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## INFORMATION: THE GLOBAL COMMODITY

Energy technology powers the human enterprise, but information technology empowers people, things, institutions, and nations. Nothing since the beginning of the Industrial Revolution has affected the human condition as positively as information technology. The only technology to approach it in significance is electricity, which turned night into day and gradually reshaped most social and personal activities. Information technology is everywhere and in everything.

The first phase of the Information Age drew to a close in the late 1980s and early 1990s. Three fields we recognize as basic today — telecommunications, computation, and imaging — had by then progressed to the point that technologies under those rubrics had developed into relatively complex technical, business, personal, and social systems. The transition to the current phase of the Information Age is marked by massive integration of all three of those systems as well as the convergence and interchangeability of their components. By 2005, television, broadcast, cable, satellite, and various forms of wireless communication had become so thoroughly meshed that there is no significant difference to the user, but only to those responsible for their technological and social management.

By 1990, the early mainstay of modern computation, the so-called mainframe, had been largely superseded by broad-scale applications of smaller computers of all sizes and by the linkage of smaller computers to massive parallel processing machines. By then, the computer had also burst out of the confines of fixed facilities. The computer by the year 2000 became a component of virtually every product and every technological system. This concept was labeled “mechatronics,” implying the combination of mechanical and electronic capabilities.

The launching of the current phase in terms of image technology is even more striking. Photography, cinema, video, bar codes, facsimile, and numerous other areas had developed as technically and economically inde-

pendent enterprises. With the advent of universal digitization of data and low-cost, high-capacity telecommunications and high-capacity computers, all those technologies fused into telecommunications as we know it today. It is useful today to talk about information technology in the somewhat obsolete categories of the last century, because it causes us to tease apart the conceptual components of our information world, which are so entwined that we often fail to see their distinct elements.

### Data to wisdom

Information technology in the last half century has affected information in four stages. The early use of information technology was as a mechanism for collecting, processing, and presenting data. The next significant stage was the interpretation of that data with the assistance of machines, to convert it into information. That stage spanned from 1975 to 1995. Emerging out of that presentation-of-information phase was the development of systems that went beyond information to generate knowledge. For example, in scientific laboratories machines create new models, new pictures, new images, and new ways of designing and building molecules. In quite different ways, expert systems have radically altered financial services, medicine, design, and scores of other activities by creating knowledge from information.

The fourth stage, wisdom — the understanding of how one should use information and knowledge — is the goal still sought. The acute awareness of our lack of wisdom is highlighted by the fact that the Harvard Business School, the University of Chicago, the University of California-Berkeley, and Iowa State University have shared in a \$26-million grant to set up programs of “Wisdom in the Information Age.” Because the grants were made in 2021, it is premature to expect or describe significant results. The grants have spawned imitators in 75 universities and 14 commercial and private think tanks.

The emergence of the three broad families of information technology and their interchangeability led to what had been called “systematization” of information technology, the linking of everything to everything else. By the 1980s, it was common to talk about networks. There was even nomenclature for local area networks (LANs), wide area networks, and metropolitan area networks. These networks evolved under different business auspices for specific purposes.

It is difficult to believe today that as recently as a generation ago, large blocks of the populations of World 1, the most advanced nations, were put off by information technology. They even had a terminology about the preferred interfaces being user-friendly. Computer users then sought systems that were interactive, forgiving, and helpful. Today, it is difficult to imagine systems not being robust in the face of our errors and ignorance and unable to teach and train us in their own use.

## **A U.S. CASE STUDY — Information technology remakes a society**

While the last generation's basic changes in information technology have already been mentioned in passing, it is worth noting that the reason we have such difficulty in appreciating the ubiquitous effects and power of information technology today is that, to a large extent, they are invisible. Virtually all communications networks have become a matter of total indifference to the user, because systems are intelligent and take care of integration on their own. Although the devices we use are visible, the rest of the technology is not.

### **Soft intelligence**

At the end of the last century, a great deal of empty hurly-burly occurred around the concept of artificial intelligence and the related category of expert systems. Many people who believed that intelligence was an exclusively human characteristic were offended by the thought that a machine could be intelligent. Eventually, however, artificial intelligence software became common, and folks began to advertise it as "soft intelligence," which was contracted to "SI." SI has become a virtually universal characteristic of all organizational enterprises. Not only is SI used to introduce vision and speech into systems, but also it is extensively used as an augmentation of virtually all professional work and is a common tool in all kinds of network management, whether electronic or other. Also, SI has become a primary factor in educational technology, in allowing the teaching system to respond to the level of knowledge of the student, to the material to be transmitted to the student, and to the preferred learning strategies of the student. Although the nomenclature battle has been lost, the substantive war has been won. The result is that SI is virtually everywhere and is the key to many of the new innovations such as the application of virtual reality to simulation, training, and recreation.

The effect is even more striking with computational tools. The vast number of embedded computers (5.6 billion in 2022) and the associated sensors and actuators in devices everywhere has made the bulk of computations not only invisible but a matter of complete indifference to us. We are aware of the devices that we choose to interact with, but a generation ago the keyboard and the awkwardly manipulated, so-called mouse were almost the only means of access. Today eye, voice, sound, and pointing finger are the primary interfacial tools.

Imaging technology is universally visible, but again, how it works and the technologies for controlling it are invisibly embedded in devices and systems.

Let us look at some of the high points of information technology today.

Screens, early known as flat screens, have revolutionized architecture and design. The typical business has 2.6 screens per worker. The typical upper-middle-class home in the United States now has 37 screens. Screen technology took off with the development of the high-definition television at the turn of the century, which made it practical to have aesthetically satisfying screens of any size from the four-square-centimeter lapel screen to two-meter wall screens. At home the screens are no longer furniture — bulky boxes

taking up floor space — but have become wall and surface decoratives, both aesthetic and entertainment sources as well as functioning work tools of the household.

Knowbots boomed when three things came together: (1) the ability to commission a search of an information system with relatively simple oral commands, (2) the assignment of knowbots to individual users by name and confirmatory identification number, (3) the knowbot was given a humanlike form.

## **My favorite knowbot**

Some people choose to have a knowbot look like Santa Claus; others, a cartoon of their grandfathers; others choose arbitrary, privately designed figures or copies of commercial figures. The most popular ones are George (Washington), since that knowbot never lies, and Data, which is a play on an old television series character. The third most popular is Nemo, the ship captain in Jules Verne's *Twenty Thousand Leagues Under the Sea*. *Nemo* is Latin for *nobody*.

Talk-listen-read, the ability of devices to both listen to standard language and to talk, is now universal. Other devices have the capability to read the written word. One of the interesting side effects was the reintroduction of penmanship into schoolrooms in 1998. The talk-listen-read capability has practically eliminated the keyboard except for the Infoquarians, a club whose members use obsolete equipment for nostalgia and fun. The favorite is the Macintosh II used in 1987. Extremists use quill pens.

