Technology Curriculum Organizers That Could Make a Difference

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As we look to the future of our profession, it will be important to consider content that will be reflective of technology while being relevant to those whom we wish to serve. Of course, attempting to even be remotely accurate more than three years ahead of an exponential curve is, at best, a guessing game. However, that shouldn't prevent us from using the most contemporary resources to support our thinking.

I hope, therefore, that as the descriptive concepts of the technological studies discipline for the future are explored, it will be not just be done in an oblique way but, more importantly, be provocative and future oriented. One should not just build on the traditions of our field of study; rather, we should attempt to be paradigm pioneers and "look to the fringes" of our profession.

It is in the nature of exponential growth that events develop extremely slowly for extremely long periods of time, but as one glides through the knee of the curve, events erupt at an increasingly furious pace. And that is what we will experience as we enter the 21st century (Kurzweil, 1999).

If we examine the organizers typically proposed for the study of technology (design, interchangeability, innovation, and the like), we can safely say that these are the same organizers the world has known and used over time in terms of technology, and I do not know why we would not continue to use these. We will continue to use them, along with the content organizers in the bio-related, physical, and informational technologies because they constitute a good part of our tradition.

However, it is much more challenging to focus on some concepts that have always been on the fringe of our discipline and charge ourselves to think about what we could and, possibly, should introduce into the core of our technology studies curricula. Perhaps we need to pay attention to that which makes us human and not lose sight of "humanness," or as Naisbitt (1999a) would put it, keeping the balance between high tech and high touch. High tech/high touch means embracing technology that preserves our humanness and rejecting technology that intrudes upon it. It is recognizing that technology is an integral part of the evolution of culture, the creative product of our imaginations, dreams, and aspirations—and that the desire to create new technologies is fundamentally instinctive. But it also recognizes that art, story, play, religion, nature, and time are equal partners in the evolution of technology because they nourish the soul and fulfill its yearnings. It is expressing what it means to be human and employing technology fruitfully in that expression. It's appreciating life and accepting death. It is knowing when we should push back on technology, in our work and our lives, to affirm our humanity.

This article is not just about the "softness of technology." However, this aspect must be considered and reflected upon if we are to see our future through as clear a lens as possible. Along with reflection, a number of questions must be asked: How does technology affect our lives today? What role does technology play in our work and play? Did technology live up to its implied societal benefits of simplifying our lives and giving us more leisure time to relax and enjoy our lives?

And what about the future? Here are some other questions we need to start thinking about: How will technology affect our lives tomorrow? Will technology determine who we are, what we do, how we think? Will we engineer our children the same way we engineer products? Will those who are wealthy have the opportunity to create a master race of designer children?

Identifying the Organizers: Proposing a New Way of Thinking About Technology

Some of the organizers that deserve consideration as units within the new technology studies framework are evolution, communication, spirituality, intelligence, consumerism, and life cycles. Although all of these organizers deserve consideration, only the last two are discussed in depth.

Evolution

Evolution was the original creator of intelligence, and technology was the one human variant of evolution. Where we will evolve given the exponential growth of technology is worthy of focused study. Technology goes beyond the use of tools—it involves a record of tool making. And a key requirement for an evolutionary process is a "written" record of achievement (Kurzweil, 1999).

Communication

The process of providing a record will always be an essential component of progress. The genetic code of early life forms was their chemical composition (of the organisms themselves), and so it was in the case of early tools; the tools themselves were the records. Then came written language and now databases. Ultimately the technology of communication itself has created new technology. In many ways it appears that we've gone "full cycle" with gene identification, using the genetic code to influence much of our physiology. In the first quarter of this century we can expect continued exponential growth in this venue to include 3-D holography and access to virtual environments as an individual or with others through a remote portal.

