit any or all of the following characteristics are of no interest to the journal: 1) insufficient awareness of prior research on this topic, 2) insufficient sample size, 3) improper survey design, 4) inappropriate survey administration, 5) high mortality, 6) inadequate statistical analysis, and/or 7) conclusions not supported by either the data or the research design employed. The journal is neutral in regards to qualitative, quantitative, or mixed method approaches to research but insists on research quality.

GUIDELINES FOR The Journal of Technology Studies (Continued)

GUIDELINES FOR SUBMISSION

Articles must conform to the most current edition of the Publication Manual of the American Psychological Association. All articles must be original, represent work of the named authors, not be under consideration elsewhere, and not be published elsewhere in English or any other language. Electronic submissions in either rich-text format or Microsoft Word formats are encouraged, although submission of three printed copies and a diskette containing the article are also permissible. E-mail submissions should be sent to the editor, Dr. Dennis Cheek, at jots@bgnet.bgsu.edu. Paper submissions should be mailed to:

Editor, Journal of Technology Studies
Epsilon Pi Tau, Technology Building
Bowling Green State University
Bowling Green, Ohio 43403-0305

Manuscripts should be no more that 25 pages, double spaced, including references. Typescript should be *Times New Roman* or a close approximation of font and 12 point. Only manuscripts in the English language will be accepted and they should conform to American usage. Figures, tables, photographs, and artwork must be of good quality and conform to APA form and style.

REVIEW PROCESS

Articles deemed worthy by the editor for consideration by Authors who submit an article that does not merit review by the editorial board are informed within approximately two weeks of receipt of the article so that they may explore other publishing venues. A rejection may be based solely on the content focus of the article and not its intrinsic merit, particularly where the topic has been extensively explored in prior JOTS articles. Articles that exhibit extensive problems in expression, grammar, and spelling are summarily rejected. Authors of articles that have been peer-reviewed are informed within about three months from the date of submission of the article. Anonymous comments of reviewers are provided to authors that are invited to submit a revised article for either publication or a second round of review. The editor does not automatically provide reviewer comments to authors whose articles have been rejected via the peer review process but makes a judgement based on whether the feedback might prove beneficial to the authors as they pursue other publishing opportunities.

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Authors whose articles have been accepted, will have their final products published in the on-line version of the journal. Selected articles from the on-line edition of the journal may also appear in two print issues that are issued per calendar year. All authors will receive a pdf version of their published article and co-retain rights to that article along with Epsilon Pi Tau. The editor will supply when requested information about an accepted article that has not yet appeared in print for faculty undergoing tenure review.