Mechatronics has already been mentioned. The embedment of computer chips coupled with sensors and actuators has made everything smart. The smart house has on average 241 embedded mechatronic devices. The most striking application of the mechatronics concept around 2010 was to water and sewer systems. Another striking example was the application to building large, relatively featherweight structures in which the whole building dynamically responds to forces and pressures operating on it. The Mechatronic Society of America estimates that, as of 2023, 16,000 products in commerce have mechatronic capabilities.

Compact interactive video discs are a mainstay of the operation, maintenance, repair, and service sector. All complex equipment comes with its own video CD explaining how to make repairs and demonstrating repairs from the point of view, vision, and angle of the person making the repairs. They have been a great success and are available in multilingual form. General Motors, a 20th century automobile firm, introduced instructional CDs in 1997 as a sales stimulus. Many people prefer direct broadcast to the cumbersome CDs.

Photonics, beginning about 2002, made deep inroads into silica-based electronics dominating computers for a quarter century. By 2020, 90% of all microprocessors were photonic. The bulk of the traditional silicon microprocessors were used for replacement parts. Photonics offered higher speed and simpler integration with fiber-optic communication.

### **Personal communicators—personal identifiers**

The personal communicators were the precursor to a system of communication that depended not on the location of a telelink but on following the individual wherever he or she went. The complete integration characteristic of The Network made this practical. As one might expect, however, all good things have their abuse. Rock stars, actors, many public political figures, were ceaselessly harassed by people who could buy their personal identifier numbers. Many other people found that the personal number facilitated harassment sometimes in the form of repeated calls and other times amounted to cutting a person off by a group overloading the system by repeatedly calling the number.

Things began to settle down after about 2010 so that today 57% of the population have personal identifiers, and 36% of those have unlisted numbers. It is estimated that another 7% work with a pseudonym. Apart from the high abuse potential for prominent figures and victims of harassment, it is a widely accepted and much-welcomed technology. It has spawned a number of subsidiary activities, such as renting a personal identifier in connection with travel to obscure or dangerous places, whereby the personal identifier is merely the sponsoring company's code number.

Encryption has been a thorny issue for over half a century. The waning of the East-West conflict in the late 1980s and early 1990s led some to believe that the need for national security would be diminished. However, the rise of the half-dozen mid-size military powers and the last seven wars involving United Nations intervention have made it clear that encryption for military security purposes must still be with us.

Business and industrial security has become the bone of contention in encryption. The Supreme Court found in 2003 that the National Security Agency (NSA)-White House plan for limiting encryption codes was a violation of First Amendment freedom of speech. There has been a rapid proliferation of private encryption technologies since then.

Digitization of all data has made text, numeric, audio, and visual images fully manipulable in storage, transmission, reconversion, and, most significantly, intermixing. Digitization effectively has made all the databases of the United States into The Database. Digitization has also led to the proliferation of image entertainment in which the purchaser substitutes for the original stars.

Digitization has made computer monitoring and control practical in increasingly broad areas, since systems can now feed their data into a central controller more readily. Digitization has also led to the creation of many counterfeit, false, or artificial documents; anything that is graphic or acoustic can now be thoroughly manipulated to any size, shape, format, or apparent age, with any other visual, acoustic, or numeric materials.

The long-time pattern of computer capacity doubling every 18 months held true for a surprisingly long time. The first teraflop computer was introduced in 1998. Many people saw that as the end of that pattern. Computer capacity continued to grow as forecast through 2017, when the rate of improvement began to substantially fall off. Computers today are 5,000 to 10,000 times faster than they were in 1990.

With each tenfold or hundredfold increase in computer speed, new practical problems were embraced in direct real-time control or manipulation. For example, the dynamic management of street traffic became practical around 2004. The ability to control and manage a street network of 1 square kilometer to optimize traffic flow and to interface with adjacent square kilometers with only somewhat less reliability, was dependent on computer capacity, models, and sensors.

## How we got where we are

Throughout the second half of the 20th century, the automobile accounted for 10% to 11% of the GDP, counting original sale, servicing, maintenance, repair, and collateral industries. The information-technology-based industries far and away swamp that modest contribution to the GDP. It has remained for the Department of Commerce to tease out the exact contribution of information technology to the economy, since so much of it is built in, embedded, and hidden in everything from construction to services. The most conservative estimate is that information technology now accounts for 40% of the GDP. That is easy to accept when one realizes that of the total workforce, 64% are information workers and 14% of those are full-time information workers. A more generous estimate puts information technology as 53% of the GDP.

### Tools of the Information Age

- Flat screens
- The Network
- Knowbots
- Universal telecommunications
- Talk-listen-read
- ID cards
- Personal communication numbers
- Geographic information systems
- Chemical tags
- Simulation
- Universal digitization
- Smart cards
- Mechatronics
- Photonics
- Robotics and automation
- Fuzzy software
- Satellite and wireless systems
- Image manipulation
- Soft intelligence

With a family of technologies so universal in application, it would be unrealistic to attribute development and evolution to any single or small set of variables. Complex situations have simulated the perpetual need for a means of dealing with complexity, which often amounts to information management. On the other hand, each new capability creates a fresh complexity. The expanding spiral of complexity in our technologically dependent world lies at the core of the evolution of the Information Age. The continual pressure for

ever-higher market performance implying ever-lower costs seems to be endless and led to the commoditization; that is, making commodities of virtually all of the information technologies and services common from 1980 to 1997.

Factors driving the Information Age are:

- Continuing pressures for improved productivity.
  - Today manufacturing in the United States, which is the world's second largest manufacturing nation, accounts for 18% of the GDP, and employs only 4.1% of the workforce. In this century, manufacturing has made the same shift that agriculture did in the middle of the 20th century, replacing human labor with information largely in the form of automation.
- Pressures for speedier, faster, and more reliable delivery of goods led to extensive networking in all logistics systems for management and control.
- New technology has continually opened up new opportunities for further productivity improvement and new products and services.
- Demands for convenience, efficiency, time, mobility, quality, entertainment, and ease of use, as well as distributed work (that is, work outside the traditional office), were powerful incentives for cheaper, more rugged, more mobile, and highly individualized systems and subsystems. Mobility and convenience are a regenerative cycle: each step stimulated the other's next step.
- The rise of knowledge work and the associated information tools makes much of knowledge work independent of time and place.
- Information overload was a much-talked-about problem late in the last century and early in the present century, but that problem disappeared with the advent of the multidimensional, dynamic, and interactive devices. The users of today's systems have unprecedented control over information flow. Many people choose to use the built-in stress sensors that determine whether they are psychologically moving into overload.
- In the second half of the 20th century, the beginning of mass data collection by old methods created issues of access. The automation of record-keeping was the two-edged sword that provided both safeguards and more potential opportunities for abuse by both private and public organizations. The situation described under "Issues of the Information Age and Their Resolution," below, seems to have come to a relatively successful resolution of those pressures, at least for the present.

