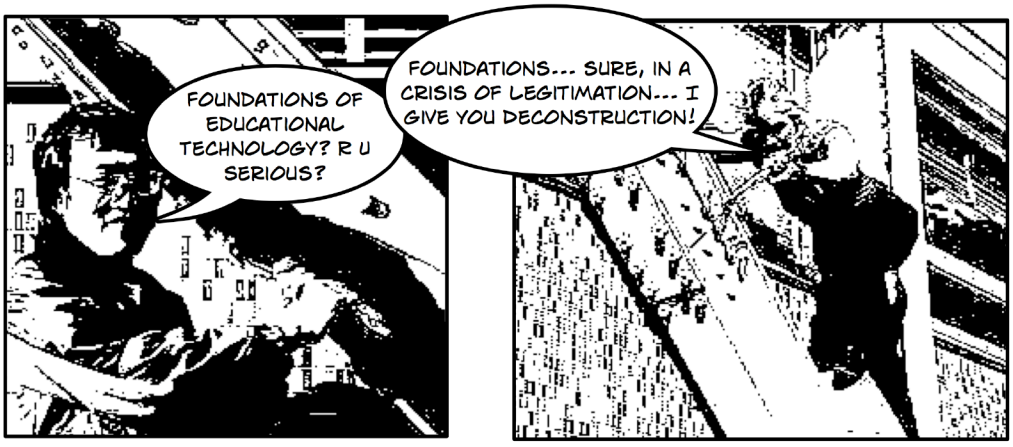
Primer for Defining and Theorizing Technology in Education,

ETEC 511 pt. 1

M E T

Foundations of Educational Technology



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August 2009
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Defining & Theorizing Technology, pt 1

Glossary (slightly edited) from: Petrina, S. (2006). *Advanced teaching methods for the technology classroom*. Hershey, PA: Information Science Publishing.

See also Petrina, S. (2002). Getting a purchase on "The School of Tomorrow" and its constituent commodities: Histories and historiographies of technologies. *History of Education Quarterly*, *42*(1), 75-111.

1. Working Definitions for **Technology**
   a. "The Greek for "to bring forth or to produce" is tikto. The word techne, technique, belongs to the verb's root tec. To the Greeks techne means neither art nor handicraft but rather: to make something appear, within what is present, as this or that, in this way or that way. The Greeks conceive of techne, producing, in terms of letting appear" (Heidegger, 1951).
   b. Technology— the world generated as artifact, or the activity, knowledge and will to make it so.
   c. We are using our working definition for **Technology** as *the world generated as artifact, or the activity, knowledge and will to make it so*. When we refer to technologies, we are *not* just talking about objects— we are talking about activities, knowledge and volition as well (Mitcham, 1994). "World" generated may refer to the natural, social or spiritual world, or lifeworld, generated as artifact. Indeed, it is important that we refer to technology as something we do and something we are *in* or *part of*.
   d. **Hence, when we refer to technologies**, we are *not* just talking about objects. Technology has four different manifestations, as identified by Carl Mitcham (1994). The most concrete manifestations of technology are in the form of **artifact or object**. This includes simple components and architecture as well as complex devices, machines, equipment and large-scale engineering systems. The second manifestation is **activity or process**. This includes processes such as scanning an image as well as activities such as designing, engineering, maintaining or building. Technology also takes the form of **knowledge**. Technology may be in the form of procedures for networking servers in cyberspace or the formulas in civil engineering for testing load-bearing capacity. The last manifestation of technology, **volition or will**, is the most abstract. It is also the most important to grasp. Technology as volition refers somewhat to technological determinism— what is it that wills us to technology? Figure 1 captures all four manifestations of technology (Mitcham, 1994, p. 160). We exert a certain amount of energy and determination into our technological activities. Our compulsions or inclinations toward technology are directed by our technologies as well as our will.