Spirituality

Our emerging understanding of genetics is beginning to upset our spiritual and political leaders in much the same way as Galileo did in the early 1600s, when he argued that the earth revolved around the sun, and as Darwin did 150 years ago, when he challenged the theory of creation. Our sense of space and place in the universe has changed as has our understanding of our place in nature. The mapping and sequencing of DNA and the technologies that this knowledge spawns will permanently alter our understanding of humans. We have experienced tremendous macro to micro paradigm shifts from the universe to nature to the human being, and each has had profound implications for organized religion and for our sense of personal spirituality (Naisbitt, 1999d).

The merging of medical technology and science, particularly manifested in genetic engineering, has continued to provide fodder for the platforms of those representing religious faiths. The work of projects such as "The Human Genome" has forced moralists and ethicists to examine the philosophical underpinnings of what it means to be human. Theories of genetic determinism—that our genes determine not only our physical makeup but also our sexual preferences, our levels of aggression, and possibly even our propensity to be religious—are causing theologians to examine their ideas of free will, the human need for religion, and the very existence of God (Naisbitt, 1999d).

"Frankly, if it turns out that genes control 100 percent, I think religion is in trouble," said orthodox Rabbi Irving Greenberg, president of the Jewish Life Network in New York City. "I think the whole world's in trouble because ultimately religion is predicated on the belief of free will" (Naisbitt, 1999d).

Intelligence

The difficulty in many applied higher education programs lies in their ability to provide their clients with adequately applied problem-solving skills (Kahn, 1998) rather than mechanical knowledge of software. Too often learning is about bringing students in contact with the most recent technology rather than providing opportunities for them to engage their cognitive-expanding and creative-generating skills. It is the instructor's responsibility to balance the seductive aspects of new technology by predicting that their present technical knowledge will become obsolete while their learned knowledge from creative problem solving will not. As processes become increasingly automated, critical thinking skills will become the industrial standard essential for job profiling. Innovation, talent, and creativity should not be annulled by the pragmatism of technology (Faiola, 1999).

Consumerism

Although consumerism, like communication, has a rich history, it is an exploding field. The two biggest markets in the $8-trillion-a-year economy of the United States are (a) consumer technology and (b) the escape from consumer technology (Naisbitt, 1999b). As such, consumerism requires a close look from technology educators.

According to Naisbitt (1999c), all technologies tend towards consumer technologies, and these gadgets, gizmos, and have-to-have upgrades are powerfully changing our relationships with time. We all try means of escape from the pressures of our work-a-day world. The old rules of having disposable income before spending it on frills have long passed to the point that a $500 concert night is not out of the question for an individual without full-time employment. On the more traditional side, we now have bigger and more technological recreation vehicles and faster and more realistic video products. The result is that consumer technologies influence and shape our lives until we finally accept them as the norm. The babysitter of the 1960s—the television—is quickly being surpassed by video games that are, for all practical purposes, unregulated. As such, these video portals allow children to access a world that blends the borders between reality and imaginary. While adults may look at these games as toys and entertainment, children may not be able to distinguish between fantasy and reality. Violence in our children's media may have a direct correlation to violence in our society. Consumer technology is changing the way we understand time—collapsing, crunching, compressing it. Today technology is a self-perpetuating engine run by upgrades, add-ons, and refills. It accelerates our lives and fosters dependence, which necessitates relief, for which we all too often turn back to technology for the most accessible, immediate solution. Stressed out? Buy a massager. Life's disorganized? Buy a personal electronic organizer. Traveling with children? Buy a Gameboy. Neighborhood unsafe? Buy a security system.

If we were able to paint a scenario of a family at the end of the workday, it might give us a glimpse of the effect of consumerism on our lives today. Consumerism has gotten us to a point where the following scenario might be considered common practice.