## 2025

- The globalizing of all the world economies, which evolved rapidly in the late 1990s through 2005, created pressures on corporations to be able to operate in all places at all times at all distances with minimum delay and minimum movement of people.
- Government was the primary and most obviously significant respondent to the growing complexities in the economy. Fifteen to 30 years ago it found itself constantly pressured by a rapidly changing pace of business and by globalization and it had to resort to increasingly sophisticated technological tools for monitoring, regulation, and control.
- Environmentalism and its associated concerns for energy and resource conservation has been a factor in the promotion of both visual and traditional data collection to promote a sustainable society and environmentally benign business practices, products, and services. Information technology has become the primary instrument of the environmental movement.
- Military and government R&D, reflecting a split interest in national security, has been a great stimulus to the Information Age. Traditional and military concerns in the 174 countries and sovereign areas of the world have led to much more complex planning for a much larger number of military and quasimilitary activities. Government has consciously recognized since 1999 that economic security was a key element of national interest. That has been a stimulus to unprecedented developments of national and international statistics by the federal government.
- Unlike population growth in the other advanced nations, the U.S. population grew substantially since 1990, adding some 65 million people to the 255 million then. This provided a powerful incentive for internal economic growth, innovation, and the adoption of new technologies.

## **A generation of technological integration and economic expansion**

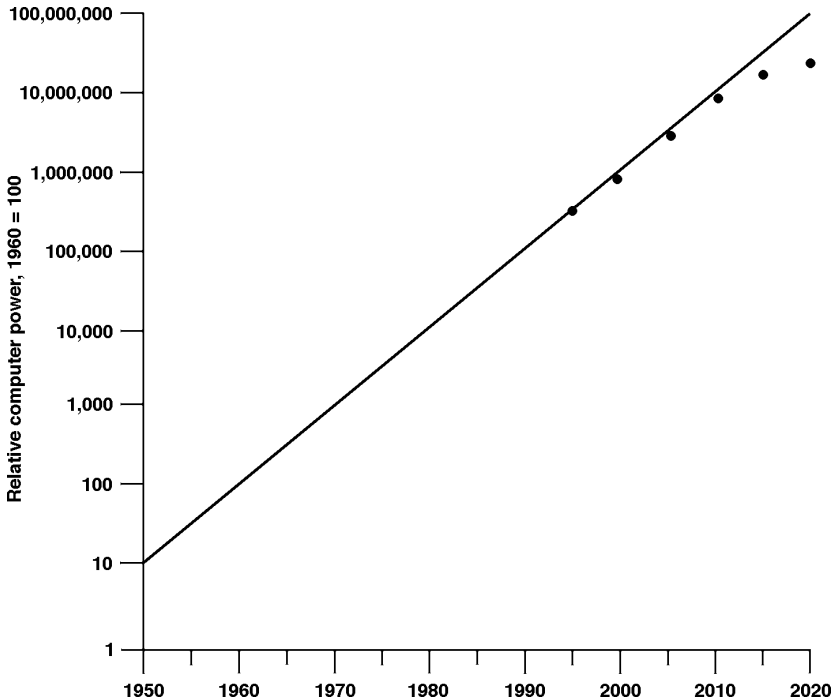
The simplest way to capture the scope of information technology today and the radical changes it has brought about in the last third of a century is to look at some of the quantitative and institutional changes in that interval.

- Internet became prominent in the 1990s and was superseded by gigabit networks around the turn of the century, and by 2007 terabit networks were common. Broadband interactive services digital networks

(ISDNs) were laid in place by 2005 and continue their expansion. The ISDN was critical to the development of The Network, since digitization of all data is one of the core developments in the Information Age.

- In 2005, optical fiber to every new home, building, structure, and new facility, was mandated by federal law. Optical fiber to already constructed homes had reached 72% in urban areas, and 14% in smaller and rural communities. Universal fiber to the home (97%) was achieved by 2022.
- High-definition TV, the first breakthrough in large-size screens, occurred in the late 1990s. It was given tremendous stimulation by the integration of the telephone and cable systems and led to the nearly universal availability of video on demand by 2006. Three-dimensional television became common (22% penetration) by 2015.
- Universal wireless coverage reached all communities of 100,000 or more by 2003, and all counties of 250,000 or more by 2004. Mobile video telephony achieved the first practical application in 2001. The associated surge in automobile accidents, however, led to legal restraints with slow growth, particularly in buses and certified work vehicles, through 2017.
- The increase in microelectronic chip capacity slowed from 2015 to today. From 1995 through 2012, doubling continued roughly every 18 months. Doubling time currently is about 4 years.
- In 2008, chip density reached 250 million transistors per chip. In 2017, one billion transistors per chip were achieved, but that never reached the market in significant numbers.
- The Network, which can be looked at as an integration of smaller telephone, cable, wireless, and computer networks, has grown tremendously. In 1988 there were 3.7 million LANs; today there are 11.6 million LAN equivalents in the United States.
- In 1995, there were 70 billion minutes of international telecommunications traffic. By 2010, that had reached 700 billion, and today (2025) it is 1.3 trillion. Thirty-five percent is machine-to-machine communication, 20% is person-to-machine, and 45% is person-to-person.
- Lassettre made an interesting forecast in 1991 of computer power growth. His forecast, reproduced below, is overlaid with the historic data from 1995 to the present (dots).

## Computer Power Growth



Source: E.R. Lassettre, National Engineering Consortium, *2021 AD: Visions of the Future*, 1991, p. 49.

## Some unexpected developments in the Information Age

Before turning to specific changes in various areas of society that accompanied the movement into our Information Age, it is worth noting some unexpected consequences.

*New modes of thinking.* Advanced computer technology and imaging by the late 1990s resulted in the widespread use of computers that were interactive with the user. These computers were dynamic insofar as things moved across the screen and were three-dimensional, giving a depth to imagery that was surprising. Furthermore, the screens were no longer merely screens but were multimedia with acoustics and voice to accompany images. The most important consequence of multimedia machines was the new modes of thinking. By 2003, it was clear that many people over age 30 were not able to work with the new technology to its fullest capacity. This put a high premium on younger workers, and it was a stimulus for introducing computer-assisted and other high technologies into colleges. It also quickly propagated down into secondary schools.

*Language* has been reshaped in the Information Age.

*Psychiatric consequences.* The development of technologies for consciously manipulating brain function, enhancing creativity, increasing stamina and performance, influencing attention, giving what was, in the old terminology, a "psychedelic experience" and feelings of exultation are all well known. The effects, however, on the morbid mind were also interesting. The first case of paranoid schizophrenia reflecting the Information Era was in 2007, where patient X reported that in his delusion, "nothing talks to me." There has also been a group of schizophrenics who seek to "release the person from the system." Some believe that their knowbots are real and that they are the agents of alien galaxies here to take over our world. Others believe the knowbots are their captured souls.

*The partial or total rejection* of the information era is reflected in the clubs and associations that celebrate earlier times using old technology such as word processors and even typewriters and pens. They take great pride in mastering obsolete and purportedly more humane technology. It is a hobby or commitment on the part of different people.

