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ABSTRACT

The purpose of this chapter is to envision how the era of technological revolution will affect the guidance, counseling, and student support programs of the future. Advances in computer science, telecommunications, and biotechnology are discussed. These advances have the potential to affect dramatically the services of guidance programs of the future on two fronts: the mechanisms through which the services of guidance programs will be offered, and how guidance programs will help prepare students to live and work productively. The chapter concludes by proposing that guidance programs of 20 years hence must prepare the majority of their students to enter technical fields; adapt themselves to extensive telecommuting and the lifestyle that it entails; and prepare primarily for self-employment or freelance employment. (Contains 24 references.) (GCP)

The Impact on Future Guidance Programs of Current Developments in Computer Science, Telecommunications, and Biotechnology

By

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Lynda K. Mitchell & Philippe L. Hardy

We are living in an era of incredible technological change. The purpose of this chapter is to envision how this technological revolution will affect the guidance, counseling, and student support programs of the future, specifically those of 20 years hence, around 2021. We have chosen to concentrate on a period of 20 years because those who specialize in envisioning the future, often called futurists, usually advise that 20 years or so is about the limit for which reasonable extrapolations can be made based upon the present.

The best way to begin to grasp the extent of change that might occur in the next 20 years is to think about the changes that have occurred in the last 20 years. What was life like in 1981? At that time, although some of the incipient technology existed, few of the products, services, and biotechnology advances that have become such a ubiquitous part of our daily lives had been created. Just as a few examples, in 1981 there were essentially no personal computers, no CD players, no CD-ROMS, no wide-screen or flat TVs, no VCRs, and no video cameras. There was no voice mail, no Internet, no global positioning system, and no virtual reality. There was no cloning and no gene mapping. The developments of the past 20 years, and the fact that change is accelerating more or less exponentially, suggest that we should expect even more dramatic developments in the next 20 years. As an aside, we should note that much of this exponentially accelerating change has occurred because during the past 50 years, computer capacity has doubled (and halved in price) every 18 months, a phenomenon known as Moore's law (Kahu, 1998). Given that it would have been very difficult for most of us to envision in 1981 what the world of 2001 looks like, in reality our minds probably cannot grasp what changes the next 20 years will bring about. Nevertheless there are numerous people who make their life's work trying to anticipate such changes, and in this article we attempt to pull together their predictions into three categories: computer science, telecommunications, and biotechnology. We will then discuss the potential impacts of these developments on the guidance programs of approximately 20 years hence. It's worth noting that developments in these three categories are inevitably converging because of increased computing capacity. For example, as Kahu (1998) points out, the number of genes that can be sequenced in the human genome project doubles every two years because the computers that drive the process are becoming ever more efficient.

Computer Science

The major immediate development in computer technology will probably be speech-directed computers. Microsoft Corporation, for example, has directed a considerable portion of its research and development budget in that direction (Gates, Myhrvold, & Rinearson, 1998). Several models of speech-directed computers already exist, but the technology requires the computers to be "trained" to your voice, and the computers still make many errors of comprehension. As Isaacson (1998, p. 34) notes, "ask a computer to 'recognize speech' and it is likely to think you want it to 'wreck a nice beach.'" As the technology becomes even more widely available, however, it should provoke a huge upsurge in computer use by technophobes who currently avoid dealing with windows, computer mice, and so forth. Imagine the ease of being able to verbally instruct your computer to power up, go online, print a document, or pay your monthly bills. Or imagine having a computer in your car that you can chat with as you are driving. Isaacson (1998, p. 35) believes that "in a decade or so . . . we'll be able to chat with our . . . telephone consoles, browsers, thermostats, VCRs, microwaves, and any other devices we want to boss around." Another recent development still being perfected is "digital ink" that turns paper into a computer screen.