> Your PowerBook sits on your desk at home beside a stack of important unread articles, but you choose a cold beer and a little TV to unwind. The evening passes quickly, and you retire to bed after the nightly news and an earful of office voice-mail. You lie awake while your spouse talks on an Internet chat room, and inventory the events of your day. You feel ashamed about losing your temper with a new co-worker; you realize that the repairman didn't return your call as promised even when you beeped him; you wish you had read your son a bedtime story despite being tired; you feel proud of holding the real estate deal to a 4 percent commission. Your mind skips ahead as you fall asleep while making a mental checklist of things that need to get done tomorrow. You wake at 6:30 A.M. with no memory of dreaming. You rise immediately to a pot of hot coffee and e-mail. You then head to the car with a bagel in your hand for a twenty-minute commute during which you listen to the first installment of a popular business book because you're falling behind in your professional reading. The cell phone rings, and your colleague reminds you a client is due for a meeting in fifteen minutes. Your thoughts drift past the noisy narrator to an overwhelming desire to get out of town. (Naisbitt, 1999b, p. 1)

As sad as it is to envision this kind of "techno-world," the picture is more psychedelic for the privileged youth of this environment—those who have access. As is often the case in our technologically enhanced world, we have less time for the "old-fashioned important things" such as determining the social responsiveness of our children's activities. The real-life example of this came screaming across our media a few years ago with the advent of Columbine. Like Kent State, we will never be able to separate the place from the act of violence. "Doom will become reality!" wrote one of the two Littleton terrorists before the Columbine High School killings began. Those two student killers won a place in history (for the moment) on April 20, 1999, by committing the worst school massacre in American history. They killed 12 fellow classmates, one teacher, themselves, and wounded 23 others in a five-hour siege. "What they did wasn't about anger or hate," said their friend Brooks Brown. "It was about them living in the moment, like they were inside a video game."

The two teenage boys were immersed in America's culture of violence delivered through television, films, the Internet, stereo systems, and electronic games such as Doom, which they played for hours daily, including a personalized version of the game that one of the boys had modified to match the corridors of his high school, Columbine. "You're one of earth's crack soldiers, hard-bitten, tough, and heavily armed," describes the instruction manual of Doom, which has sold about 2.7 million copies. "When the alien invasion struck Mars, you were the first on the scene. By killing, killing, and killing, you've won." The boys had linked their home computers so they could play first-person-shooter "death matches" against each other while sitting alone in their own rooms.

"America is entrenched in a culture of

violence. Our reputation in the world as a violent culture is based on crime statistics, but far more prevalent—and damaging—is the steady stream of violence on our screens: film, television, Internet, and electronic games. And many electronic games, which grant the player the privilege of pulling the trigger, are relentlessly violent, militaristic, and graphic. Living in a Technologically Intoxicated Zone, we are not troubled by the violence on our screens, yet we are perplexed by the violence committed by our young" (Naisbitt, 1999c, p. 1).

Life Cycles

Perhaps the attribute of technology that is most likely to be added to our curriculum is one that is less controversial but reflects a new and updated approach to viewing our products of technology. To quote Einstein, *we don't need to think more, we need to think differently.* Though not actually new, it is a process that is not often addressed in our general study of technology—the process of life cycles.

The importance of this process may become clearer when the following observations are made:

- We are in a constantly tightening time frame market.
- Product life cycles are shorter, making it more difficult to achieve long-term goals.
- Competition catches up to innovation very quickly.

Observations such as these support the need for the use and thorough understanding of life cycles. Technology studies lends itself to the understanding of life cycles as presented in Kurzweil's (1999) model of the life cycle of a technology in *The Age of Spiritual Machines*. Kurzweil believed that technologies undergo their own characteristic life cycle, of which there are seven distinct stages. First is the *precursor* stage, where dreamers contemplate the prerequisite elements of a technology coming together. Dreaming should not be confused with inventing, by the way, even if one were to write down the dreams. For example, da Vinci drew convincing pictures of airplanes and automobiles, but he is not considered to have invented either.

The next stage in the life cycle of a technology is indeed *invention*. This is a brief stage. (To use an analogy, this is not dissimilar to birth after an extended period of labor.) The inventor blends curiosity, scientific skills, determination, and usually some bit of showmanship to combine methods in a new way to bring a new technology to life. Edison was a master at this stage.

The next stage is *development*, during which the invention is protected and supported by doting guardians (which may include the original inventor). Usually this stage is more crucial than the invention and may involve additional creation that could lead to even greater significance than the original invention. For example, many tinkerers had constructed finely tuned horseless carriages, but it was Henry Ford's innovations with mass production that enabled the automobile to take root and flourish.