*Strong resistance* has been met in seeing art, health, literature, and political interactions as mere information. There is great resistance on the part of many people to the handling of that material in the same categories in which we handle more traditional and routine information.

*Affinity groups*, that is, groups of people voluntarily coming together because of some common interests, have flourished in the last quarter century, belying the early belief that information technology was isolating and alienating. The overwhelming number of people in the advanced nations have expanded their orbit of connections, although research shows that these new contacts are generally topic-specific. By concentrating on the intense interest of the participants, they prove on balance to be most satisfying. In 2015, the Massachusetts Institute of Technology (MIT) Laboratory for Telesocial Studies showed that in 2002, the 2,000 contacts that the average middle-class citizen had over a lifetime in terms of personal face and name recognition had been augmented by 68 GlobeNet contacts, 80% domestic and 20% overseas. In the course of a lifetime, the total number of GlobeNet contacts will run to approximately 1,600. GlobeNet has for billions of people meant the end of boredom.

*Farming* is an example of continuity and change as a result of the movement to the Information Era. Growth of the large industrial farms slowed during the 1990s as they went for more intensive agriculture and the transition to a less chemical- and pesticide-intensive agriculture. The greatest effects, however, were on the small- business farm, capitalized at \$200,000 to \$500,000. They became information-driven just like the rest of business, with information and electronic controls managing feeding, grain stock, planting, and soil treatments.

The most dramatic effect was the resurgence of what have come to be called “hobby farms,” usually run by people who had small land holdings and where both the man and woman of the family work off the farm for primary income. The other kind of hobby farm is run by exurbanites who have moved to rural areas or to the metropolitan fringes to farm a few hectares and have struck a felicitous balance between old-fashioned agriculture and the use of modern information as their key planning tool.

## Effects of the Information Age

Information technology is the only truly universally enabling technology. From 1980 to today there have been four primary enabling technologies: information, genetics, energy, and materials, but only the first has been universal in its applications and consequences. It is referred to frequently in the other chapters.

### The home

Home life has been radically altered by information technology. The home has become safer and more secure, both from human and natural intervention, from accidents, emergencies, and disasters. Eighty percent of midpriced and 100% of all high-priced homes are smart, and over half of the less-expensive homes have some smart features.

The spread of distributed work, particularly work-at-home, has led to the rapid evolution of the home work-study center (HWSC) center, sometimes called the work-study-entertainment center, as the centerpiece of domestic life. An *ad hoc* consortium, “The Home for Millennium Three,” in 2005 held a nationwide contest for the design of an electronic home work-study-entertainment center. The top five winning designs were built as prototypes. That launched work-at-home in a new, positive direction. The HWSC is the place where the adults in the family do a portion of their work, the children reach out to the resources of the world, and the family seeks entertainment, recreation, the pursuit of hobbies, and a wide range of social contacts.

By 2005, 19% of the workforce was in distributed work. By 2024, 39% was in distributed work, that is, working at some location other than the traditional central workplace at least two days a week. The average time is 4.5 days per week for those in distributed work.

### Recreation and entertainment

One effect of the Information Age has been to promote all kinds of scorekeeping, for personal performance, group performance, and team performance. The information era has also seen the rise of new kinds of enter-

tainment and recreation as well as massive public competitions. One of the more interesting elements of the information era has been the rationing of limited public recreational space such as access to the Appalachian Trail and access for climbing the most popular mountains. The nationwide system of certification provides access to those who can make the best and fullest use of the restricted facilities. The rationing operates not by money but by skill and competence. One consequence has been the spinoff of many kinds of training programs to qualify for those new steps-up. For mountain climbers, there are six certification grades, each about one-tenth the size of the grade beneath it. For example, only 1,000 people worldwide are certified to climb Everest and Annapurna.

## **Work**

As early as 1993, 60% of the workforce was in information. By 2006, this peaked out at 66% using the obsolescent nomenclature. The method of tallying work categories that was developed in the 1940s proved unreliable by 1980. The new organization of work that was proposed in 1997 and partially implemented by the government in 2001 had become standard by 2005. Consequently, the transition of work categories from the Industrial to the Information Era has not been smooth or clear. Today, well over 98.5% of all work involves some use of information technology, whether direct or embedded.

The displacement of manufacturing workers from 1980 to 2005 created a number of social proposals. One proposal that was put forward in the 1980s for distributing the benefits of manufacturing automation was given a try around 2007. The concept was to have individual citizens, nominally displaced workers from manufacturing, own robots and lease them to manufacturers as a source of income. The National Federation of Robot Leasers was formed, and the system worked within limits. But by 2015, the system effectively withered away for lack of interest.

## **Science and technology**

Almost all scientific research is pure knowledge work. Even empirical field work now involves extensive use of space satellites. The collection of ground data by video, audio, and other sensors, night-and-day, round-the-clock, is routine. The development of miniature and full-scale artificial animals from insects to hippos has added new understanding to ethology and animal behavior and has been a primary component of ecological management.

In more traditional laboratory sciences, the universal availability of information technology and multidimensional modeling have drastically reduced the amount of hands-on experimentation and greatly increased the

amount of experimentation and design on computers. In many of the most advanced laboratories, the experiments themselves are automatically set up and operated by labots. The old smell of the lab and the touch of the equipment is alien to most working scientists.

## Health and medicine

The health care debate of the late 1990s gave unexpected impetus to the automated medical center. Based on the work of Project Caduceus, there was the now-popular proliferation of shopping mall and work-site health centers. These are expert systems tied to physical equipment. Typically, the way the earliest versions worked, a person walked into the center, was greeted electronically, asked to urinate into a bottle, spit into a test tube, puncture the skin to get a blood droplet for the slide, and place each of the containers into the appropriate receptacles. While the samples were being processed, the person sat at the Caduceus and engaged in a medical dialogue. Effectively Caduceus did everything that a physician at that time did on the first two visits, including presenting alternative diagnoses, the need for further tests, and the subsequent diagnosis on the completion of the tests.

The early version of Caduceus could diagnose 614 diseases. The system has measurably reduced health-care costs in the United States. At the same time, it has given people great confidence in the services that they are receiving. The current system Pasteur is the fourth-generation descendant of Caduceus.

In the last few years, typically 74% of the U.S. adults have used Pasteur, and 84% of urban families with children have used Pasteur.

## Education

The effects on education have been three-fold, representing the effective meeting of the 100-year objectives of public education in the United States:

- Universal Education
- Lifelong Education
- Individually-tailored Education

Educational tools and apparatus are everywhere. Although nearly all children (96.3%) go to a public institution for schooling, the experience is hardly like what was provided in the schools of the 20th century. The in-classroom learning time has shrunk greatly, and the schools are directed at physical, social/interpersonal, and artistic development. The educational components of traditional reading, writing, and arithmetic are split 60/40 between school and

home. For high school students, the shift has been even more striking to a 40/60 split. High school is primarily for interpersonal development, hands-on activities, and group activities such as teams, theater, and song.

