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A Framework for the Technology Cognate
At Baylor University

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Introduction

Nicholas Negroponte, a founding Director of the Media Technology lab at MIT and author of the book, *Being Digital*, asserts that "Computing isn't about computers any more. It is about living." Throughout the remainder of the book, Negroponte describes the pervasive character of technology's impact upon virtually every aspect of life. Lewis Perelman, former Director of Project Learning 2000, draws similar conclusions about technology's impact upon education in his book, *School's Out*. Perelman coined the term "hyperlearning" to differentiate 21st century learning from current educational practice:

> [Hyperlearning] is not a single device or process, but a universe of new technologies that both possess and enhance intelligence. The *hyper* in hyperlearning refers not merely to the extraordinary speed and scope of new information technology, but to an unprecedented degree of connectedness of knowledge, experience, media and brains—both human and nonhuman. The *learning* in HL [hyperlearning] refers most literally to the transformation of knowledge and behavior through experience—what learning means in this context goes as far beyond mere education or training as the space shuttle goes beyond the dugout canoe (Perelman, 1992).

Individuals within the "education enterprise" must address a fundamental question: How does one use technology to facilitate the processes of teaching and learning in 21st century learning environments?

A Definition and A Metaphor

In almost any technology conversation the dominant device is the computer. However, ask any participant in the conversation and one would certainly be able to identify additional examples of technology–everything from the ballpoint pen to the space shuttle qualifies. "Technology," defined broadly enough encompasses both devices and processes. Within the Baylor technology cognate, "technology" is defined as "the systematic application of what one knows to what one does." Humans learn and apply many concepts. Creating the ballpoint pen required at least a partial understanding and application of the concept of gravity; a more complex understanding and application of the concept of gravity underlies the launching system for the space shuttle. In this manner, teaching can be approached as a "technological processes." It is the systematic application of what one knows about teaching and learning to what one does about teaching and learning. In contrast, the "traditional" teaching process is more of a "buckshot" approach; small "pellets" of knowledge are loaded into course-based "shots" which are fired at students. If not mortally wounded, some students will carry the embedded knowledge pellets to the next instructional encounter, where additional shots are fired.

Given the rapid rate of technological development, it would be folly to attempt to identify what technology teachers will be using as many as ten years or as few as three years in the future. However, a metaphor, identifying the functional components of technology could serve as a framework for incorporating technology into teacher preparation programs. Figure 1 illustrates a "prism metaphor" which compares the ubiquitous nature of technology to "white light." Within the natural environment, "white light" is abundant and is readily adapted for various functions, analogous to the manner in which technology has become commonplace and functional within our personal environments (ATMs, CDs, cellular phones, etc.). When "white light" is refracted through a prism, one can observe a variety of components in the light spectrum; each component has unique qualities that can be appropriately utilized (such as infrared and ultraviolet light). If one could expose the "white light of technology" to a prism that would separate its various components, the spectrum might disperse as proposed in Figure 1: “Mathetics” and Pedagogy, Data technology; Communication technology; Video technology; and Ethics.