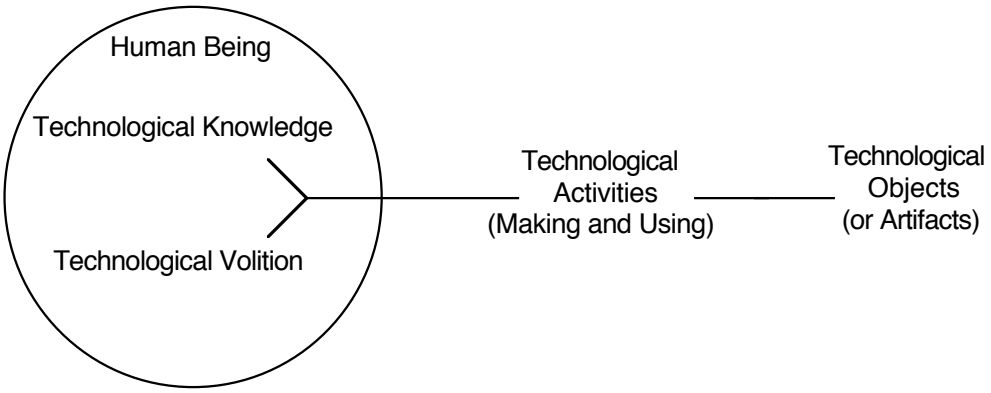

Figure 1. Manifestations of Technology

e. And, technology can also be defined as a matrix or framework, as was the approach of the Frankfurt School and Heidegger in "The Question Concerning Technology." As Marcuse (1941/1978) wrote: "Technology, as a mode of production, as the totality of instruments, devices and contrivances which characterize the machine age is thus at the same time a mode of organizing and perpetuating (or changing) social relationships, a manifestation of prevalent thought and behavior patterns, an instrument for control and domination" (pp. 138-139).
f. Technology can also be defined as "the systematic, purposeful manipulation of the material world. It has four components: materials, technique, power, and tools or machines. Thus technology is the process of applying *power* by some *technique* through some medium of some *tool* or *machine* to alter some *material* in a useful way. These components are necessary and sufficient to describe any technology at any time, but they are static; they do not address technological change" (Roland, 1992, p. 83).

Technology, as product and service, or as activity and as knowledge, pervades every economic sector. Think comprehensively when you think of labour and technology (Fig. A1).

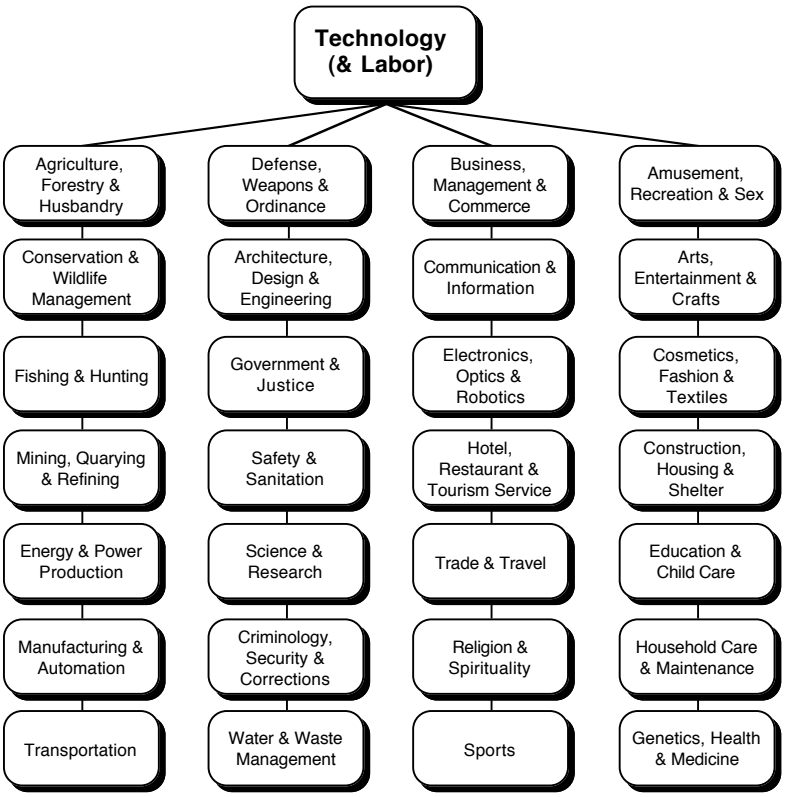

Figure A1. Economic Sectors in Technology

The way we define technology determines the scope of what we study when we study technology. Narrowly define technology and the scope of will be limited. Broadly define technology and the scope will be expansive. Philosophers of technology have been interested in the definitions of technology at least since the ancient Aboriginal, African, Chinese, Greek and Egyptian philosophers began to make sense of their worlds. Currently, technology is divided into eight branches (Bunge, 1999) (Fig. A2):