College just is not what it used to be. The typical student now enters college with one year of advanced placement, and it is not unusual for extremely bright students to earn two-and-a-half years of advanced placement. The college is primarily a social acculturation institution for youth and young adults. It has also become a site for continuing education by people of all ages.

The sea change in education in the United States has been the shift from primary, secondary, and tertiary (college) to quaternary education, that is, lifelong, individualized education. The sites of quaternary education are 50% at home, 15% at work, and 35% elsewhere.

Video University has one to 16 alternative versions of every college and university course offered in the United States and Canada. It also has selected courses in 16 foreign languages for most of the 4 years of undergraduate work and a more limited amount for postgraduate training. These are routinely available in the classroom for subsequent collateral exercises with human instructors and professors or for rental at corporate facilities or for private rental use at home.

The major award in the field, the Athena, is given to the best instructor or instructor team in the arts, sciences, and social sciences and humanities, on a three-year cycle.

## The classroom in the Information Age

As a child grows older, school becomes increasingly a socialization institution, and more and more of the cognitive content of school is conducted off-site, primarily at home. Even socialization in the physical and collective activities in school has a strong information component. Fourth grade students collectively will build a building and subject it to a storm or hurricane. This is simulated on screens. In the seventh grade, 13-year-olds design and operate some kind of organization. It may be a Red Cross chapter, a business selling toys, whatever the group of four or five chooses to do. Perhaps the most interesting simulation is in the last year of high school. Typically, 16- and 17-year-olds team up to simulate a marriage and household, learning the ins and outs of income, expenses, planning, furnishing a home, confronting acts of God, and so on.

At each level, the traditional basic training in reading and writing, arithmetic, geography, and history is heavily augmented by work on computers and screens. Children early become virtuosos in both traditional reading of books and publications and contemporary reading on screens. Younger children particularly love the old-fashioned books because they can carry them, take them to bed and on trips, and hide them away. They enjoy the kinesthetic feel and smell of the paper. The individualization of education from kindergarten on allows each child to progress at his or her own pace, eliminating much of the sometimes adverse effects of one child being far ahead of his or her classmates in an open-classroom situation.

For very bright children, it is standard to begin research projects in second grade. For those in the 99.9th percentile, the research can be quite provocative and stimulating – anything from the origin of buttons to the history of Nepal. They find it particularly attractive working on The Network, where they are linked not only with their classmates but to children throughout the nation and in many cases outside the country, who share their special research interests. In the education of extremely bright children, a major component of socialization is to learn to tolerantly deal with less capable people. Socialization is often carried on through interpersonal simulations. One of the dramatic effects of the Information Age has been the flowback of college-level material into high school, and in turn the flow from high school into elementary school as children are able to progress intellectually at their own pace. The result is that a large percentage of students move into higher education with advanced placements.

Preparation for work life has always been a challenge for schools. Currently there are computer video games which present some 34,000 different occupations and crafts and are designed to acquaint the student with not only the superficial aspects of those occupations but the day-to-day nitty-gritty elements. One consequence has been a vast proliferation of vocational training, and diversification of childhood expectations for future employment.

## Criminal justice

Several components of the criminal justice system, police, corrections, parole, and probation, have been augmented in the last 15 years by crime prevention. All of those components depend heavily on information, with the most effective application being at the prevention and the parole/probation stages. Personal and family profile behavior analysis has gone far to identify crime-prone children and adults. It has been more successful with those prone to physical violence than with those open to commercial, financial, and information-related crimes. Similar results apply to parole, probation and corrections. As discussed below under “Issues of the Information Age and Their

Resolution," the applications of information technology in these areas are constantly interacting with the concerns for privacy and other civil rights.

Testimony and forensic evidence have been radically changed in the Information Age. The use of testimony from remote sites, the universal availability of video recordings, and the capability to take interactive testimony at distances, have greatly improved the efficiency of criminal justice, and, incidentally, of civil justice, proceedings.

## **Business**

The first effect has been to virtually wipe out the notion that a firm is in the shoe business or the food business or the lumber business or the hotel business. All of these enterprises are mere information machines that incidentally provide shoes, food, lumber, or hotel space. Information management has become the central focus of successful business.

The second effect on business in the information era has been to force organizations to not deliver a single product or a single service but to deliver total service packages. This is embodied in the concept of the integrated performance systems (IPSs), in which more and more companies sell outcomes, not products. For example, one firm sells energy, one sells health, one sells transportation, one sells housing, one sells food. The way this is done is, in many cases, to provide a total package that reduces costs, increases diversity, and most interestingly, has had profoundly positive effects on the environment. An IPS, on average, uses 34% less total energy and the system lasts 117% longer, with 80% less maintenance and repair.

## **Rural America**

Rural America was a primary beneficiary of the information era. Twenty-five years of rural decline, outmigration, job loss, and stagnation were reversed when fiber optics linked rural areas to metropolitan business centers and to global business centers. An equally dramatic effect was the expansion of metropolitan areas into sprawling suburbs. The changing patterns of movement to work and the large-scale growth of distributed work made it attractive, for reasons of time, flexibility, and the amenities of the open landscape, to move to the metropolitan fringes.

## **Disaster and risk management**

As part of the general trend toward a totally managed globe, the handling of both natural and human disasters has been improved by information technology. The most dramatic of these interventions is the San Andreas project, which is directed at relieving the stresses to prevent San Francisco Quake 3. The 7.8 earthquake that hit San Francisco in 2011 was enough to put the fear of the future into both the state and

federal government. The present projects involve a 2,000-kilometer stretch of faults and a complex daily and weekly schedule of lubrication (water injections) into the fault to steadily relieve the tensions that can lead to a big quake. The goal is to drop the quake by 5 orders of magnitude from one Richter 8 to thousands of Richter 3s. Injection, which has been in use since 2016, seems to be working. There is steady and measurable slippage. An average of 23 quakes per day occur in the 2.5-3.5 Richter range along the fault.

The effectiveness of emergency police, fire, and ambulance service, hinges on the fact that emergency vehicles have a built-in database that fully informs the crew chief during transit about the site of the emergency. In the last 20 years, deaths from fires due to toxic smoke inhalation have dropped 47%. Traffic accidents have had a 21% increase in survival rate in the same period.

### Government

Activities in government that parallel those in the private sector such as purchasing, hiring, and service delivery, have all changed in the same ways that they have in the private sector. The special effect of information technology on government has been to stimulate democratic processes. Scientifically impeccable wide-scale surveys are a routine part of local, state, and federal government. Much of government's personal services under the broad category of health and welfare are now thoroughly interactive. Close attention is paid to the quality and effectiveness in delivering services. This has enhanced services to the elderly, the indigent, and the handicapped. A study in *Political Science Review* in June 2014 compared the quality of legislative debate in terms of the detail of options considered, and found striking improvement between 1990 and 2014. The effect of the Information Age on the judiciary has been to accelerate the processes at state and federal levels leading to much more coherent pretrial preparation of material and to higher levels of interaction between jurists and contenders. The effects on the criminal justice system have already been noted. It is also worth noting, however, that the average time to final resolution of criminal trials has dropped 34% in the last 20 years. The effects are more dramatic in civil suits, in which the time to resolution has dropped 84%, not counting the large numbers that have been shunted out of the legal system to arbitration, conciliation, and mediation.