Similar developments are expected with regard to how computers output information. There is no particular reason why we should have to get all of our information from a computer by staring at a screen. In the future, computers will probably communicate with us through a variety of sensory input. For example, a stockbroker may have a computer that communicates the number of shares traded via a sound, such as a waterfall. As the volume of shares increases, the sound gets louder and louder (Gross, 1997). From speech-activated computers it is a short step to the development of robots we can interact with as though they were human beings. In fact, computer scientists at the Massachusetts Institute of Technology (MIT) feel they have already developed such a robot (Port, 1997). According to Isaacson (1998), we will provide so many thoughts and preferences to our computers of the future that they will ultimately be able to mimic our minds and act as our proxies. And yes, then they will probably build their own computers.

The preceding developments are relatively modest. Most of this increase in capacity has come about because the makers of silicon chips, on which all the software and memory of computers are stored, have devised ways to make them ever more efficient. This increased efficiency is accomplished by making the circuits that store information on the chips tinier and tinier. In about seven years, however, around 2008, the circuits will have to be the size of atoms, and silicon chips will no longer be a viable medium. At that point it is expected that computers based on the silicon chip will disappear, and some new model of computing will arise. Many feel that the real future of computing lies in nanotechnology (Rogers & Kaplan, 1998). A *nano* is one-billionth of a meter, and microscopic devices that have already been developed based on nanos may allow us to manipulate atoms and molecules. With this capacity we could literally create any substance we wanted. Computers of the future could thus, upon command, materialize a cheeseburger and fries, and the stove to cook them on, out of a primordial fog in our kitchens.

Along the same lines, a coalition of researchers from IBM, MIT, Oxford University, and the University of California at Berkeley recently reported that they created a computer in which the central processor consisted of atoms of hydrogen and chlorine, and used it to sort a list of unordered items (Markoff, 1998). The computer is based upon the principles of quantum physics and is assembled from units the size of molecules known as *cubits*. This development is considered especially exciting because unlike conventional computers, which are assembled from arrays of millions of digital switches that represent either a 1 or a 0, a cubit can represent 0, 1, or potentially many other states simultaneously. This potentiality could eventually enable machines that function millions of times faster than today's supercomputers.

At cutting edge computer labs all over the world, computer scientists are working on these and other future prototypes for computers. With the demise of the silicon chip, many scientists believe that computers of the future will be patterned much more closely on living creatures, and will no longer be based on the old desktop metaphor (Judge, 1997). For example, some computer scientists are studying how computers might be modeled upon ant colonies, which function perfectly with no central authority, or upon rushing rivers of data, or upon materializing three dimensional images in space (Gross, 1997) rather than the current binary (0/1) digital format.

No matter what form computers eventually assume, one thing is certain. In the past 20 years, the number of doctorate degrees in computer science has risen from 10 to 1,000 a year, with master's degree holders rising concomitantly. And it is advances in computer science that drive many of the other developments we discuss in this chapter.

Telecommunications and Netware

Today some 40% of the U.S. population regularly accesses the Internet via personal computers. By 2021, most telecommunications specialists predict that every man, woman, and child will be using information technology as an integral part of their daily lives (Port, 1997). If this state is to be achieved, however, the use of information technology must become as easy as driving a car. Most people can drive a car easily without knowing how the engine works. The use of the Internet needs to become equally simple.

Currently, the main obstacle to easy access and use of information technology is the difficulty of economically transporting broadband (video and audio) information with our current narrowband technology. Broadband technology is now in wide use for transmission of information, but most of the receiving sites (e.g., homes and offices) can accept only narrowband information. However, more and more organizations, such as the California State University system, are putting broadband technology in place for receiving information. In addition, Microsoft Corporation is in the process of launching a project they call *TELEDESC*, which will put into orbit a series of satellites to transmit two-way broadband information to anyone who wants to receive it, much like a giant cellular phone system. Finally, during the Clinton administration, Vice President Gore unveiled national plans to build a new Internet that can transmit at speeds that astound current users. The new Internet, dubbed *Internet* 2, will be able to transmit the entire *Encyclopedia Britannica* in one second and the content of the Library of Congress in less than a minute. In short, the future promises pervasive broadband technology combined with completely affordable computing power for all (Markoff, 2000).

