Wave, which creates new values and life styles with greater tolerance for ethics, cultural and sexual diversity, and individual choices concerning the kind of life one wants to lead (Inglehart, 1997). Habermas (1984; 1987) also is not satisfied with modernization's effects and thinks that it is an unfinished project. Although Western-oriented industrialization is responsible for packed highways and banal TV sitcoms, it has also been the root of an extended life span and an increased focus on the well-being of humans. The transformation from modernization to post-modernization means shifts, from maximizing economic growth to maximizing subjective well-being, from achievement motivation to post-materialism, and from rational-legal authority to a de-emphasis of both legal and religious authority (Inglehart, 1997).

These shifts are results of huge improvements caused by the influence of Western civilization, which can afford such advances of life sense. Certainly, other developing civilizations still look for the maximization of economic growth. Perhaps even the mainstream of Western civilization, whose middle class is in decline at the dawn of the 21st century due to offshore outsourcing of jobs, may not like new values. Needless to say, these new values are mostly liked by better off and better *informed* citizens, who may count for 5%-10% of Western population, certainly coming from the elite and academic circles. Furthermore, the de-emphasis of legal and religious authority values is caused by the fact that people possess better *knowledge*, which opens their eyes to some sorts of manipulations by those authorities.

THE CONTROL REVOLUTION IN THE 19TH AND 20TH CENTURIES

To say that the advanced, industrial world is rapidly becoming an information society may already be a cliché. In the United States, Canada, Western Europe, and Japan, the majority of the labor force now works in the information sector and wealth comes increasingly from information goods such as computers, software, telecommunication services. For the economies of developed countries, the processing and handling of information has begun to overshadow the processing of matter and energy.

Until the Information Wave, the processing of information ran literally at a human pace within a bureaucratic system. Since the purpose of the Industrial Wave was to speed up society's entire materiel-processing factory system, it was necessary in order to do so to apply an effective control system, either manual or mechanized by office and punch-card machines.

The Information Society, as Beniger (1986) concluded, is not so much the result of any recent social change as of increases which began more than a century ago in the speed of materiel and energy processing. Microprocessors and information-communication technologies, contrary to currently fashionable opinion, are not new forces only recently unleashed upon an unprepared society. They are merely the latest installment in the continuing development of the Control Revolution. This explains why the first examples of information technology, such as Babbage's Analytical Engine (1832), the telegraph (1844), the typewriter (1860s), the transatlantic cable for a telegraph (1866), the telephone (1876), wireless telegraphy (1895), and the magnetic tape recording (1899) were developed beginning with the first signs of a control crisis in the middle 19th century.

The transformation of an economic system from extraction and agriculture (Agricultural Wave) into production, distribution and consumption (Industrial Wave) was achieved through the advancements in control systems. They were needed since the speed and volume of demanded goods exceeded the current capacity of the existing infrastructure. The signs of this crisis are presented in Table 9-1.

It is interesting to mention that one of the richest men of this era was the industrialist Andrew

Table 9-1. Signs of a control crisis in the industrial wave in the 19th century

Economic Sector	Symptoms of Control Crisis	Solutions
PRODUCTION	Slow flow of parts	Improved a factory layout to minimize bottlenecks Cost control Bureaucracy-office workers specialization in data-oriented routines
DISTRIBUTION	Slow wholesalers	Hierarchy of professional managers
TRANSPORTATION	Delayed trains and unsafe travel	Telegraph-oriented communication for a centralized traffic control. Formalized procedures and statistics of operations
CONSUMPTION	Demand greater than supply	Market research Weekly trade papers Advertising agencies

Carnegie (1835-1919), who began his professional career as an information man: operating a telegraph and fixing traffic problems of the Pennsylvania Railroad Co. He was doing his work so well that he was noticed by his boss, who later lent him seed money to open a small business, which eventually led to the development of the U.S. Steel Co., the foundation of the American Industrial Wave.

The following examples of applied information technologies in the 19th century have been the solutions to improve the transition from the Agricultural Wave to the Industrial Wave, particularly developed within Western civilization[3].