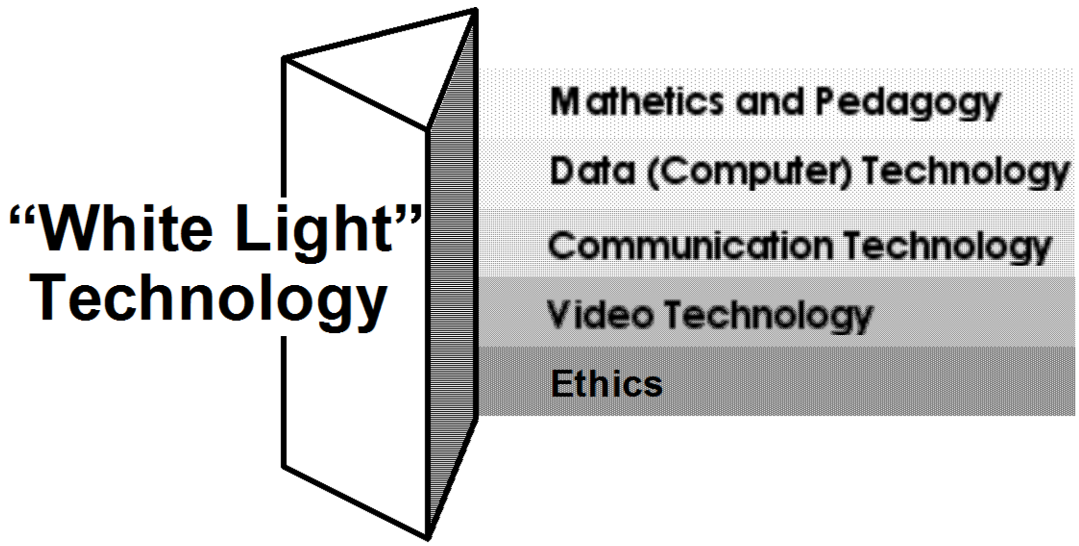

Figure 1

The Technology Spectrum

Two attributes of “white light technology” should be noted. “White light technology” should be considered both synergistic (the whole is greater than the sum of the parts) and centripetal (drawn toward the center). While each of the components within the spectrum can be used effectively in isolation, combinations of the components create new, and largely unexplored, synergistic learning environments, such as two-way video/audio teleconferencing, on-line chats, and distance learning alternatives. Likewise, the components are being drawn toward a common center. Currently, the common center is primarily a computer environment, though many believe that the common center may shift to a microprocessor controlled home-entertainment/communication environment.

Functions within the Technology Spectrum

Each component of the spectrum provides a primary function within the metaphor. The primary functions help focus professional development. Technology literate individuals can use the functions represented in the metaphor to answer the following questions:

1) Given the functionality provided by this technology, what can/should I do differently? and;
2) Given the functionality provided by this technology, what can/should I do that I have never been able to do before?

Data (Computer) Technology provides interactivity and control. Data technology provides interactive (input/output) functionality to previously linear and/or passive processes. Interactivity dramatically alters knowledge construction and acquisition. Microprocessors expand interactive possibilities. Seymour Papert, founding member of the MIT Media Laboratory, director of its Epistemology and Learning group, and creator of the Logo programming language, believes that the interactivity of technology allows students to create "microworlds," in which learners experience the power to manipulate ideas (Papert, 1993). Rivard (1995) concludes that interactive technology "is an exceptionally fine candidate for implementation in learning environments because of the way it accommodates cognitive views on learning. The cognitive model explores how knowledge is acquired as a result of the internal processes learners use in gathering, organizing, and storing information."

In addition to interaction, the microprocessor provides control. Negroponte describes one of two primary changes associated with converting various media to a common digital form ("the DNA of information"):

> [A] new kind of bit is born—a bit that tells you about the other bits. These new bits are typically "headers," which are well known to newspaper reporters who file "slugs" (which we never see) to identify a story. Such headers are also familiar to scientific authors who are asked to provide key words with their journal articles. These header bits can be a table of

> contents or a description of the data that follow. On your CD today, you have simple headers that allow you to skip from song to song. These bits are not visible or audible but tell your computer, or a special purpose entertainment appliance about the signal (Negroponte, 1995).

An embedded microprocessor which translates the data and the "header bits" expands the functionality of virtually any electro/mechanical device. In the digital future Negroponte envisions, computers will "filter, sort, prioritize, and manage multimedia on our behalf. [Computers] will read newspapers and look at television for us, and act as editors when we ask them to do so." He asks the reader to "think about the consequences of a broadcast television show as data which includes a computer-readable description of itself. You could record based on content, not time of day or channel" (Negroponte, 1995). The element of "control" provided by data technology is the primary characteristic of technology's "centripetal" nature.

Communication Technology provides connectivity and shared meaning. Communication technology, in the form of Internet connections, fax machines, and other telecommunications networks and devices, creates what George Gilder (1991) calls the "telecosm." In the telecosm, the "portable, personal *telecomputer* will combine and succeed the palmtop computer and the cellular telephone," in an attempt to make information available to anyone without the usual constraints of time, distance, or location. Perelman (1992) describes a "telelearning environment where distance, location, and attendance become arbitrary and largely irrelevant factors." Perelman's hyperlearning environment creates a new role for organizations currently called schools:

> Basically, schools will be transformed from a centralized architectural and bureaucratic *structure* to a dispersed information and service *channel*…school will not be identified with any distinct building or location, but rather a brand or franchise of media through which services are accessed…they will house a diversity of alternative services and programs, somewhat analogous to today's shopping mall "food court" which provides, under one roof, a wide choice of menus and vendors to serve individual preferences and needs.

Negroponte (1995) estimated that 1 billion people would be connected to the Internet by the year 2000. This connectivity, provided by any of four current electronic "paths" (telephone, cable, satellite, and terrestrial broadcast), demonstrates that "the true value of a network is less about information and more about community" (Negroponte, 1995).