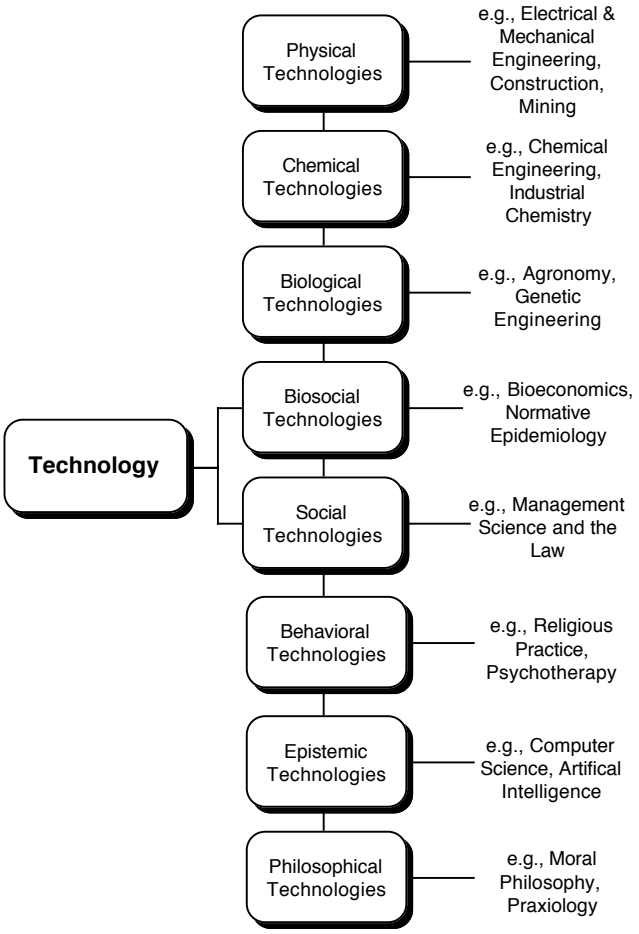

Figure A2. General Branches of Technology (Adapted from Bunge, 1999)

Are there any universals of technology, that hold regardless of place or time? Are there universals that cut across all cultures? Anthropologists who study different cultures end up describing these cultures in an ethnocentric way. They project their own views of the world onto the cultures of interest. They see what they look for. So when they describe the cosmology of another culture, the anthropologists often group components of this cosmology into classifications that correspond to their own culture: economic, social and technological systems for example. Similarly, it is easy to make historical assumptions that what holds now also held at all times in the past. In the anthropological instance we commit the fallacy of ethnocentrism and in the historical instance we commit a fallacy of presentism. There are differences as well as commonalties across cultures and time. The challenge is to remain sensitive to both while refraining from asserting that dimensions or systems of technology are universal. The content or content organizers of any discipline or subject are not universal. They are contingent on a culture at particular points in time. In technology, there are no universal dimensions or systems. There are, however, dimensions and systems that gain a consensus at points in time (Fig. A3). Perhaps at this point in time, ecological-natural, ethical-personal, existential-spiritual, socio-political and technical-empirical **dimensions of technology** challenge us most.

