The Future Isn't What it Used to Be

Comments to Citicorp on emerging trends relating to education by

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Futurists do not predict the future for the simple reason that the most exciting things likely to happen in the coming years will be driven by developments that have yet to be discovered. These new innovations are called wild cards, and we live in a time when wild cards are emerging at an unprecedented rate. So what can I do to develop a useful overview of the coming years? The best I can offer is a glimpse of some emerging trends -- things that have already happened, but have yet to blossom to their full potential. As science fiction author William Gibson has said, "The future already arrived, it just wasn't evenly distributed." In is in this spirit that I offer the following comments and observations.

First, I'd like to share a quotation from Professor Ikujiro Nonaka at UC Berkeley:

The dynamics of knowledge have become the most important competitive resource of the firm.

Notice that he is suggesting it is the rate of change in the information, not the information itself that is the the important factor today. Given the incredible rate at which things are changing, this is wise advice. Many years ago a similar idea was expressed by the longshoreman/philosopher Eric Hoffer when he said:

In a time of drastic change it is the learners who inherit the future. The learned usually find themselves equipped to live in a world that no longer exists.

I'll have more to say on this topic later, but suffice it to say that lifelong learning needs to become the dominant paradigm for education if our institutions are going to remain relevant in the lives of their students.

It is often said that what you earn is determined by what you learn. We recently conducted a study based on data from the US Census bureau in which we examined median salaries for high-school dropouts, high-school graduates, those with some college, bachelor's recipients, and those who have advanced degrees, for the period

from 1975 to 1994. While it has always been the case that median salaries have increased with increased educational level, the gap is widening. For example, in 1975 the salary gap between highest and lowest educated in the US was 2.6:1. By 1994 the gap had increased to over 4:1. More interestingly, the median salary of high-school dropouts has leveled off while the salaries for college graduates and those with advanced degrees is accelerating away from the rest. The results would be even more spectacular had we adjusted the data for inflation. Details of this work appeared in another white paper entitled "Learning a Living," available on our Web site (http://www.tcpd.org).

Our society is being squeezed between two compounding trends: an increase at the speed with which information is doubling (currently estimated to be 22 months), and the collapse of the information float -- the time between a discovery and its application in the commercial marketplace. These trends provide the sensation that time is collapsing. For example, many people who use the World Wide Web seem surprised to find that the Web is only a few years old. It seems like we have had it for a long time. An advertisement by Semantec that appeared in mid-1997 said: "Are you still designing Web pages the way they did way back in 1996?" While the intent was humorous, the rapid advances in authoring software reveals a hidden truth -- the world is changing quickly, especially in the high-tech arena.

Survival in a period of rapid change requires an openness to rethinking our concepts of time itself. For example, the industrial revolution was very much influenced by the concept of linear time. Work schedules were driven by the clock. Time clocks, steam whistles, etc. set the pace for work and education in the society of that time.

Today it is probably worth examining a chaotic model of time -- one based on the evolution of non-linear systems that increasingly describe current reality. Two aspects of chaos theory are relevant here. The first is the extreme sensitivity of non-linear systems to initial conditions -- the so-called "butterfly effect" (in which it is suggested that a butterfly flapping its wings in Taiwan can cause a tropical storm in the Caribbean), and the existence of "strange attractors," states in which complex systems can settle that are extremely resistant to change.

For an example of a "strange attractor" in the real world, consider the keyboard arrangement on today's computers.   In general, this arrangement is the same one used in the original commercial typewriter developed by C. Latham Sholes in the 1800's. This arrangement of keys (often called QWERTY after the first six letters of the top letter row) was designed to make typing difficult in order to prevent the type bars from jamming. Even though we no longer use mechanical type bars, and far better keyboard arrangements exist, most people persist in using this antique key arrangement because the perceived barrier to change is so high, it is not worth the effort.

According to Regis McKenna, author of *Real Time* (published in 1997), the nature of innovation has changed markedly as we entered our current period of rapid change. Prior to 1975, he suggests that innovations took place under the control of large institutions, and that these innovations were slowly diffused into the marketplace where they were finally accepted by the public at large. Henry Ford, for example, said you could have any color you wanted on his cars as long as it was black.

But, according to McKenna, all this changed starting around 1975. Innovations are more likely to take place today in small dynamic organizations, or to be created by individuals working alone. Small enterprises can bring innovations to market quickly where they are accepted by society, leaving the old established institutions to respond or not.

To see just one small example of this new trend, consider that the personal computer market went from zero to $100 billion per year in sales in the period from 1980 to 1990. This is the fastest growing market in history -- and it is one that was virtually ignored by the established computer companies until the mid-1980's. It was upstarts like Apple and others who created this industry. IBM, DEC and others had no concept of the power of personal computing in the early 1980's, and actively argued against the future of this technology!

Similar events are happening today. In the area of sales, for example, companies like Dell and Cisco Systems are selling their products directly from their Web sites. By November, 1997, Dell was selling over three million dollars worth of computers from their Web site a day. Cisco, a manufacturer of network routing equipment, was selling three times that amount, and will probably rack up over three billion dollars in sales from their Web site for fiscal 1997 -- about 40% of their total sales!

By having customers specify, in detail, the desired configuration of their systems, companies like Dell and Cisco are able to implement just-in-time manufacturing -- mass-customization -- using factories driven by verbs, not nouns. One way to handle inventory management is not to have any inventory. This is Dell's approach. Their factory is virtually devoid of nouns -- inventories of parts and finished computers. Instead, parts are ordered for each machine being built, and as soon as the computer is assembled and tested, it is boxed and placed on the FedEx truck for delivery. All you see in a factory like this is verbs -- computers in the process of assembly and testing.