What are the implications of readily available, portable Internet access? First of all, people will be walking around while online. Telecommunications specialists envision clothing that turns body heat into electricity in order to power the transmission and receipt of information (Gross, 1997). Your pacemaker will be able to send information directly to your doctor. Caps will have video visors that allow you to scan information constantly. Your watch will also access the Internet, giving you the entire planet's knowledge on your wrist (Kahu, 1998). Some pundits have coined the term *Homo cyberneticus* for these online people of the not-so-distant future (Flynn, 1997).

It is not just people, but their houses and appliances, that will be online. When you step on the scale, your weight will go to your physician (or your Weight Watchers group). Your refrigerator will receive your weight and decide what to feed you that day. It will also notice when you're low on milk or other groceries and order them directly from the market (Gershenfeld, 1999). The thermostat in your house will sense a shiver and turn up the heat, or sense perspiration and turn it down.

In academic settings, researchers from different continents can be part of visually rich virtual laboratories and participate jointly in discoveries. In medical settings, physicians will have the virtual reality techniques to conduct operations thousands of miles away. Such an operation has in fact already been conducted during the recent war in Kosovo (Margolis, 2000). In short, easy and inexpensive access to the Internet should have the same revolutionary effect on everyday life that the access to electricity did half a century ago (Davis & Wessel, 1998). It will simply permeate every aspect of human functioning.

As Isaacson (1998) notes, the digital revolution that we are in the midst of today is likely to "pale in comparison to the revolution in biotechnology that is just beginning" (p. 34). The most important aspect of this newest revolution is that humans now have the ability to replicate and modify their own DNA. The ability to modify our DNA has powerful implications for the treatment of disease. For example, several French infants with severe immune system disorders, which previously required them to live in sterile "bubbles," have now been cured via gene therapy (*New York Times*, 2000). We will also probably be able to select the characteristics of our offspring. The ability to replicate our DNA means that we will undoubtedly start to clone ourselves, despite all the current thrashing about with regard to the ethical implications of cloning. The researchers from Great Britain who cloned Dolly the sheep have already applied for and been awarded permission to look at certain aspects of human cloning.

Among the predictions floating around is that ultimately we will carry around our entire genetic makeup on a handy CD. A trip to the doctor's will entail an examination of the information on the CD, rather than a physical. If something is wrong with us, we will be given a shot designed to rearrange our DNA so as to make us immune to the illness.

Once we start cloning ourselves and selecting the genetic characteristics of our children, it is anyone's guess as to what is likely to happen to humans. One idea that immediately comes to mind is that there will be a huge preponderance of tall male offspring. Silver (1998) predicts that cloning technology will be too expensive for mass use, and thus will be used only by a small percentage of the population. He goes so far as to predict that this small percentage of the population will then proceed to clone itself into a different species.

Another exciting development appears to be a promising approach to the treatment of cancer (Kolata, 1998). Medical researchers have discovered two new drugs, angiostatin and endostatin, which operate by cutting off the blood supply that tumors require to grow. In trials with mice, the drugs have been shown to be effective for all types of known cancers, and the National Cancer Institute has made human trials its top priority.

The combination of a cure for cancer and genetic engineering certainly suggest that *Homo cyberneticus* could have a life span immensely longer than that of *Homo sapiens.* Again, as with revolutions in computer technology, our minds probably cannot grasp what changes advances in biotechnology are likely to produce.

One thing is certain. Unlike in previous decades, there is essentially no gap any more between what is in research and what is in production (O'Hamilton, 1997). For example, a glance at the reference list for this article shows that all but one of the references are dated between 1997 and 2000, the span in which this article was written. Further, although we reference mostly hard copy sources (books and magazines) for the convenience of the reader, all the information contained in those sources can be easily retrieved from the Internet.