From 1998 to 2010, the postal service received a shot in the arm as it became the general electronic point of contact with government for large numbers of people. As The Network grew, however, that role of the postal service sharply declined, and it is now primarily effective in some rural areas.

### **Quality comes to religion and goes**

One basic effect of the Information Age on organized religion has been to open the system to the expression of the members in regard to shaping policies and practices. The second effect has been to widely expand pastoral services. Pastoral services do not solely involve clergy in one-on-one relationships to the membership, but often involve many-to-one, and particularly interesting has been the development of religious-based affinity groups under church auspices, which discuss various special interests or affinity group concerns.

In the early teens, with the great movement toward quality in the service sector, a number of churches saw that many of the religious functions are closely analogous to private-sector services. Because the quality movement had been so successful in the corporate world, the attempt was carried over to religious institutions. Lutherans and Roman Catholics, with their commitment to the confessional, albeit even then a declining enterprise, attempted to use quality control measures by assigning penitent code numbers, coding the penalties, and making a continuous record of the behavior of the penitent. All were maintained at a high degree of security by the pastor. After three years of experimentation in seven churches (two Lutheran and five Roman Catholic), it was concluded that the pastoral functions as reflected in the confessional had no significant effects on behavior, but did raise spirits.

## **Issues of the Information Age and their resolution**

The issues associated with the Information Age crop up at different places along the spectrum — from data to information to knowledge to wisdom. As is often the case, one resolution later leads to a new issue. Many would argue that if we did not collect certain data we would not be able to abuse it. Others argue that we need the data, and the problem is to safeguard it. Others argue that well-developed knowledge bases will provide their own unique safeguards. Lying in the background is the plea for us all to be wiser and more anticipatory in what we do.

Radiation health effects from the universal availability of information technology intensified as an important public policy issue in the late 1980s. In spite of increasing research, it never was clearly established that radiation from information technology was a health risk. High-voltage transmission lines, however, were established as a risk, especially to children, by 2001. The effect on information technology was to stimulate a round of designs to keep people at a greater and presumably safer distance from the radiators. The flood of innovative designs also introduced a new generation of enhanced technological capabilities.

Local confrontational challenges and codes limiting telecommunications had become the bane of the several industries involved. Fifty-four state codes and thousands of local variations had to be rationalized. The Supreme Court found that local restraints on rules and regulations governing information technology were in violation of the Constitution's Commerce Clause, and that all such codes and regulations were voided. Responsibility was totally with the federal government or through agreements with international organizations.

## The age of the image

Many folks believe that we have passed through the Age of Information and are emerging into the Age of the Image. Digitization of images has had dramatic effects on the way we do our recreation and entertainment. It has also shaped the way we think. One interesting commercial application is to pop a customer into a product advertisement. Food ads are particularly effective with this. A customer-of-the-week is selected by lottery and integrated into a food ad, with results often that are just cute, but sometimes strikingly hilarious. The incongruities between the character and the ad have drawn a great deal of public attention.

In home entertainment, personalized videos are now available. One hundred thousand were sold in 2019. Five million were sold in 2024. The technology is relatively straightforward, although complex in detail. A favorite film is the classic Charlie Chaplin, *The Great Dictator*. Another favorite is *Snow White and the Seven Dwarfs*. In the first case, typically a purchaser will have members of his or her family take the lead roles, and in the latter case, there is an intermediate process in which the family is cartooned before taking the roles.

Imaging has affected the way we process data. The ability to picture things in three dimensions and dynamically moving has long ago been used in the laboratory in genetic engineering and the design of proteins. That capability has moved into the general economy and into business. Flow models literally showing the cash flowing are now common.

The explosive development in imaging technology from 1995 to 2012 created widespread concern about the legitimacy of images. The early and relatively benign abuses came about in the cinema. Quickly, broadcast news, historic programs, and entertainment moved into creating synthetic events showing real characters, living and dead, in circumstances that had never occurred. The Authentication and Certification Act of 2006 required that all images be certified as to authenticity, and that four classes of false, synthetic, doctored, or modified images required suitable warnings and descriptions. It also clarified intellectual property rights to altered images.

## Privacy Safeguard Act of 2003

The primary irritations had come from the business sector in the constant push for the next edge, the next marketing opportunity, the next understanding of microdemographics. Businesses have pushed toward more finely tuned data collection and analysis. The Privacy Safeguard Act of 2003 has worked reasonably well. It prohibits commercial enterprises from basing any advertising on populations smaller than 1,500, 2,000, or 10,000 people, depending on the nature of the product or the service. In other words, one cannot market to individuals on the basis of individual knowledge about that person or a small group like that person. An escape hatch has proved to be quite popular, in that release from that restraint can be granted by individuals at both a personal level and household level. As it stands today, 63% of the U.S. public have waived those commercial privacy rights. The remaining 37% have chosen to use them.

Privacy is another outstanding issue in relation to information technology. It has been a concern since the late 1960s and its intensity skyrocketed around 2002. The privacy issues frame themselves in the United States around the Fourth Amendment, which makes us secure from search and seizure. Search and seizure originally assumed physical property and physical intru-

sion. Information technology allows us to acquire information about people and their affairs with no physical intrusion into their private space. Consequently, the question of expanding privacy rights under the Fourth Amendment has been a nettlesome issue.

The ultimate risk to privacy is government. Courts, corrections, and probation systems are the main troublesome actors in the United States. The crime prevention issue centers around the ability to identify highly crime-prone groups and individual members of those groups and the limited surveillance and intervention now permitted. There are three levels of probationary and parole surveillance that have caused great concern.

Infoterrorism has flourished as information became central to the economy. After a terrorist group effectively shut down Cleveland, Ohio, from all external communication for seven hours, Congress was strongly motivated to relax the constraints on monitoring and surveillance groups and to severely upgrade the penalties.

Terrorist acts by individual groups, vengeful workers or former workers, and psychotics are chronic. There seems to be no clear way of preventing them as the cost of both information and transportation continues to fall.

*The economics of information.* The Nobel prize awarded in 2016 for the theory of the economics of information altered the tax structure and the payment structure for information. It has not, however, removed all of the problems associated with the cost and value of information. Laureates Lee and Richovsky recognized the limitations on Claude Shannon's information theory as the key to the economics of information. But working with that as a base and combining some thermodynamic concepts and work early in the century on time and human values have led to their prize-winning work. The primary consequences of their work, which began to have its effect around 2006, were:

- The monetization of information on a national and international scale opened up tax incentives to shaping information-rich products and services more in the public interest.
- The United Kingdom from 2007 to 2011 tried an experiment in the economics of information by making all network services free. The five-year experiment proved a smashing success, and now with minor exceptions, notably the interlacing with overseas information nets, all information networks in the United Kingdom are free.
- In the United States, an alternative tack was taken. AT&T led the way in conjunction with US West in the reformulation of payment for information services. Research had shown that late in the 1990s in steady state there was generally less than a 2% fluctuation in the annual use of information by a typical family or business. The great experiment in 2016 that proved successful was to annualize network use costs and

to build them into mortgage payments or rents. The effect was to submerge awareness of the cost of the network. This led to a rapid expansion in its use. The cost of the networks had fallen so low relative to the cost and value of end uses that this new formulation of price structure was both realistic and a great user incentive.