The fourth stage is *maturity*. Even though it continues to evolve, the technology now has a life of its own. It has a place in part of the community, so interwoven in the fabric of life that many observers think it will last forever. Imagine the horse collar prior to the Civil War. This circumstance presents an interesting drama for the next stage, *pretenders*.

During the pretenders stage, an upstart threatens to eclipse the older technology and its enthusiasts prematurely predict victory. The pretenders may even have some distinct benefits, but they are missing some key element of functionality or quality. When in the end it proves to dislodge the established technology order, the technology conservatives take this as evidence that the original approach will indeed last forever. But this victory is usually short lived. Shortly thereafter, another new technology typically does succeed in pushing the original technology into *obsolescence*.

As obsolescence approaches, the original technology lives out its senior years in gradual decline. New competitors are beginning to take over. This stage (perhaps 5-10% of the life cycle, according to Kurzweil, 1999) finally yields to *antiquity*. Examples of this are the horse and buggy, harpsichord, manual typewriter, and most applications of the electromechanical typewriter (Kurzweil, 1999).

An example of the entire seven-stage life cycle model is the phonograph record. In the mid 19th century, there were several precursors, such as Edouard-Leon Scott de Martinville's phonautograph, a device that recorded sound vibrations as a printed pattern. Thomas Edison in 1877 brought together his scientific skills and techniques to invent a device to both record and reproduce sound. Many of us can still recall the refinements that resulted in the

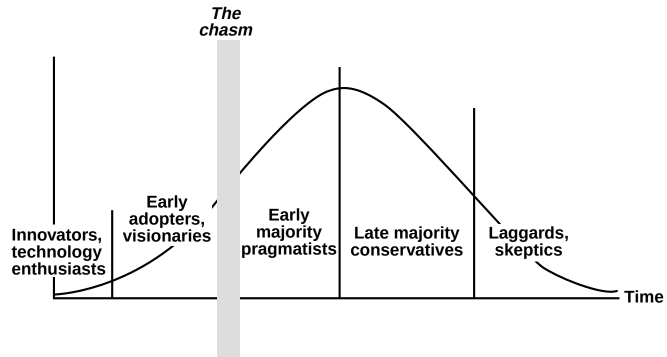

Figure 1. Life cycle of an innovation.

45 and 33 rpm "platters" that were introduced at the end of WWII, making this device a mature product of technology.

The pretenders were many, but most memorably were the 8-track tape and the cassette tape—a significant innovation because the latter could be recorded by the consumer. However, the tapes were still quite noisy and they were difficult to randomly access. They also were prone to wear more quickly than a well-maintained record. And, how can any of us who have experienced tape running out of the cassette forget that fatal flaw! The real push toward obsolescence was given by the digital compact disk, which offered all of the positive characteristics of the best of the record and tape technologies while providing virtually distortion free sound. While records and albums are still produced for the vinyl audiophile, it will become a smaller and smaller market while the CD and its pretenders lead the way to the next level.

Life cycle of innovation

The classic study of the diffusion of innovation exemplified by the transition from early to late adopters can be found in the work of Rogers (1995). His fourth edition of *Diffusion of Innovation* classifies adopters into the categories of innovators, early adopters, early majority, late majority, and laggards. This is the source of the categories that Moore (1995) used in his work *Crossing the Chasm* (1995) that Norman (1998) so aptly represented graphically in his work *The Invisible Computer* , which has been further modified to address the issues discussed in this paper (see Figure 1). The chasm is the shift in market-driven acceptance (or consumerism) as customers drive the life cycle of innovation, not the inventors or innovators.

Figure 1 identifies the life cycle of an innovation. In the early days, the innovators and technology enthusiasts drive the market; they demand technology. In the later days, the pragmatists and conservatives dominate; they want solutions and convenience. Note that although the innovators and early adopters drive the technology markets, they are really only a small percentage of the market; the big market is with the pragmatists and the conservatives (modified from Moore, 1995).