Effects on Guidance Programs of the Future

The advances discussed thus far, in computer science, telecommunications, and biotechnology, have the potential to affect dramatically the guidance programs of the future. This impact could be felt on two fronts: the mechanisms through which the services of guidance programs will be offered, and how guidance programs will help prepare students to live and work productively in this new world.

How Services Will Be Offered

Traditionally, guidance programs have operated within a school site. But will schools as we know them exist in 20 years? Perhaps not. Most education can easily be conducted through virtual reality experiences via the Internet, especially once broadband transmission becomes universally available. Books and films need no longer be the media of choice. Further, with the technology of virtual reality, the boundary between training and doing may soon disappear. In short, with Internet access universal, inexpensive, portable, and easily available, there is absolutely no reason why a school as a geographical location needs to exist. Schools could probably function almost totally through their websites.

Once schools are operating primarily through telecommunication, it logically follows that guidance programs could do the same. Personal and career counseling are already being offered on some websites, and there is no reason to expect the trend to slow down, especially considering "Internet use has grown an astonishing 65 percent" just in the last year

(Jaco, 1998, p. 7).

We envision the guidance program of 2021 as potentially consisting of parents, teachers, students, and counselors communicating through the medium of networked computers. The counselors will be able immediately to transmit various kinds of information to interested subgroups via the twenty-first-century version of mailing list servers and bulletin boards. Group and individual counseling sessions could be conducted via interactive videoconferencing. Career development could be enhanced via virtual reality experiences with various occupations, culminating in virtual reality job interviews.

We qualify all the above statements with words such as *could* and *might* because schools (and their associated guidance programs) are notoriously slow to change. Most of us, in walking into a contemporary school, would find it little changed from the schools we attended 10, 20, or 30 years ago. It is true that we might find some computers there, but they would likely be old, out of date, and little used. And this situation is frequently exacerbated in poorer schools. Therefore, although we hope that guidance programs of the future will take advantage of the incredible developments in technology that are certain to occur, we fear that we may be overly optimistic.

The World for Which Students Must Be Prepared

Like Johnson and Johnson (1993), we believe (or at least we hope) that accountability in the form of results-based programs will dominate guidance models of the future. One of the major results for which guidance programs have always strived is to prepare students to become productive members of the workforce. If guidance programs of the future are to help prepare students to enter the workforce, the facilitators of these programs must have a clear picture of what the world of the future will look like, and an even clearer picture of what the world of work will look like. Once we can envision these worlds more clearly, we should be better able to prepare students to succeed in them.

In envisioning the world of 20 years hence, the scenarios tend to fluctuate between those from a pessimistic point of view and those from an optimistic point of view. The pessimists like to point out the problems and dangers inherent in the use of the new technologies. Sometimes these problems seem relatively trivial. For example, a refrigerator that is supposed to sense when you are out of milk and order it from the market would probably have to be designed with sensors to detect the weight of the milk carton. These sensors would only function properly if the milk were returned to the same place every time. But what if your child put the milk on the bottom shelf instead of the top shelf? (Guernsey, 2000) More frightening scenarios have been proposed by Joy (2000), who feels that "genetic engineering, nanotechnology, and robotics . . . carry a hidden risk of huge dimensions" (p. 9). With regard to genetic engineering and robotics, he points to the possibility of bio-engineered plagues and robots so much more intelligent than humans that they come to consider humans expendable. He also notes that the materials created with nanotechnology might be foreign to our environment and could destroy our existing biosphere. Of more immediate concern to counselors and educators, the data on whether computers actually aid learning in school are still not completely in. For example, there is evidence that reliance on computers for routine drills in math classes actually decreases math performance compared to instruction by a live teacher (Mathews, 2000). A pessimistic scenario for the future world of work is often articulated by Robert Reich, the former Secretary of Labor under the Clinton administration (McGuinn & Raymond, 1998). According to Reich, the "blue collar/white collar" labor classification that has dominated the work world since the industrial revolution is rapidly becoming a thing of the past. In our information society, good jobs will require more training than ever, and full-time positions will give way to freelance talent for hire. Most of these workers will telecommute to their offices.