The factory system required one or more control systems. Among the earliest information control systems one can mention:

- Pre-programmed, open-loop controllers in the Jacquard loom (1801)
- Integration of production within a *factory system* (1820s-1830s)
- Modern accounting techniques (1850s-1860s)
- Professional managers (1870s)
- Bureaucracy (Weber's term created in 1890s)

Mass-produced goods demanded similar innovations in information-driven control of distribution and transportation:

- Baltimore–Washington D.C. railroad linked by telegraph (1860s)
- Department store, chain store, and wholesale jobber (1860s)
- Monitoring of inventory movement "stock turn" (1870)
- Mail order house (1870)
- Punch-card machines (1884, Hollerith)
- Commercialization of telephone (1880s)
- Long-distance telephone (1890s)

The distribution and sale of mass-produced products required inventions in controlling the marketplace through mass-communication of marketing materiel:

- Powered printing of 2,500 pages per hour (1829, Germany)
- Montgomery Ward mailed throughout the continent a 540-page catalog listing about 24,000 products (1887)
- Sears and Roebuck's mailed catalog reached 1 million copies in 1904

The Control Revolution intensified through the 20th century, when such "soft" sciences of economy and management contributed with new methods of optimal decision-making aiming at the state level as well as at the organization units of the defense and private sectors:

- "Scientific management" (1911, Taylor)
- Modern assembly line (1914, Ford)
- Statistical quality control (1929)
- Central planning (1920s, Soviet Union)
- Fiscal policies (1920s, Keynes, in England)
- *R.U.R Rossum's Universal Robots, (Thinking Robot)* a play written in 1921 by Carl Capek, in Czechoslovakia
- National income accounts (1933, in the U.S.)
- Econometrics (1930s, Frisch, in Norway)
- Input-output analysis (1936, Leontief, in the U.S.)
- Linear programming (1930s, Koopmans in the U.S. and Bogdanowicz in the USSR)
- Statistical decision theory (1930, Shewart, in the U.S.)
- Operations research (World War II, McNamara, in the U.S.)
- General system theory (1945-1951, Bertalanfy, in the U.S.)
- Cybernetics (1949, Wiener, in the U.S.)
- System analysis (1955, Hitch, in the U.S.)
- System engineering (1960s, US-TRM)
- Production information control system (1960s, US-IBM)
- Project management by PERT (1961, Bendix, in the U.S.)
- Management by objectives (1970s, in the U.S.)
- Management information systems (1970s, in the U.S.)
- Infostrada (1972, in Poland)
- Information superhighway (1980s, in the U.S.)
- Computer integrated manufacturing (1980s, in the U.S.)
- Information warfare systems (1991, in the U.S.)
- Telecity (1990s, in the U.S.)
- America On Line (1990s, in the U.S.)
- Enterprise Resource Planning (1990s, in the U.S. and Germany)
- Balance scorecard (1990s, in the U.S.)
- Global positioning system (1990s, in the U.S.)
- Enterprise information systems (2000s, in the U.S.)
- Mobile interactive travel navigation systems (2000s, in the U.S.)

To support the application of these control techniques, the following information technologies were developed:

- Radio (1906, in the U.S.)
- Television (1923, in the U.S.)
- Nielsen's audiometer monitoring of broadcast audience (1935, in the U.S.)
- Gallup poll (1935, in the U.S.)
- Digital processing of signals (1935, Atanasoff, in the U.S.)
- Binary digits (BIT 0,1) (1937, Shannon, in the U.S.)
- Turing machine (1937, Turing, in Great Britain)
- Relay computer (1938, Bell-Stiblitz, in the U.S.)
- Digital computer (1941, Zuse, in Germany)
- MARK I – relay computer (1944, Aiken, in the U.S.)
- ENIAC – electronic computer (1946, Eckert, Mauchley, Goldstein, in the U.S.)
- UNIVAC I – first commercial computer (1951, in the U.S.)
- IBM 1400 – popular family of computers in data processing (1960s, in the U.S.)