*Systems vulnerability.* Aside from the interference of terrorists and psychos, the simple complexity of information systems has left them vulnerable to system failure and to the effects of natural hazards. The insurance industry of the United States has made redundancy the universal model for business and for those private individuals who wish their databases to be safeguarded.

Many systems exceed the intellectual capabilities, particularly the temporal capabilities of the human being. The tension is between turning operations over completely to machines or having human beings as backup. In the late 1990s and through the first decade of the present century, problems of this sort came up with regard to aircraft for which the information capabilities of managing the aircraft made the pilot redundant and gave him or her little opportunity to practice. No one was fully satisfied with virtual reality training.

*Safeguarding intellectual property.* In a world increasingly drenched with information, the ownership of intellectual property has turned into a chronic issue. The development of the global patent system in 2009 helped, but the abuse in terms of products sold primarily on a regional basis has not been dealt with. Strictly intellectual property involving no significant physical embodiment has proved to be extremely troublesome. The fifth triennial meeting of the Global Intellectual Properties Commission is scheduled for June 2026.

*Informationally impoverished* people who have limited access, skills, and understanding of the information world are purported by many to be suffering serious disadvantages. In spite of extensive research, it has not been established that there are significant adverse consequences for those of limited ability. The usual situation seems to be that people with limited capabilities rely on friends, relatives, and associates for the information that they cannot quite manage or control themselves. The issue, however, is chronic.

The world has watched as a half-dozen times in the last quarter century, distant, rebellious people have risen up against their oppressive governments. The pressures created by the worldwide visibility of those events could only have been possible because these people had the competence and skill to deliver their message and the accounts of events in real time. The argument, therefore, is that other oppressed people around the world, by being isolated from the information systems, are likely to remain perpetual victims of their oppressors.

## Global applications

The Information Age has not uniformly penetrated all parts of the world. It has, however, to some extent penetrated every part of the world. Some of the highlights of that follow.

*GlobeNet*, 2003, sponsored by the United Nations Educational, Scientific, and Cultural Organization (UNESCO), provides continuous video around the world. Because uplinks are not available everywhere, it provides a minimum of 10% of the time, 17 hours a week, of uplink. It has 11 roving uplink teams that travel to different parts of the world. *GlobeNet* was launched after the undeniable success of the Motorola Iridium project (Motorola was a firm that was prominent in information technology toward the turn of the century). The favorite content is health, child education, adult education, agronomic practices, animal husbandry, and kit assembly and use. *GlobeNet* has been extremely successful in promoting various kits applicable in specific regions of the world — electrical, household plumbing, and six auto kits are the most popular. Many programs are cartoons with culturally specific formats. They are designed to be informative and entertaining.

*The environment* has grown to be of such dramatic importance since the confirmation of global warming in 2013 that the *Annual Condition of the Planet Report* has become a landmark document. The quantitative scaling of individual nations and regions, and for larger countries, provincial and state conditions, has been a great stimulus to positive response to environmental issues. For many of the 174 independent countries of the world, the annual report has become both a recognition and a stimulus. The *Condition of the Planet* has as its long-term objective stimulating sustainability, particularly in agriculture, mining, and water use. The *Condition of the Planet* has also become a tool for reporting on national as well as corporate abuse and misuse of the environment. The 2024 report earmarked 1,600 facilities polluting at level one (critical risk to people and the environment), and 3,600 at level two (degrading the environment), and 14,000 at level three (important and readily correctable). The annual report depends heavily on space satellite data and extensive networks of traditional on-the-ground database generation. The annual planetary report takes up one-quarter of the *GlobeNet* time for two weeks every year.

*Regional telelinks* have become important as conflicts have grown among European, North American, and Japanese trade blocs. Telelinks have expanded on a highly subsidized basis. For example, the United States, Canada, Mexico, and the Caribbean islands all enjoy the same telelink user fees irrespective of the actual costs. The same applies to Europe, including Turkey and the Commonwealth of Independent States (CIS). Their latest expansion is the complete CIS in 2016, Russia having been included in 2011. The Japanese telelinks have been much more competitive. The United States and Japan are

in intense conflict for telelinks to the Philippines and to Australia. On the other hand, Japan has been successful in mainland China and the Chinese peninsula. There has been for the last seven years a raging conflict to establish regional telelinks throughout Latin America with the United States and Japan being the primary contenders and Europe a secondary contender.

*Arms control* and disarmament have evolved slowly, control more slowly than monitoring, though it did receive a powerful stimulus with the nuclear disaster in 2011. The general flow of arms has declined dramatically since the peak of international conflicts and the last of the seven wars in 2015. The problem is still far from resolved.

One of the benefits appropriate to global information has been large-scale conciliation as conflict resolution. It is not uncommon now for as many as 30,000 people in an internal or transborder conflict to participate over a period of eight to 15 months in broadscale discussion. There have been several successes as well as some regrettable failures.

*International standards*, especially in information technology, have become a successful global enterprise, building on 100-year history. Today 99.7% of all information technology is fully compatible. The remainder is associated with the intended introduction of new technologies and the exploration of new bandwidth incorporations and allocations.

*Information terrorism* and crime have been a steadily evolving concern of the global community. The knotty issue of dealing with different international standards, practices, and customs has been resolved at the international level; it was ruled that the law of the country in which the alleged crime is committed is the law that prevails in the pursuit, apprehension, trial, punishment, and incarceration of the criminal. The amount of contraband material—drugs, stolen goods, illegal materials—has over the last 12 years declined by 63%.

*Financial services*. The most complete and earliest globally integrated sector has been financial services. The centuries-old institutions of transborder finance burgeoned as global financial transactions became commonplace in the early 1980s and reached an unprecedented level by 2003. The market collapse of 2007 and the earlier collapse of derivatives in 2002 were largely due to the suborning of public officials, in the former case, and the overly zealous application of computer programs in the latter. They have led to stringent global financial flow controls. As a crime control measure, the United States in 1999 called in all currency and reissued it in machine-readable form. The ability to literally trace the flow of individual \$50 and \$100 bills had a radically depressing effect on organized criminal activities. During the call-in which occurred over a period of seven years, there was a 12% depreciation in the value of U.S. currency for each year after year one in which it was turned in. Only 40% of currency was turned in during year one, and by the end of year seven, 13% of currency had ceased to have any value. There was an inevitable and necessary escape hatch from the regulation for found money,

lost money, buried resources, and small holdings. A minor industry flourished in that seven-year period, in helping foreigners exchange money. Surprisingly, only 0.002% of turned-in currency was counterfeit.