With the demise of the blue collar job, Americans with only a high school education cannot ever expect to earn comfortable middle-class salaries as they have in the past. Robots are already capable of taking over all unskilled assembly work and can be expected to move rapidly up the ladder. At best, unskilled workers can probably expect to become low-paid personal service workers, although not many of those jobs will exist either, since most of them will be moved overseas or replaced by computers. Reich predicts that middle-class jobs will be those requiring training, especially upgrading of computer skills, beyond a high school diploma. He points to high-tech auto mechanics as an example, and suggests that most of these employees will be trained by community colleges and private technical schools. Finally, he believes that the upper class will consist of persons with advanced graduate degrees focusing on an intensive ability to manipulate knowledge and information.

Computer scientists, physicians, and investment bankers are a few of the professions he cites as comprising this twenty-first-century upper class. We view this scenario as more pessimistic because Reich tends to emphasize the kinds of jobs that are likely to be lost, the lack of financial security for individuals, and the difficulty of revamping the educational system when he talks of the future work world.

A more optimistic scenario of the future work world is often offered (Davis & Wessel, 1998), especially by those actually dominating the telecommunications industry, such as Bill Gates (Gates et al., 1998). Although Gates has recently been attacked by the Justice Department for monopolistic practices on the part of Microsoft Corporation, he clearly has been able to anticipate computing needs and future trends in the telecommunications world. He predicts that entire professions and industries will fade as new technologies develop, but he also predicts that new ones will flourish to replace them. He notes that the personal computer has altered and eliminated some companies (e.g., typewriter manufacturers) but that overall the microprocessor and personal computer have created a burgeoning new computer industry that has produced a substantial net increase in employment. Even most workers who were laid off by now-defunct companies have found employment within the computer industry. He draws the analogy to the time prior to the industrial revolution, when most people lived and worked on farms. "If someone had predicted back then that within a couple of centuries only a tiny percentage of the population would be needed to produce food, all those farmers would have worried about what everyone would do for a living. The great majority of the 501 job categories recognized in 1990 by the U.S. Census Bureau didn't even exist 50 years earlier" (Gates et al., 1998, p. 253).

Attali (1998) also believes that the majority of the jobs of the twenty-first century do not yet exist today. He predicts that occupations will continue to become more and more diverse. He notes, for example, that the 30 most common occupations of today employ only 50% of the population, whereas they employed 75% in 1900. Further, most of these 30 most common occupations now require some extent of computer literacy.

He predicts a fascinating compendium of occupations of the twenty-first century (Attali, 1998), some with titles already in use, some of which he has created. These titles include microsurgeon, corporate lawyer, computer repair person, software patent specialist, inspector of author rights for computer games, Internet advertising specialist, Internet conceptual technologies specialist, software graphics creator, director of high-tech companies, insurance agent for risky innovative software, genomician, esthetic engineer, nanotechnology specialist, genopharmacist, and cloning technician. He also outlines the occupations (many of them in the personal service field) that currently exist for which he believes there will always be considerable demand: gardeners, janitors, medical assistants, continuing education specialists, teachers, psychotherapists, counselors, resume specialists, human relation analysts, manicurists, actors, salespersons, cooks, and skilled artisans.

We would add to Attali's (1998) predictions that the explosive growth in Internet use will also mean that an ever greater percentage of the population will work from home. "By the year 2010, 40 percent of all Americans are expected to be self-employed" (Jaco, 1998, p. 7), and even large corporations are expected to be little more than networked computers.