The communication portion of the technology spectrum extends beyond the physical connections provided by hardware to the abstract connections provided by community-adopted language, meaning, and culture. Michael Schrage (1990), in *Shared Minds: The New Technologies of Collaboration*, indicates that the major problem with the dominant communication model currently in use, is that "the idea of actually *understanding* a message has no place in this model…*It takes shared space to create shared understandings*." Schrage envisions new technological tools that will complement the human collaborative process. Schrage, like Negroponte, notes that physical connectivity isn't the crucial issue; "the emphasis shifts from networks of information distribution and transmission to networks of shared space. The question no longer is 'What do I do with this?' but 'Who else should see this so I can understand and use this better?' The issue isn't just *processing* information—it's *creating* information." Professional educators must understand and appreciate the interaction between the transmission medium and an individual's attempt to encode, transmit, decode, and receive messages. There are both substantial and subtle psychological differences in messages delivered in multimedia formats and messages delivered in textual formats.

Video Technology provides "presence" and "affect." The ability to simultaneously capture, modify, store, and transmit visual images is video technology's potent contribution to the technology spectrum. Perelman (1992) cannot over estimate the significance of the "video microcamera…which will permit video camcorders to shrink to the size of a pocket calculator or even a credit card."

> Beyond near-term applications—such as unobtrusive security cameras for houses, automatic teller machines, and eventually automobiles—this microvideo technology promises Dick Tracy-style videophones in a wristwatch…Considering the impact the purse-size camcorder already has had on law enforcement, journalism, entertainment, and military intelligence, the societal implications of virtually invisible, cheap, all-seeing "eyes" could easily fill another book.

Appropriate applications of video technology permit individuals and groups to witness global events, microscopic or time-sensitive processes, and inherently dangerous activities. Video technology establishes a "presence" heretofore unavailable. [National debates about the impact of "presence" are associated with events such as the O.J. Simpson trial and the execution of Timothy McVeigh.] Expertise, previously limited by physical constraints of time and travel, can be available to wider numbers through an electronically transmitted "presence."

A video "presence" extends into the classrooms, homes, and daily routines of students and teachers. Video technologies enable time-shifting (recording in the present for later use) and enable multi-level and curricular-sensitive instruction from a single teacher (or other appropriate source). Student processes and procedures can be recorded and reviewed, minimizing dependence upon a single final product that may do little to document and reveal the quality and quantity of work involved.

Visual images also have the power to "move" an audience. Few other media forms, except perhaps music, have greater impact upon the viewer's affect. While direct causal links remain inconclusive in the research literature, intensive study continues to implicate video in much anti-social aggressive and violent behavior.

"Mathetics" and Pedagogy provide purpose to the technology spectrum. In his book, *The Children's Machine*, Seymour Papert introduced the term "mathetics" to describe a field of study devoted to how individuals learn. "Mathetics" assimilates all that is currently discussed in the realms of human growth and development, brain research, multiple intelligence theories, learning differences (abilities and disabilities), and any other area that contributes to the knowledge base regarding the processes by which an individual acquires, integrates, and demonstrates new knowledge, skills, and values. Perelman (1992) includes “brain technology” as one of the crucial components of “hyperlearning.” There exists a tremendous need for both research and application of various technologies to human learning processes.

For the purpose of this metaphor, pedagogy is used in its generic sense to refer to the study of instruction at all levels (from infancy to senior adulthood). Technology has created a demand for continuous learning throughout a lifetime, as information and skills are made obsolete by rapid technological development; and technology has extended the quality and number of years in which individuals may be engaged in the acquisition of new knowledge, skills, and values. Perelman (1992) speaks of “Life-cycle integration [which] is more complex than just passing through successive stages of ‘lifelong’ learning—it means people of various ages ‘recycling’ learning at any or all levels (basic, intermediate, advanced) depending on individual needs and circumstances.” The expectations of a pluralistic global community require that educators identify and incorporate appropriate methodologies that address the educational enterprise’s diverse constituencies: multi-cultural (gender, ethnic, socio-economic, multi-generational, physically challenged, and mentally challenged, etc.).

> The reality is that bridging cultural differences—national or disciplinary—is fast becoming one of top management’s greatest headaches. These problems are independent of an organization’s size or mission…People come with mixed perspectives that might otherwise build barriers. We have to compensate and this technology helps us share a common platform…A flexible collaborative tool—one that facilitates the easy display of both words and images—improves the chance for creating shared understanding. More explicitly, it gives participants from different cultures a medium to search for and create shared meaning (Schrage, 1990).

Paraphrasing a saying by Confucius: "Pale ink is better than best memory;" Schrage concludes, "A flickering video-display is even better than pale ink."

Ethics provide the boundaries for technology. While technology provides choices, the human operator is accountable for responsible use. Neil Postman (1992), cultural critic, communications theorist, and Chair of the Department of Communication Arts and Sciences at New York University, warns of the consequences of a digital "technopoly," in which humans have relinquished control *to* technology. Postman advocates that humans exert control *over* technology. Controlling technology, from nuclear reactors to personal computers, requires a more intelligent user—one who is prepared to make decisions that reflect moral, ethical, and legal responsibility.