One of the goals of calling in currency was to draw in the large caches of criminal- and drug-related funds outside the United States. The program was extremely successful. The major flow of illegally gotten funds into the United States occurred in years two and three, when presumably the holders of those funds realized that they had no choice but to cut their losses and turn in their money. As a result of the call-in, 1,034 arrests were made worldwide, with 930 prosecutions and 812 convictions. All of these were big fish.

## **INFORMATION TECHNOLOGY IN WORLD 2 AND WORLD 3 SOCIETIES — The world's largest information technology market**

Worlds 2 and 3, the middle and destitute societies, together underwent a population growth from 4.6 billion in 1994 to 7.1 billion in 2025. They have proven to be the world's largest market for information technology. However, they are by no means the dominant market for high-end, and highly integrated systems. Worlds 2 and 3 each have some big cities that are modeled on Western cities, and large portions of them are completely modern in their information technology. However, as one moves into the countryside, the situation becomes more spartan.

None of the 174 countries and sovereign states in the world are out of touch with the rest of the world, although it still is the case that, particularly in World 3, large portions of their indigenous populations have little or no outgoing communication. As discussed under "Global Applications," below, World 2 and World 3 have been primary beneficiaries of GlobeNet.

Satellite delivery has proliferated in three forms: (1) GlobeNet, sponsored by UNESCO; (2) commercial broadcasting, which in its early stages, through 1999, was largely sponsored on a user-fee basis (this proved not to be feasible in Worlds 2 and 3) with the bulk of the costs borne by advertising; and (3) individual public networks of countries or regions. Six regional satellites operate over Africa, four over South America, and six over Southeast Asia.

In metropolitan areas, which are now the dominant domicile for people throughout the world, wireless was popular from 1989 through about 2011, when the transition to fiber optics began on a country-by-country basis. The metropolitan areas of the world, including Worlds 1, 2, and 3, are now fiber-optic wired, with wireless being the feed-in and feed-out for many people.

With regard to public networks, the World Bank has been a force in promoting more effective government planning. In particular, it has insisted

on the use of information technology as a form of public participation with central government planning authorities. It has also provided teams — there are 75 now in the field — doing video recordings and in many cases video broadcasting of the status of World Bank-funded programs in World 2 and World 3 countries. This unprecedented feedback has added measurably to the sophistication and effectiveness of international programs and has had the net effect of raising the productivity and income of several World 2 and World 3 countries.

The Peace Corps network has become extremely popular as the United States Peace Corps became internationalized. The United States is now the training ground for Peace Corps participants from 13 advanced nations and 22 World 2 countries. PeaceNet has been so popular that it has raised the prestige of the Corps. PeaceNet, although it has some visual capabilities, is primarily an information networking system that brings analytical capabilities and databases to 6,000 locations throughout Worlds 2 and 3.

Today the world's largest corporation is Universal Technology (UT), formerly known as AT&T. It changed its name in 2013, although it maintains the obsolescent name in North America. Currently, UT has 267 primary world business alliances, average duration 23 years, covering 137 countries and indirectly covering 26 more states and sovereign areas. For countries within its global alliance, UT provides manufacturing, distribution, broadcasting, and wire and wireless services.

The global division of labor applies to information technology as well as everything else. One of the most striking outcomes was the dominance that India came to enjoy around 2005 in software design.

**Information Technology in Worlds 2 and 3**

Number per 100 Households

The Device	World-2	World-3
Screens	226	11
Knowbots	10	2
ID Cards	400	300
Smart Cards	4	0.2
Personal Computers	6	0.7
Telephone—Basic	50	4
Telephone—Advanced	7	1
Embedded Computers	500	60
Fiber to Home	26	3
Wireless and Other Personal Communications	80	7

### Critical Developments 1990-2025

Year	Development	Effect
Late 1990s	Flat screens introduced.	Changes the use of computer screens from office or domestic furniture to decorative and work/entertainment tool.
1998	Knowbots become prominent.	This leads to widespread public approval of the systems and greatly expands use by those semiliterate with regard to computers.
1999	The U.S. government calls in all currency and reissues in machine-readable form.	Crimp in organized crime and international terrorism.
2000	Environmentalists see information technology as a primary tool for promoting sustainability.	Broad pressure for widespread global and national surveillance by satellite and by collection of ground-truth data.
2002	Collapse of derivatives market.	Securities and Exchange Commission (SEC) intervention to severely restrict derivatives.
2003	GlobeNet initiated by UNESCO.	Continuous around-the-clock video information primarily to countries in Worlds 2 and 3.
2003	Supreme Court drops limitations on encryption codes.	Widespread industrial and business applications expand; spying in disarray.
2003	Privacy Safeguard Act.	Severely limits use of databases for intrusive exploration of customer base.
2005	Contest held on "Home for Millennium III."	The contest and building of prototypes began the radical change in domestic architecture, design, and furnishings.
2006	Telecommunications Computer and Business Stimulation Act.	Relieves industry of monopoly constraints.
2006	Authentication and Certification Act.	Requires certification of images with regard to authenticity or extent of doctoring.
2006	AT&T and US WEST annualize telecommunications fees and integrate into mortgage payments.	Dramatic expansion in use of information technology.
2007	Market collapses.	Tighter controls on public officials connected with financial services.
2009	Adoption of global patent system.	Greatly reduces abuse of intellectual property.
2011	San Francisco earthquake 7.8 on the Richter scale.	Large-scale civil works to prevent San Francisco Quake 3.

2011	Supreme Court finds state and local regulations governing information violate the Commerce Clause.	All responsibility for regulation is in the hands of the federal government or through treaties with international organizations.
2011	Second nuclear disaster in Pakistan.	Stimulates international attention to disarmament.
2011	First triennial meeting of Global Intellectual Properties Commission.	Much improved control over intellectual property abuses by World 2 and World 3 countries.
2013	Global warming confirmed as real and significant.	Pressure for effective information gathering, including initiation of the annual <i>Condition of the Planet</i> report.
2016	Nobel prize to Lee and Richovsky for economics of information.	Radically alters public policy toward information, including making it a practically taxable asset.
2018	Nobel Prize to Smith and Garcia for their research on the structure of the workforce.	New understanding of work and its flow and organization in the Information Age.

### Unrealized Hopes and Fears

Events	Potential Effects
Health effects from electronic-device radiation	Severe cutback in the use of such devices.
Split of nations into electronic haves and have-nots, with powerful political disparities in power.	Division within countries into two hostile groups of exploiters and exploited, rich and poor.
Massive invasions of privacy by both commercial and government data collection and use.	Arbitrary intrusions on people's well-being and their ability to engage in private and commercial activities, and government political intervention in citizens' private lives.
Collapse of the public school system, replaced by a dual system of fee-for-service for the prosperous and public schools for the impoverished.	A two-class society, information-rich and information-poor.
Identity cards promote fascistic governmental implications.	The end of free movement, democracy, the closing down of the open society.