Transformations of this magnitude reach far beyond manufacturing -- they reach into the service sector as well, and even have a potential impact on education, as we will see later.

The driving force for transformations of this magnitude comes from the digital tornado sweeping across the planet -- the telematic revolution typified by the rapid popularization of the Internet and the World Wide Web. Continued advances in

the technologies of silicon chips and broadband communications feed this digital tornado.

Chip complexity is continuing to advance at a rate predicted by Moore's Law -- named after Intel's Gordon Moore who observed that the capabilities of silicon chips were doubling every 18 months. This geometric growth rate is expected to continue well into the next century. The result is that the small chip inside today's throwaway musical greeting card has more computing power in it than existed in the entire world prior to 1950. The ubiquity of this technology is such that there are 40 million transistors in operation today for every person on the planet.

The bandwidth revolution is in its infancy, at least as far as implementation at the consumer level is concerned, but even so, the World Wide Web is doubling in size every few months, and the Internet has extended its reach to most countries on the planet.

The effect of ubiquity, driven by lowered cost and increased reach, is to create a new network-based economy -- one in which value is inversely related to cost. Consider, for example, the high cost of the original fax machines, and the low value associated with them because so few people had them. By manufacturing fax machines that can be sold for under $200, this technology has become commonplace, increasing its value to those who want to fax a message to someone else. Bob Metcalfe, inventor of the Ethernet, has suggested that the power of a network increases by the square of the number of users. Metcalfe's Law, combined with Moore's Law, provide the continuing impetus for the increased use of networked systems, and for some deep economic changes that result from the resulting digital tornado.

An what of the impact of this digital tornado on education?

This is the first time in history that the student, teacher and content do not have to be in the same place at the same time. I don't think very many people have grasped this yet. Once they do, the face of education at every level may change in some profound ways.

Instead we are seeing new tools being used to replicate old educational models. Instead of a solitary teacher lecturing to a single class of 30 students, for example, some teachers are using broadband distance learning tools to deliver boring lectures to many thousands of students simultaneously.

It need not be this way.

The educational models of the past operated on the assumption that content was king. In fact, content is free and overwhelming in size. In a world of rapid information growth, it is context that matters. Context is king. This means that learners at all ages need to master two very important skills. The first is the ability

to locate information specifically related to the question they are exploring, and the second is to establish the veracity and utility of this information. These are non-trivial skills -- ones that librarians have long honored, but which are often lost on the public at large and, tragically, lost on some educators as well. The richness of high-quality educational Web sites such as the Library of Congress or NASA is free for all who have a grasp of these skills. Without them, the Web reverts to another piece of "thumb candy," a video-game-like experience that may be pleasurable, but not necessarily of great educational value.

This is important today because I believe that 1998 will be the year of the Internet appliance. In addition to the large number of current Web users who gain access through their personal computers, we will see increased use of Network Computers in offices, as well as the increased proliferation of these devices in public settings such as 7-Eleven Stores. Devices like WebTV may start to show up in homes, although the greatest growth in home use will probably come from cable companies providing high-speed alternatives to voice-grade telephone line connections to the Net through services such as @Home.

The other realm of Internet appliances is the hand-held computer systems that are dropping in price, increasing in performance, and providing direct access to the Web either through existing telephone lines or through wireless services. These devices range from the latest Nokia cellular phone to the Game.Com system from Tiger Toys that retails for under $100.

Once Web access starts to achieve the kind of ubiquity associated with televisions and telephones, it will support a transition in education from a "Just in Case" to a "Just in Time" paradigm.

Consider the current curriculum in most schools. Students are still being taught a lot of information without any need to apply this information in a meaningful way. They are taught things just in case they will need them later. For example, when is the last time you needed to take the square root of a large number by hand? Consider the shift to just-in-time learning where context is ever present. Something is learned because it is needed to answer a larger question. This transformation has already taken place in a few schools, but it needs to become more widespread if our schools are to remain relevant to their students.

Given the lifelong nature of learning in our world of rapid information growth, educational systems should stop thinking in terms of K-12, or college, and move instead to the concept of educational maintenance organizations, or "EMO's." Why is it that the only time we hear from our colleges after graduation is when they want money? Why don't they continue to offer educational services to us for a lifetime? The only educational organizations in the US currently equipped to do this are our community colleges. This needs to change.

It needs to change for two reasons -- first, because it is what the students need. The second reason is that EMO's will spring up on the Web. The Open University in the UK has been in business since the 1960's, and is using the Web to extend its reach globally. Other new colleges are being designed with virtual campuses, offering their courses to students on a global scale, and providing mass-customization as well. Peter Drucker has said that the bricks and mortar colleges are doomed. Perhaps he is right. Unless our institutions aggressively reinvent themselves, his prediction may come true sooner than later.

As Jack Welch, CEO of General Electric, once said,

When the rate of change inside an institution is less than the rate of change outside, the end is in sight.

Business and education face a future filled with rapid change. It is up to each institution to decide how it will respond.

Author notes: Dr. Thornburg is Director of the Thornburg Center and Senior Fellow of the Congressional Institute for the Future. As a consultant for both education and business, he is active in exploring the skill sets needed by highly skilled workers in the coming years.

His work on educational futures and the use of emerging technologies has resulted in several workshops, including one on Thinking Skills for the 21st Century. Information on this, and other, programs can be found at the Thornburg Center website: http://www.tcpd.org