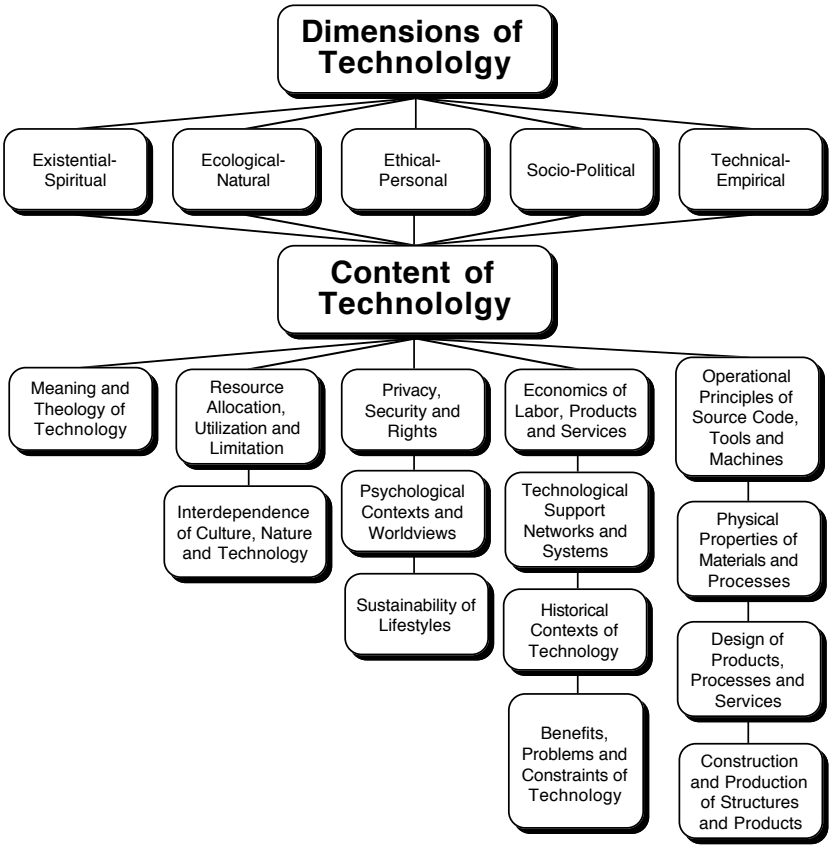

Figure A3. Dimensions of Technology

Audio-Visual Education (AV) began as a response to the proliferation of visual resources created for education during the late 1800s and early 1900s, and the introduction of motion pictures and radio into education during the 1920s. Educators were initially interested in the production of AV aids for teachers and AV effects on students (Fig. A11). However, high schools began to develop infrastructure and studios for AV programming, production, recording, and repair. Signifying the popularity of the new audiovisual or media specialists, the Department of Visual Instruction in the National Education Association grew from a few dozen members in 1923, its founding year, to 500 in 1942, and to 5,000 in the early 1980s. Funded for the most part by private media corporations, the audiovisual specialists were enlisted in the 1920s and 1930s to produce educational media and assess the "effects" of media images and technologies on young people. The Eastman Kodak Company funded a range of market and "effect" studies of their educational silent films produced in the 1920s. Agencies formed to regulate media industries in education, such as the Motion Picture Research Council, argued for censorship, moral codes and literacy lessons for educational film and radio in the 1930s. Ironically, the arguments from media industries and their censors were the same: film, radio and television could maintain powerful influences on the bodies, hearts and minds of students. The expectation was that the welcoming of each new media into education would be checked with precautions for legitimate assimilation. A result was a strange hybrid and, like textbooks, only those media messages that were ideologically appropriate were officially admitted into the schools. It was no coincidence that media content selected as appropriate for socialization by private enterprise was the same as that selected by most educators. Through the 1950s and innovations with teaching machines, computers, and systems theory, AV morphed into **Technology Education** and **Educational Technology** (Petrina, 2003).

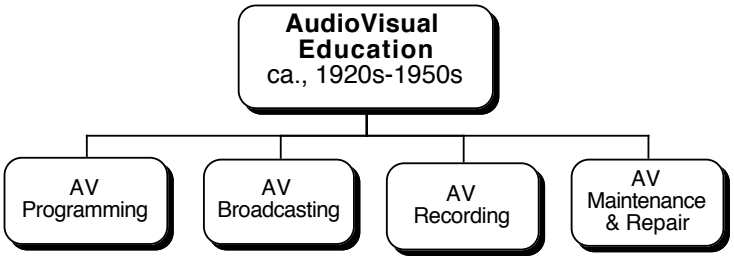

Figure A11. Audio-Visual Education

Educational technology (ET) has a wide range of connotations and in simplified terms refers to any use of technology for teaching and learning (e.g., books, computers, projectors, etc.) (Petrina, 2003) (Fig. A12). In more sophisticated terms, ET is the architecture, buildings, premises, processes, systems, techniques, devices and artifacts (tests, textbooks, media, curriculum, teaching machines, computers, etc.) that mark and shape the control, hygiene and therapeutics of administration, counselling, teaching, and learning. This includes technologies to individualize, socialize or automate administration, counselling, curriculum and instruction (Petrina, 2002). ET basically derives from **Audio-Visual Education**, where artifacts such as AV materials, projectors, and teaching machines constituted the discipline. In universities, educational technology continues this tradition of instructional design and the current focus is on web-based online instruction and the efficient use of technologies for learning. ET has lost its currency, hence in countries such as Canada, England, and the USA, ET is referred to as information technology, information and communication(s) technology (ICT), learning technology or technology education (TE) (see Petrina, 2003). Some teachers have moved from a neglect of design tools and implications to an integration of design and information. ET deals with a variety of design tools and hence the new trend in switching the combination of words from ET to TE. These blurred boundaries are evident in schools where content and practices in ET and TE are indistinguishable (Petrina, 2003). The pioneering work of Seymour Papert and the MIT Media Lab had much to do with the blurring.

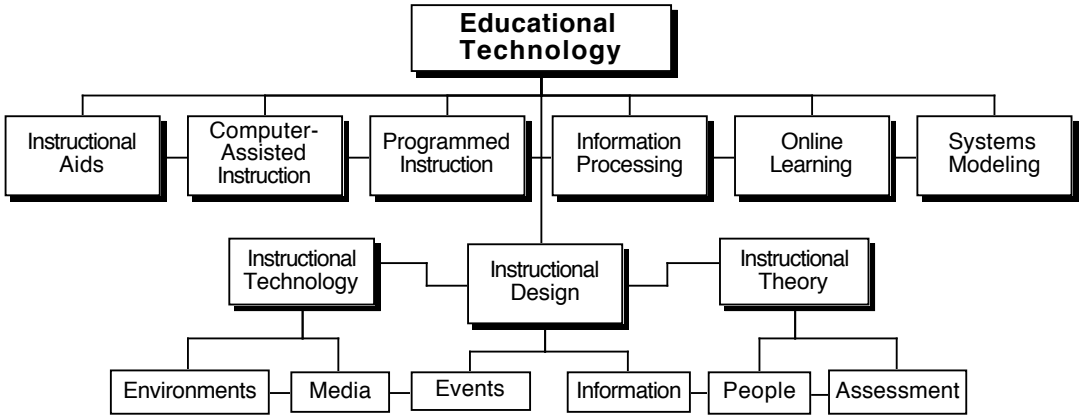

Figure A12 Educational Technology

e-Learning is a hybrid term combing electronic (e-) and learning. Hence, the term is refers to an extremely wide range of practices. As Loh (2007) describers it:

> *e-Learning* remains ambiguous, to say the least. A quick search on Google reveals that there is no agreement about the term, either in the way it is spelled (e.g., eLearning, e-learning, elearning, "e"learning, e-Learning) or in the way it is defined. Many will argue that the *e* in e-Learning should never be capitalized, and just as many will define e-Learning to fit their

> business or argument. For instance, NetTel@Africa's Network for Capacity Building and Knowledge Exchange defines e-Learning as follows: "the effective teaching and learning process created by combining e-digital content with local community and tutor support along with global community engagement" (Beebe, Tusubira, & Twaakyando, 2002). To the Open and Distance Learning Quality Council (ODLQC) of the United Kingdom, e-Learning is "the effective learning process created by combining digitally delivered content with (learning) support and services" (Waller & Wilson, 2001). (p. 574)

The "e-" in e-Learning is necessarily ambiguous, just as the "i-" in i-pod or i-phone is ambiguous. Over the past decade, e-Learning has supplanted terms such as distance education and online learning, although some suggest that e-Learning refers to the enterprise or business of learning in the twentieth century while online learning refers to a specific mode of learning.

Learning technology was coined in England in the mid 1990s as a response to changes in the interrelationships between learning and technology, economic imperatives in human resource development (HRD) and the waning currency of educational technology. For example, the Canadian Office of Learning Technologies (OLT) was created in 1996 to centralize affairs relating to HRD and the new technologies—to "raise awareness of the opportunities, challenges and benefits of technology-based learning and to act as a catalyst for innovation in the area of technology-enabled learning and skills development." The Canadian OLT defines learning technologies as

- information and communication technologies used to support learning. New learning technologies include the Internet, computer networks,
- CD-ROM, video and computer conferencing, interactive television, computer-assisted
- instruction, multimedia, animation, virtual reality and simulations.

Similarly, the Association for Learning Technology (ALT) defines the concept as

- the use of a broad range of communication, information, and related technologies to support learning and teaching;
- learning technologists apply, or support learning technology in practice, and/or undertake research relating to learning technology.

In more sophisticated terms, learning technologies refer to architecture, buildings, premises, processes, systems, techniques, devices and artifacts (tests, textbooks, media, curriculum, teaching machines, computers, etc.) that, either by design or incidentally, mark and shape adaptive reorganization in a complex system (i.e., learning).

While he generally uses epistêmê and technê interchangeably, in *Philebus*, Plato divides knowledge into two types: the first addressing education and upbringing and a second addressing making and production (Mitcham, 1994, pp. 117-125). Historically however, the two types of knowledge are inseparable; education and technology will always require each other. Never fully didaskê, epistêmê, mechanê, or technê, Archimedes' planetaria, as Cicero described it, effectively communicated knowledge of heavenly bodies and the gods. This type of mechanical art along with printing and writing, or what Diderot classified in the tree of knowledge for the *Encyclopaedia* as arts of both remembering and communicating, were part and parcel with pedagogy (Cubberley, 1920, pp. 397-467). The English word "technology" was first coined in 1828 but was not actively used until the early twentieth century (Marx, 1997). In education, the terms "audio-visuals," "instructional materials," "mechanical aids," and "teaching aids" referred to the technologies of administration, learning and teaching through the early 1950s. Sidney Pressey, eventually crowned the "grandfather" of computer-assisted instruction, was among the first to use "educational technology." He declared in 1933 that "there must be an 'industrial revolution' in education in which educational science and the ingenuity of educational technology combine to modernize the grossly inefficient and clumsy procedures of conventional education" (p. 582) (Petrina, 2002, 2004a). Although learning and teaching became increasingly capital-intensive through the 1930s, he and others

depicted education as handicraft rather than technological practice.[1] By the late 1950s, educational technology was increasingly employed alternatively with the term "instructional technology" to displace "audiovisual education" and "audiovisual communications" as disciplinary referents and practices (Januszewski, 2001). Currently, "learning technologies" seems to be displacing educational and instructional technologies as the disciplinary referent.