The relationship of life cycles to technology studies

Technology exists today to accomplish prototyping phase tasks in the shortest time frame possible. Future life cycle phases are dependent on an accurate information model, as well as an accurate physical model. Change history, design review documentation, test results, material disposition, and other configuration information must be captured during this phase and made accessible to the appropriate personnel. Plans to transfer products from one life cycle phase to the next must also be documented and maintained. An easy-to-use configuration and change management tool is essential in laying a solid information foundation and reducing time-to-market.

Further evidence of the need to teach life cycles in technology contexts is provided by the Environmental Protection Agency (EPA), which according to Kenneth Stone, life cycle assessment team leader at the National Risk Management Research Laboratory for the U.S. EPA in Cincinnati, Ohio, is internally placing heavy emphasis on developing and implementing decision-making tools based on life cycle assessment (LCA). The EPA has found instances where a technology intended to reduce wastes has created unanticipated impacts in other media and/or stages of the life cycle. LCA is being developed as a means to identify and deal with these impacts before they occur. LCA differs from other pollution prevention techniques in that it views all the resource and energy inputs to a product (life cycle inventory), as well as the associated wastes, health, and ecological burdens (impact assessment), and evaluates opportunities to reduce environmental impacts (improvement analysis) from cradle to grave. LCA is often confused with other assessment tools, such as the U.S. Department of Defense's life cycle cost (LCC), which is sometimes referred to as "environmental life cycle costing." However, as the term is applied by the EPA and the international community, LCA is significantly different from these techniques (Stone, 2000).

The Challenge of Dealing With the "Moving Target" of Technology

As we look at preparing a technologically literate individual for a world quite beyond our imagination, we must go beyond the surface definition of a person's ability to use, manage, assess, and understand technology. We must provide a curriculum that is accountable to a literacy commitment that ensures that all learners "understand, in increasingly sophisticated ways that evolve over time, what technology is, how it is created, and [most important] how it shapes society, and in turn is shaped by society" (Technology for All Americans Project, 2000, p. 9).

Our challenge and commitment to our students must be to provide opportunities for relevant content in "learner contemporary" contexts. From a curriculum development perspective we must cast off our conservative curriculum cloaks and provide energizing courses and programs that challenge both our students and faculty. We have observed that our students live "in three worlds; the natural world, the social world, and the designed world" (Technology for All Americans Project, 2000, p. 140). We must, for relevancy and programmatic survival, link, at minimum, the social and designed world in our curriculum efforts in a creative and bold fashion. To continue to "stay the course," providing traditional approaches to curriculum development and delivery, will deprive students of creative and relevant subject matter that is dynamic, meaningful, and much needed by those individuals who will leave an indelible mark on our society.

To prepare ourselves and our students to deal with technology in the new millennium, we should begin the process of addressing the ramifications or impacts of these aforementioned concepts. Perhaps courses across the curriculum could be developed, such as Theological Implications of Technology or Biological Implications of Technology—or, possibly, curricula could be developed that help students become experts at customer service/interaction. We have to address what it means to be human because, after all, it is humans who will determine where our technologies go.

As technologists and educators in technology, it is our obligation and responsibility to take the initiative and at least consider organizers such as the ones presented here as a new way of thinking about technology. We owe it to our programs. The moral implications could be staggering. We may be approaching the point where the human form will be nothing more than simply a vessel to carry a preprogrammed silicon chip! Is it not our duty to provide the forum for understanding of these technologies—an essential component of sound decision making?

As technologists, we need to make a commitment to profess the virtues of spiritual growth, adaptation, and human development or performance improvement as opposed to focusing solely on the technology itself and fanning the fires that represent the manifestation of perhaps losing touch with what it means to be human. If we really wish to prepare ourselves for the future we have to be willing to shake off those prejudices of the past that have come to be so ingrained in our culture and look at our opportunities and challenges through a clear lens. We can't affect the future if we're not prepared to face the future.

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