- IBM 360 – popular family of computers family in management information systems (1960s-70s, in the U.S.
- Supercomputers to control scientific computations (weather, defense) (1970s, in the U.S.)
- LAN-Alohanet computer network (1971, in the U.S.)
- Artificial intelligence-driven smart systems (1975, in the U.S.)
- Microcomputer Apple II (1977, Wozniak and Jobs, in the U.S.)
- Most popular personal computer (1981, IBM, in the U.S.)
- Information warfare, precision-targeting (1991, in the U.S.)
- Computer servers (1992, in the U.S.)
- Rapidly expanding telecommunication services (1990s, in the U.S.)
- The booming Internet (1990s, World)

From the mid 1950s, it became apparent that energy and material-based industries were backward and waning in industrial nations. In the United States, for example, while the labor force grew by 21% between 1965 and 1974, textile employment rose by only 6% and employment in iron and steel actually dropped 10%. Similar patterns were evident in Western Europe, Czechoslovakia, Poland, Hungary and Japan. As these old-fashioned industries began to be transferred to so-called "new emerging markets" where labor was cheaper and technology less advanced, the social influence of Western civilization also began to die out and a set of dynamic new, information-based industries took a leading role in the marketplace (Toffler, 1980).

As the economy, based on the Industrial Wave, languished, the industries and regions based on the Information Wave thrived. In the United States, the shift from the Second to the Third Wave took place sometime in the middle 1950s. Old regions like the Merrimack Valley in New England sank into the status of "depressed area" while places like "Route 128" outside of Boston or "Silicon Valley" in California zoomed into prominence. Their suburban homes filled with specialists in solid-state physics, systems engineering, artificial intelligence, and polymer chemistry. The backbone industry of the Third Wave is the electronics and computer industry, with about $500 billion annual sales in the 1990s, which makes it the world's fourth largest industry, after auto, steel, and chemicals.

THE LIMITS OF GROWTH AND THE DECLINE OF THE INDUSTRIAL WAVE

The negative impact of the Industrial Wave on civilization was the subject of assessment by The Club of Rome, which asked MIT scientists to make a report on this issue. A team led by future nobel laureate Dennis L. Meadows published a book called *The Limits to Growth*, which was a best-seller with 9 million copies sold in 29 languages. The book created a furor. The combination of the computer simulations, MIT, and The Club of Rome pronouncing upon humanity's future had an irresistible dramatic appeal. The book was interpreted as a prediction of doom, but if it was a prediction at all, it was not about a preordained future. It was about a choice. It contained a warning, to be sure, but also a message of promise. Here are three summary conclusions:

1. If the present growth trend in world population, industrialization, pollution, food production, and resource depletion continues unchanged, the limits to growth on this planet will be reached sometime within the next 100 years. The most probable result will be a sudden and uncontrollable decline in both population and industrial capacity.
2. It is possible to alter these growth trends and to establish a condition of ecological and economic stability far into the future.

The state of global equilibrium could be designed so that the basic material needs of each person on Earth are satisfied and each person has an equal opportunity to realize his or her individual potential.

3. If the world's people decide to strive for this second outcome rather than the first, the sooner they begin working to attain it, the greater will be their chances of success.

Exactly 20 years later, the same authors published a book called *Beyond the Limits*, in which they stated that the human world is already beyond its limits. The present way of doing things is unsustainable. The future, to be viable at all, must be one of drawing back, drawing down, and healing. Poverty cannot be ended by indefinite materiel growth (interpreted as the Industrial Wave); it will have to be addressed while the material economy contracts. The authors stated:

- Human use of many essential resources and generation of many kinds of pollution have already surpassed rates that are physically sustainable. Without significant reductions in materiel and energy flows, there will be in the coming decades an uncontrolled decline in per capita food output, energy use, and industrial pollution.
- This decline is not inevitable. To avoid it two changes are necessary. The first is a comprehensive revision of policies and practices that perpetuate growth in materiel consumption and in pollution. The second is a rapid, drastic increase in the efficiency with which materials and energy are used.
- A sustainable society is still technically and economically possible. It would be much more desirable than a society that tries to solve its problems by constant expansion. The transition to a sustainable society requires a careful balance between long-term and short-term goals and an emphasis on sufficiency, equity, and quality of life rather than on quantity of output. It requires more than productivity and more than technology; it requires maturity, compassion, and wisdom.

This is a conditional warning, not a dire prediction. It offers a living choice, not a death sentence. The idea of limits, sustainability, equity, and efficiency are not barriers, obstacles, and threats. They are guides to a new world. Sustainability, not better weapons or struggle for power or materiel accumulation is the ultimate challenge to the energy and creativity of the human race.