Learning technologies was coined in or about 1993 when the Association for Learning Technology was established in England, generally as a response to changes in interrelationships between learning and technology, economic imperatives in human resource development (HRD) and the waning currency of educational technology. Ben Davis also used the term in 1993, as if by accident, and it remained rare and basically undefined until the mid to late 1990s. Typical of the progress narratives that still characterize the term, Davis wrote that "the sweeping technological advances in learning technologies, now in prototype phase, will be the substantive achievements of the twenty-first century" (p. 21). A sense of how learning technology began to displace educational technology is in the two editions of Laurillard's (1993, 2002) textbook. *Rethinking University Teaching: A Framework for the Effective Use of Educational Technology* became *Rethinking University Teaching: A Conversational Framework for the Effective Use of Learning Technologies*. Reflective of changes in England, the Canadian Office of Learning Technologies (OLT) was created in 1996 to centralize affairs relating to HRD and the new technologies— to "raise awareness of the opportunities, challenges and benefits of technology-based learning and to act as a catalyst for innovation in the area of technology-enabled learning and skills development."

The primary policy directions defined by the Canadian OLT included skills development through e-learning, and provincial ministries and universities eventually aligned themselves with funding and policy. For example, the University of British Columbia's (UBC) Office of Learning Technology (UBC OLT) was established in 2002 and began to centralize resources on campus, including e-Portfolio initiatives. Recognizing the politics of this change, Faculties (i.e., Colleges) fell in line. In September of 2004, UBC's Faculty of Education renamed the Office of Continuing and External Programs to External Programs and Learning Technologies (EPLT).

Coincidental with the Canadian OLT, in 1996 the U.S. National Science Foundation (NSF) launched a Collaborative Research on Learning Technologies (CRLT) program and continues to offer funds through the Advanced Learning Technologies program. Like the Canadian OLT, the NSF inspired university service units and research centres to shift, in either name or focus, from instructional technologies to learning technologies. For example, the CRLT program funded the establishment of the Center for Innovative Learning Technologies, maintained through 2004 (Pea et al., 1999; Sabelli & Pea, 2004). Learning technologies in the NSF's (2007) current Advanced Learning Technology program "include (but are not limited to): systems for tutoring or assessment, modeling and sensing of cognitive or emotional states, context awareness, natural language interfaces, collaboration, and knowledge management." The emphasis is on learning systems, environments and platforms.

The Canadian OLT (1998) defines learning technologies as:

> information and communication technologies used to support learning. New learning technologies include the Internet, computer networks, CD-ROM, video and computer conferencing, interactive television, computer-assisted instruction, multimedia, animation, virtual reality and simulations.

Similarly, the Association for Learning Technology (ALT) (2007) currently defines the concept as

- the broad range of communication, information and related technologies that can be used to

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[1] So called "new education" and "new psychology," or "progressive education," with Dewey's "learning by doing," underwrote an intense production of new technologies of learning (Petrina, 2002, 2004a). Sense realist philosophies of Pestalozzi and Froebel were celebrated, as a well-known educator put it in 1885: "watch the magic influence of a diet of things prescribed by the former in the place of words, and a little various practice in doing, in the place of talking, under the direction of the latter" (Woodward, 1885).

support learning, teaching, and assessment.

- [and notes that learning technologists] apply, or support learning technology in practice, and/or undertake research relating to learning technology (c.f., Oliver, 2002).

With this description, the ALT also indicates that "a very wide range of people in industry and in private and public sector education have learning technology as a core part of their role: you do not have to be called or to call yourself a learning technologist to be one!"

Hence, the boundaries are blurred between the learning technologist and the learning scientist (and perhaps the learning artist). Nonetheless, upon introducing the *International Journal of Learning Technology*, Uden (2004) was perfectly content to rely on a stereotype of science discovering and technology applying. "Learning technology," she says, "is the application of technology for the enhancement of teaching, learning and assessment" (p. 1). One problem here, as Bruce (2001, p. 735) found, "depending on the use, practically any technology can be considered a learning technology." For example, researchers specifically interested in tracking the discourse of learning technologies are content to accept any technologies (e.g., "electronic mail, presentation systems, multimedia and computer-based applications, audio and video conferencing, and Web-based applications") as learning technologies (e.g., Cukier, Middleton & Bauer, 2003).

> "The term learning technology is ambiguous in at least four ways," says Bruce, 2001, p. 735). It can mean (1) the tool that helps one learn and thus enables *learning through* technology, (2) *learning how to use* technology, (3) *learning about* technology, or (4) a technology that itself learns. In (4) for example, genetic algorithms in effect learn how to perform more effectively in some environments based on feedback about their success and failure; thus they are *technologies that learn*.

The challenge is to acknowledge that learning technologies refer to the things and media of learning as well as the field of learning technology (or technologies), which in many ways displaces or transforms the fields of instructional or educational technology. Like the learning arts and sciences, learning technologies collect together a range of disciplines, including design, education and engineering, to shape learning. Hence, learning technologies can refer to architecture, interior designs, premises, processes, systems, techniques, devices and artifacts (bots, curriculum, computers, media, teaching machines, tests, textbooks, etc.) that shape learning.