The ideas presented in the previous paragraphs all suggest that in terms of "results," there is little doubt that guidance programs of 20 years hence must prepare the huge majority of their students to (a) enter technical fields, (b) adapt themselves to extensive telecommuting and the lifestyle that it entails, (c) prepare primarily for self-employment or freelance employment, and (c) live an extremely long time.

In this article we have tried to outline some of the features of the world of 2021 that we expect to be affected by current trends in computer science, telecommunications, and biotechnology. As is so often the case, however, the only things we can predict with any certainty are change and the ever-accelerating rapidity of change. For example, as we wrote this article, almost every day we came across a newspaper or magazine article, or information on the Internet, outlining a new technological development or new finding that we felt we should mention. If guidance programs of the future are to plan successfully for change, they must find a structure that allows virtually instantaneous adaptation and accommodation to new information and developments. We sincerely hope that if we walk into a school in 2021 and observe the guidance program in operation, we will see both a physical plant and a provision of services that would be unrecognizable in today's world. Otherwise, it would be unlikely that the school and guidance program had prepared successfully for change.

References

Attali, J. (1998). *Dictionnaire du XXI siècle.* Paris: Fayard.

Davis, B., & Wessel, D. (1998, May 5). Broadly shared prosperity: Why the middle class will do better in the decades ahead. *Wall Street Journal Interactive Edition,* HYPERLINK [Online]. Available: http://interactive.wsj.com/

Flynn, J. (1997, June 23). British Telecom: Notes from the ant colony. *Business Week* (European Ed.), 61.

Gates, B., Myhrvold, N., & Rinearson, P. (1998). *The road ahead.* London: Viking.

Gershenfeld, N. (1999). *When things start to think.* New York: Henry Holt & Co.

Gross, N. (1997, June 23). Into the wild frontier. *Business Week* (European Ed.), 44–52.

Guernsey, L. (2000, April 17). Is it smart to make refrigerators think? *International Herald Tribune,* p. 13.

Isaacson, W. (1998, April 13). Our century and the next one. *Time,* 30–35.

Jaco, J. L. (1998, March). Preparing for the future. *Counseling Today,* p. 7.

Johnson, S. K., & Johnson, C. D. (1993). *The new guidance: A systems approach to pupil personnel service programs.* Fullerton, CA: California Association for Counseling and Development.

Joy, B. (2000, April 19). The dangers of new technology. *International Herald Tribune,* p. 9.

Judge, P. C. (1997, June 23). MIT: Two big rivals on campus. *Business Week* (European Ed.), 56.

Kahu, M. (1998, March 16). As science finds answers, it uncovers questions. *Los Angeles Times,* p. B2.

Kolata, G. (1998, May 4). A cure for cancer? Elated doctors cautiously point to healthy mice. *International Herald Tribune*, pp. 1, 10.

Margolis, J. (2000, March 6). Cutting edge humanity. *Time*, p. 40.

Markoff, J. (1998, April 30). Quantum computing takes a quantum leap. *International Herald Tribune*, p. 12.

Markoff, J. (2000, April 24). Microsoft cofounder closes California research lab. *International Herald Tribune*, p. 11.

Mathews, J. (2000, May 2). Do computers aid learning in school? *International Herald Tribune*, p. 9.

McGuinn, D., & Raymond, J. (1998, February). Workers of the world, get online. *Newsweek*, 32–33.

New York Times. (2000, April 30). Success in gene therapy at last. *New York Times*, OpEd page.

O'Hamilton, J. (1997, June 23). Stanford: Eggheads and entrepreneurs. *Business Week* (European Ed.), 55.

Port, O. (1997, June 23). Dueling brainscapes. *Business Week* (European Ed.), 53–54.

Rogers, A., & Kaplan, D. A. (1998, February). Get ready for nanotechnology. *Newsweek*, 52–53.

Silver, L. (1998). *Remaking Eden*. New York: Avon.

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