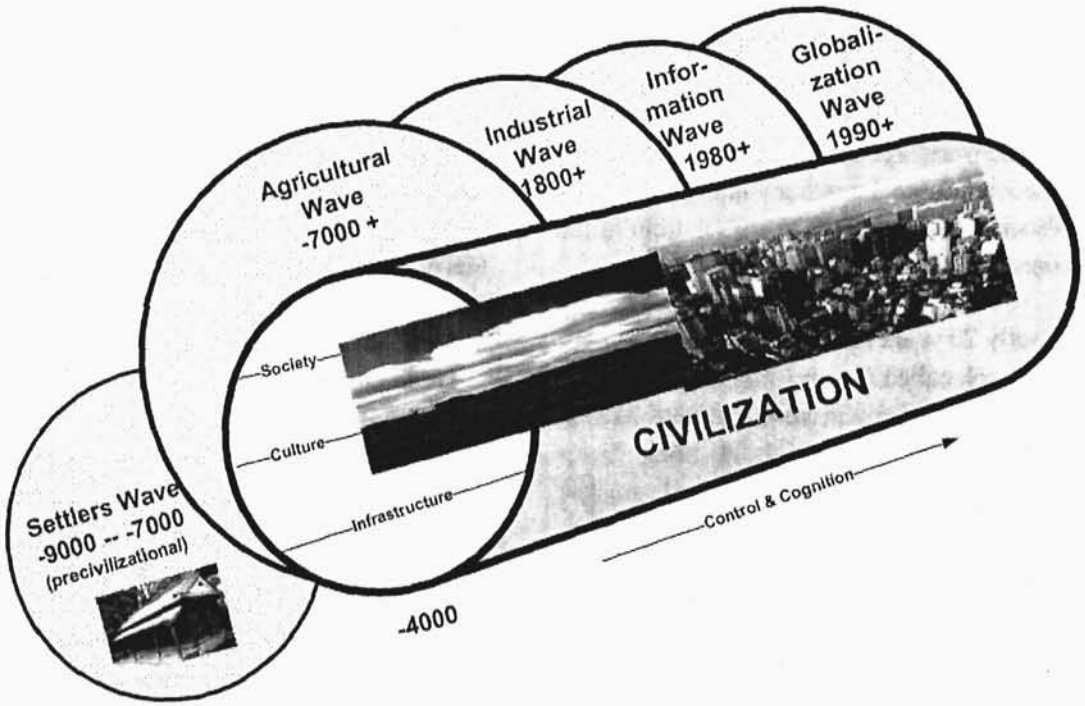
In the 20 years since the publication of *Limits of Growth*, many people, politicians, and business executives have understood the message. The consumption of energy and materiel per capita is declining and the issue of efficiency is discussed daily in business and government in some countries, particularly in Scandinavia. This message contributes to the decline of the Industrial Wave and the search for a new social control system. As we will see later, the Information Wave is a partial and optimistic answer to this quest.

THE RISE OF THE INFORMATION WAVE

Most of the writing on civilization waves was done by Alvin Toffler (1980) who recognized the three waves, First Wave (Agricultural Wave), Second Wave (Industrial Wave) and the Third Wave (Information Wave). However, there are more waves of development of humankind, possibly five in total (Figure 9-5):

0. Settlers' Wave (9,000 B.C. - 7,000 B.C.)
I. Agricultural Wave (7,000 B.C. ff.)
II. Industrial Wave (1814 A.D. ff.)
III. Information Wave (1980 A.D. ff.)
IV. Globalization Wave (1990 A.D. ff.)

Figure 9-5. Civilization waves before the 2000s



The Zero Wave, the Settlers' Wave, transformed hunters and farmers into settlers, who organized the first villages in the Middle East and stabilized their lives around animal domestication and food production. After 5,000 years of wealth accumulation, this led to the rise of the first civilization about 4,000 B.C. It is interesting to notice that after 9,000 years (7,000 B.C. to 2,000 A.D.), mankind is again on the move, becoming a "global hunter" for profit or jobs, while the Fourth Wave, globalization, takes off in the 1990s through the global infrastructures of information-communication and transportation.