Information technology or **Information and Communication(s) Technology (ICT)** spans most economic sectors. Given the intensive automation that is currently taking place in industrial technology and service, ICT is currently the fastest growing economic sector. As a field of study, information technology is a sub-discipline of computer science, business management and engineering technology and a school subject. In the schools during the late 1970s and 1980s, courses called computer science or computer studies continued the practices of educational technologists, whose focus was on programming and applications. While a general literacy was advocated, little was done on the issues of implications. The courses were renamed information technology in the early to mid 1990s. In BC for example, the computer courses were renamed in 1996 when computer studies had little currency.

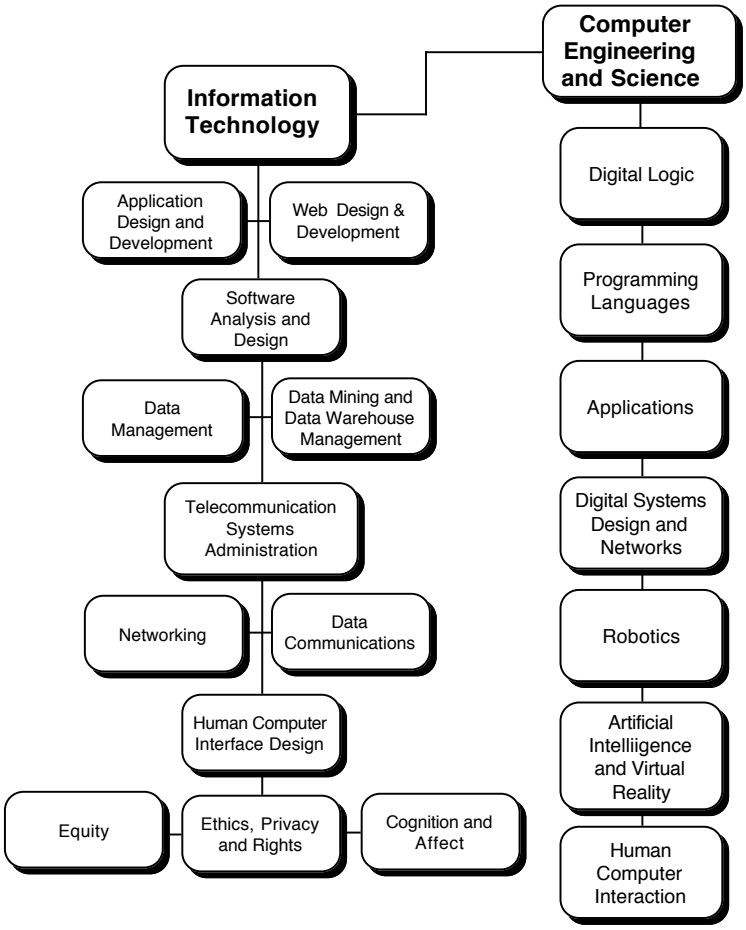

Figure A13. Information Technology and Computer Science

Like computer science and studies, information technology reflects preoccupations with applications and in business education is information technology management. Currently, the *term* (not the practices) "information technology" is losing its currency, as most researchers argue that the new digital technologies extend well beyond information and communication. They engage a wide range of actions and are not merely conveyances of information with technology. New media is becoming the new term of choice. In universities, cultural studies of information technology and of cyberculture are often part of a larger practice of technology studies (Fig. A13).

Digital media design can be defined as simply design of, and with, new media (Fig. A14). **New media** reflect the convergence of communication, media and information

- technologies (camera, computer, copier, fax, messaging, phone, printer, audio & video player etc. convergences),
- modalities (image, print, sound, etc. convergences),
- practices (art, communication, design, fashion, film, marketing, media, medicine, programming, technology, etc. convergences) and
- corporate formations (cable & internet providers, music, newspaper, radio & television convergences).
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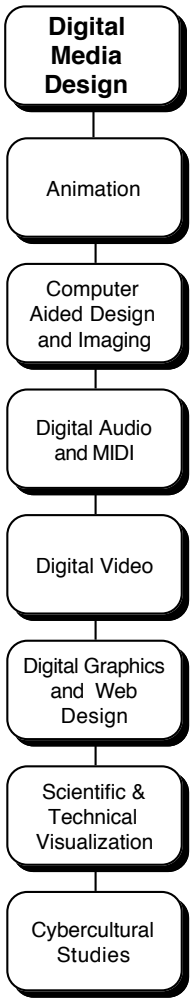

Figure A14. Digital Media Design

Digital design refers to a branch of electrical engineering that deals with the design of digital hardware. However, the accessibility and applicability of software accompanying the convergences noted have resulted in a new knowledge worker and a new field of discourse, practice and study. Like industrial design, new media occupies a necessary space between art and computer engineering and science.