The "Aesthetics" of the Technology Spectrum

Many technology models have an additional element frequently labeled "integration," which refers to both the merging of technologies (such as the merging of video and communication technologies to create teleconferencing systems); and the merging of technologies and learning. However, both Negroponte and Perelman continuously return to a theme of technology's pervasive infiltration, which is a dramatically more fundamental and complete transformation. Within the prism metaphor of this article, integration might be compared to the natural occurrence of a rainbow instead of the scientific identification of the light wave spectrum. In its most recent report, *Teachers and Technology: Making the Connection*, the Office of Technology Assessment (OTA, 1995), identified major barriers which could limit the natural occurrence of the technology spectrum:

- Teacher time;
- Access and costs;
- Vision or rationale for technology use;

- Training and support; and
- Current assessment practices.

However, the purpose of this document is to envision the "rainbow" that might appear, if the technology spectrum occurred naturally in a technology-rich environment under the direction of a technologically skilled professional. Twenty-first-century education professionals must begin to address conditions that will permit the functional use of "white light technology." This can be accomplished by focusing on the five functions illuminated in the technology spectrum.

Professional educators must prepare to exercise judgment in the use of data technology and to maximize new interactive and control processes provided by data technology. Twenty-first-century "hyperlearning" interactions will be qualitatively different. Teachers will spend more time inquiring about learners' experiences than in creating them. Questioning techniques employed by educators will be designed to "draw out" the learner's experience, to facilitate reflection, and to formulate new avenues of inquiry. Technology will facilitate this exchange in multiple forms, including text, visual images, sound, and various combinations. Perelman (1992) believes that "high-tech processes of certification will focus on *screening in*—identifying the nature and degree of specific shortcomings and leading directly to the most efficient learning resources needed to close the gaps and qualify people to perform the work they desire."

Unlike today's learning, where interactions are based upon a contemporaneous communication model (learners and teachers must be in the same place at the same time); 21st century interactions will be based upon an asynchronous communication model (participants are not in the same place at the same time). E-mail, voice mail, Internet and the World Wide Web, provide for dialogues that take place at the convenience of the participant. They are not forced into "synchrony" for the exchange of information.

Professional educators must prepare to establish and utilize meaningful connections provided by new and various forms of communication technology. Technology will enable and will facilitate the development of hybrid locations (perhaps a virtual or cyber place, as both Perelman and Negroponte believe). This location may be called a "professional development school," as advocated by the Holmes Group (1995), or it may be a "center for pedagogy," as described by Goodlad (1994); regardless of what it is called, it is a place that represents Schrage's "shared space" to all of the collaborative partners involved. As a result of technology, this hybrid location is connected, via multiple channels (data, video, and voice), to all of its partners—learners of various ages (and the parents/guardians where appropriate); scholars in a variety of locations; local and remote businesses and industries; other professional and community service organizations, and especially other learning locations. The expanded connectivity of the learning enterprise will facilitate new modes of interaction.

With the connectivity provided by technology and the barrier of real time synchronous communication eliminated internship sites and mentor professionals will be more widely dispersed. As Goodlad suggested, professional development will take place only in the "shared" learning environments of professional educators widely dispersed throughout the education enterprise. Professional development will no longer be limited to the experiences available within driving distance.

Professional educators must prepare to exploit the expanded presence provided by video technology. Video technology provides a window for remote observation and a channel for communication and demonstration as needed. Not only will dispersed expertise be available through a video presence, but also the diversity of environments will be expanded by video technology. Educational environments (or classrooms) will certainly be available, but so will the work place. Educators must be prepared to use video information that can be delivered "on demand." Learners will have access to a wider range of visual experience than ever before. Curriculum design will be impacted by the ease with which individuals will be able to create video messages, modify them for appropriate audiences, and develop interactions that can take place regardless of time and distance. Negroponte (1995) anticipates that a video network will develop along the lines of the computer's Internet. This would allow each appropriately equipped computer to "broadcast" video programs for reception by interested parties.

Professional educators must prepare to apply manifestations of the technology spectrum (data, communication, and video) to the dual processes of learning and teaching. Perelman (1992) concludes that, "the essence of the coming integrated, universal, multimedia, digital network is *discovery*—the empowerment of human minds to learn spontaneously, without coercion, both independently and cooperatively. The focus is on learning as an action that is "done by," not "done to," the learner. There can't be a better description of a professional preparation guided by "white light technology."

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