The First Wave – the Agricultural Wave – began about 7,000 B.C. and will remain active as long as food is needed, which means that it will be active as long as humankind exists. The Second Wave, the Industrial Wave, is about 200 years old. It minimized human physical effort through mechanization and released free time for education, which led to the Scientific Revolution and the invention of aircraft and computers. The latter is leading to the Third Wave, the Information Wave, and its magic tool, the Internet. The airplane and Internet increase human global mobility, which triggers the Fourth Wave, the Globalization Wave.

The civilization waves are shown in Figure 9-4. Each wave has its own set of civilization tools, which primarily support control processes by elites over their clients. The main control solutions for each wave are shown in this figure. It is important to notice that none of these waves replaces the wave that precedes it. For example, information cannot replace food, steel or plastic; it can only improve their creation and utilization.

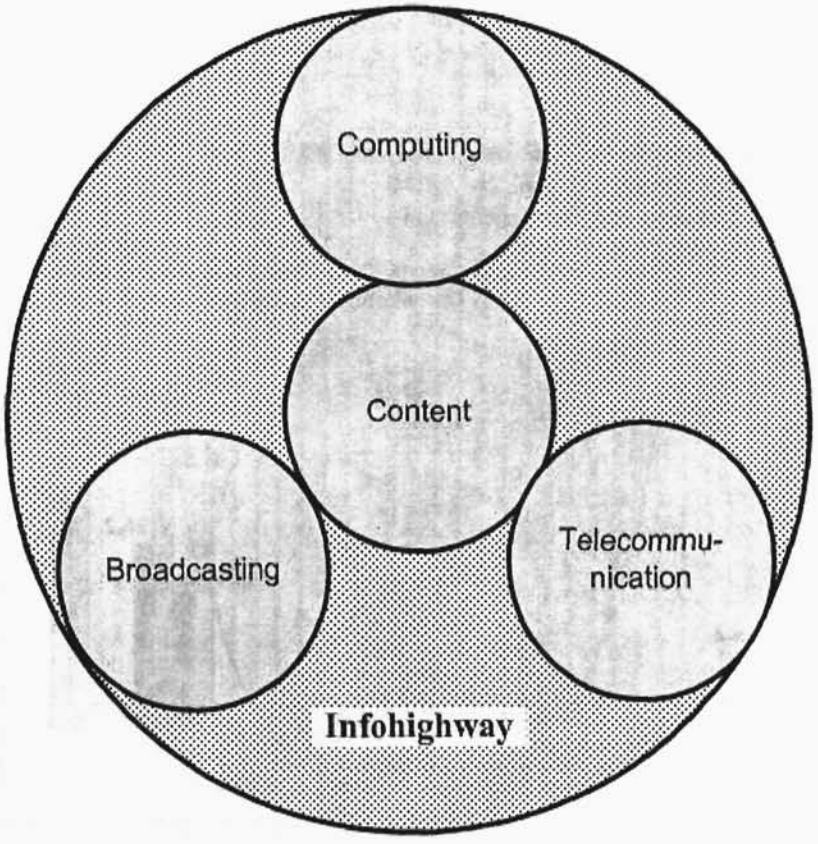
Individual civilization waves are not displaced, except that the Settlers' Wave was de facto pre-

civilized. Perhaps each new wave takes the leadership in civilization development and intercepts the best talent to work for it. Furthermore, each wave perpetuates other waves, as is shown on a model in Figure 9-5. Current job trends, which focus on such things as the outsourcing of computing to India, contradict earlier assessments that the millennial American workforce would be heavily focused in computing. In the 2000s, it is even possible to outsource computer programming to India, thousands of miles away from a company's headquarters.

As the Industrial Wave declines and the Control Revolution rises, the Information Wave rises as well. Much of the concept of the Information Wave as the Information Society draws from the theory of *post-industrialism* advanced by Daniel Bell (1976). Bell's concept of post-industrial society has five dimensions:

1. There is a shift from a goods-producing economy to a service-producing one.
2. There is an increase in size and influence of the classes of professional workers.
3. The post-industrial society is organized around theoretical knowledge.
4. A critical aim is the management of technological growth.
5. There is an emphasis on the development of methods of intellectual technology.