New media focus on the design of animated and interactive content for the internet, TV, CD, DVD, and other media environments. New media create experiences environments with time-sensitive data. New media involve the design of interactive, malleable, and motion and sound oriented messages, and expand to bidirectional communication in which content responds, adapts, and changes in response to users, hosts, or circumstances. Motion allows content and form to utilize an added dimension of time to transform the capacity of still images while sound provides additional sensory capacities. New media or digital media design signifies the new digital curriculum in the schools, such as animation, gaming, mobile computing, web design and video, and has more currency than IT or ICT in education.

New media accounts for IT, ICT and digital media design and necessarily responds to cultural studies, communication studies, media studies and cyberculture. Hence, new media refers to new practices with digital technologies *and* a field of study of these practices. Coined in the mid 1960s in a book titled *New Media and Education*, "new media" was reintroduced in the mid 1990s and eventually superceded "multimedia" to contradict reductions to the software of image, text and sound and to a larger referent of the aesthetics, designs, devices, artifacts and practices occasioned by new technologies and cyberculture.

In *The Language of New Media*, Manovich proposes five principles of the digital aesthetic, which defines new media: numerical representation, modularity, automation, variability and cultural transcoding. Or are the terms of the digital aesthetic or new media more or less as follows: Accessibility, Automativity, Compatibility, Connectivity, Interactivity, Mobility, Modularity, Portability, Predictability, Repeatability, Reproducibility, Transparency, Variability, Virtuality and Cultural Disassembly? Either way, the point is that new media recall old media and yet are different. According to Lister et al. (2003, p. 12), new media refer to:

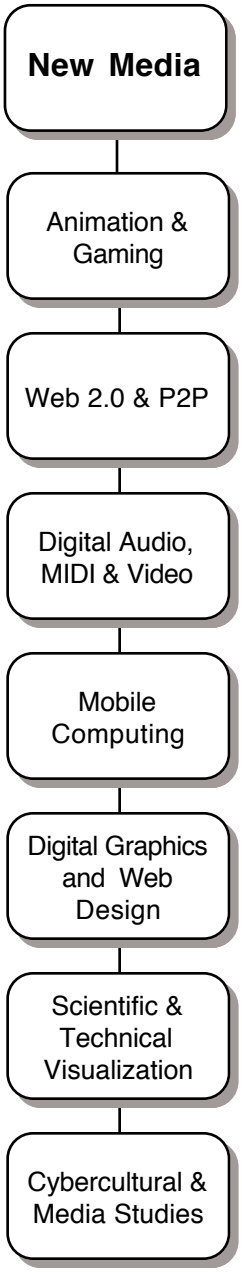

Fig. A15. New Media

- **New textual experiences**: new kinds of genre, textual form, entertainment, pleasure and patterns of media consumption (computer games, hypertexts, special effects, cinema).
- **New ways of representing the world**: media which, in ways that are not always clearly defined, offer representational possibilities and experiences (as in immersive virtual environments, screen-based interactive media).

- **New relationships between subjects (users and consumers) and media technologies**: changes in the use and reception of image and communication media in everyday life and in the meanings that are invested in media technologies.
- **New experiences in the relationship between embodiment, identity and community**: shifts in the personal and social experiences of time, space and place (on both local and global scales) which have implications for the ways in which we experience ourselves and our place in the world.
- **New conceptions of the biological body's relationship to technological media**: challenges to the received distinctions between the human and the artificial, nature and technology, body and (media as) technological prostheses, the real and the virtual.
- **New patterns of organization and production**: wider realignments and integrations in media culture, industry, economy, access, ownership, control and regulation.

In effect, this includes a convergence of **devices** (camera, computer, audio & video player etc.), **networks** (information, nodes, packets, power, etc.), **modalities** (image, text, sound, etc.), **aesthetics** (hyperreality, immediacy, virtuality, etc.), **practices** (blogging, browsing, hacking, podcasting, programming, surfing, etc**.**), **practitioners** (desires, experiences, expertise, powers), **conditions** (inequities, globalization, power, etc.), **disciplines** (authorities, exemplars, case lore, norms, paradigms), **cultures** (vlogging, gaming, online learning, etc.), literacies (digital, media, multiliteracies, etc.), **policies** (funds, strategies, rewards, etc.), **embodiments** (AI, cyborg, distributed cognition, VR, etc.), **coordinations** (capital, division of labour, expertise, etc.), **ecologies** (natural, artificial, hybrid, etc.), **corporations** (cable, content & internet providers, hardware and software vendors, etc.), **convergences** (AOL-Time-Warner, Walt Disney Internet Group, etc.), **concentrations** (media control, power, wealth, etc.), and **spiritualities** (machine consciousness, technopaganism, Electric Gaia, etc.).