Figure 9-6. The convergence of multimedia in the infohighway



Intelligent technology under the form of global computer networks dramatically expands the power of the brain into hyper-intelligence. With appropriate control programming, a network becomes a sensitive device, not only as a physical but also as an economic, social, and political one.

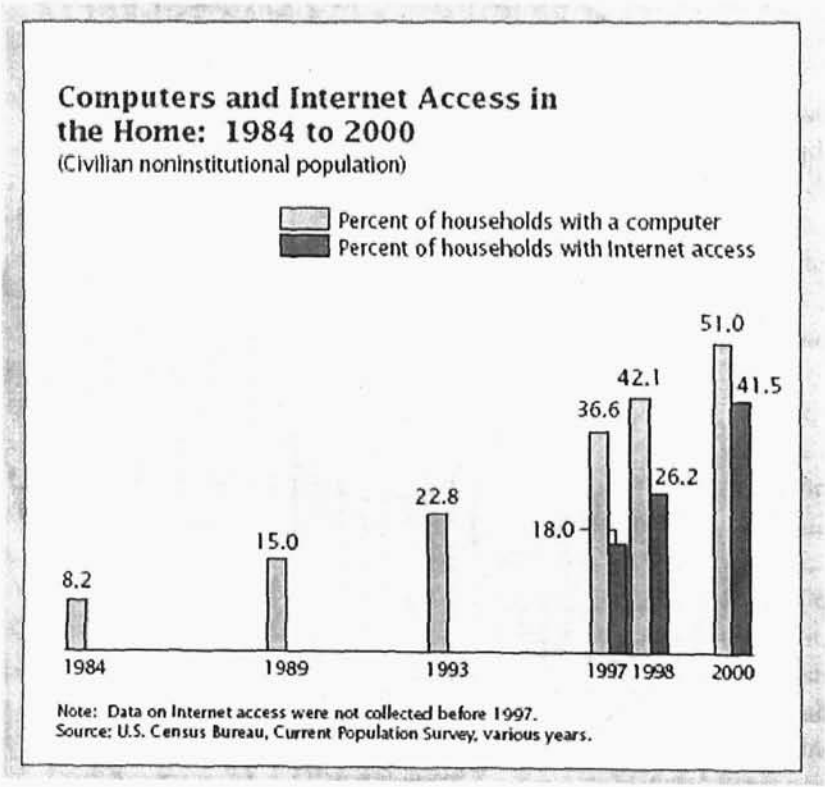
The spending on information-communication technology (ICT, a core of "intellectual technology") in the U.S. in the scope of equipment was in a range of $845 billion in 1997, growing at an average rate of 12.3% a year, which can be approximated for the year 2000 to be $1 trillion[4]. If one includes information management (on the application side), it could be up to $2 trillion, which is about 16% of GDP, equal to current spending on healthcare (World Bank, 2007)!

A new approach to transmitting information (in a general sense) is represented by the concept of the information superhighway (infohighway)[5], which is emerging from the convergence of the following media (Figure 9-6):

- *Content* (entertainment, publishing, education, e-commerce, travel, marketing, information systems, etc.)
- *Computing* (computers, software, services of information systems, end-user computing, etc.)
- *Telecommunication* (telephony, cable, satellite, wireless as information-communication services)
- *Broadcasting* (television, radio).

The infohighway certainly is no longer merely a cute aphorism. It has become an important tool in many of our professional lives. The speed and

Figure 9-7. Computers and Internet access in the U.S. home: 1984 to 2000



immediacy with which it can deliver valuable *information* and images is mind-boggling. Suddenly, e-commerce is no longer just an oblique concept, but rather the accepted way that we all shall be doing business in the not-so-distant future.

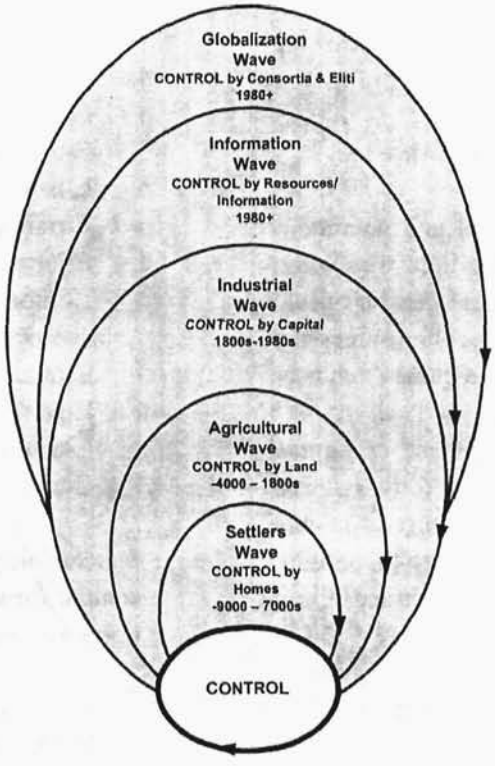
In August 2000, 54 million households in the U.S., or 51%, had one or more computers at home, with 41% having access to the Internet, as is shown in Figure 9-7. These figures mean that more than 100 million people in the U.S. use the Internet at home in the second part of the year 2000.

The Information Wave in Western-West civilization is becoming a mature endeavor. It has impact on work transformation, where *information (symbolic) workers* (1990: 45% of jobs in the U.S.) passed the number of *in-person service workers* (1990: 35% of jobs in the U.S.) and *routine production/service workers* (1990: 25% of jobs in the U.S.) (Reich, 1992).

The formal education of information (symbolic) workers entails refining four basic skills: abstraction, systemic thinking, experimentation, and collaboration. In the Information Wave, more people are involved in information and communication than in mining, agriculture, culture and manufacturing combined. Unlike finite industrial resources such as oil, ore, and iron, there is an inexhaustible supply of knowledge, concepts and ideas as people gain their education.

The Information Wave impacts people and organizations in almost every country and also provides the information infrastructure for the development of global civilization, where "distance" is dead since communication among remote corners of the world is instant for business or private exchanges. This trend triggered the new economy, whose products/services are "soft" and delivered immediately anywhere and anytime.

Figure 9-8. The role of control in the evolution of civilization waves



A new economy brings also new problems, particularly in the sphere of employment and pay. Three-quarters of the American workforce is now employed in service but a substantial portion of these are in low-paying, dead-end jobs.

THE MISSION, GOALS, STRATEGY, AND ARCHITECTURE OF THE INFORMATION WAVE

The 19th century eliminated wilderness through railroads. The 20th century developed science and technology that improved the well-being of many and pushed the planet to its limit resources-wise. The 21st century perhaps will implement the Information Wave across all particular civilizations to improve knowledge-based critical decisions about social life in the situation of limited resources.

The *mission* of the Information Wave is:

To knowledgeably and wisely *control* development and operations of the Agricultural Wave, Industrial Wave, Global Wave, and other following ones (Figure 9-8).

The *goals* of the Information Wave are:

1. To *optimize* development and operations of the Agricultural Wave, Industrial Wave, Global Wave, and the other following ones in order to minimize the use of resources and ecology and to increase a citizen's choices and its quality of life.
2. To sustain the development of human *cognition* in order to make conscious and wise decisions about: the sense of human possibility, life, education, health, politics, defense, business, entertainment and leisure time.

The *strategy* of the Information Wave is:

To develop and apply information-communication technology in *control systems* in a rational and human manner.

These aims should be applied at all levels of civilization, including national and local governments, schools and colleges, business and other organizations, homes, and individuals.

The general architecture and control role of the Information Wave, shown in Figure 9-9, is composed of the following metaphoric elements:

- *Info-factories*, which generate information and seek new information, among them the following:
  - Virtual enterprises
  - Virtual schools and colleges
  - Virtual communities
  - Online governments
  - Electronic republic
- *Info-malls*, which provide the following services:
  - E-mail
  - E-education courses
  - E-commerce
  - E-business
  - E-banking
  - E-trading
  - E-job recruitment
  - E-information services (news, weather, sports)
  - E-research
  - E-publishing
  - E-entertainment
  - E-telephony
- *Info-highways*, which transmit information content through information-communication services, such as:
  - LAN – Local Area Networks
  - MAN – Metropolitan Area Networks