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CHAPTER 27

Digital Confluence, Space, Time, and Civilization

The Cognitive Revolution

It is a cliché by now that we are living in an Information Age, a knowledge-based society. Some people even call it the post-Information Age. Economists are working on new theories based on the presumption that knowledge, a renewable resource, is now the true capital. Business administration experts counsel businesses to focus on the marshalling and utilization of knowledge and to emphasize constant innovation. In the academic world, the cognitive revolution took place in the first half of the 20th century, beginning with new ideas about mathematics and logic, interrupted by a decade or so of preoccupation with behavior, then back on course by 1936 through the work of Alan Türing, a British mathematician. Howard Gardner, in *The Mind's New Science,* lists the key theoretical inputs to cognitive science.

1. mathematics and computation;
2. the neuronal model of the brain;
3. study of neuropsychological syndromes;
4. information theory pioneered by MIT's electrical engineer, Claude Shannon, who said the basic unit of information is a bit (which is short for binary digit);
5. ideas based on Norbert Wiener's cybernetics.

Gardner concludes: "By the 1940s . . . the principal intellectual capital on which cognitive science was to be constructed had already emerged," not only in the United States but also in Great Britain, France, and the Soviet Union.[1]

The paradigm shift from behaviorism to cognition, not only in neuroscience and psychology but also in linguistics and anthropology, was hastened by Noam Chomsky's *Syntactic Structures,* published in 1957. Roy D'Andrade, in *The Development of Cognitive Anthropology,* says: "The shift from the study of institutional behavior—'natural systems'—to the ethnographic study of 'idea systems' or 'symbolic systems' appears to have been a very general trend . . . the dependence of society on the growth, organization and retrieval of information was becoming clearly apparent in the development of telephone, radio, television, phonograph, and film industries. *The computer was not the cause of the cognitive revolution in psychology, but rather the new piece of technology that symbolized in physical form the power of information manipulation*" (italics mine).[2]

The Computer Revolution

Mainframe computers evolved during World War II in response to wartime needs and came into general use in the 1960s. Transistors were perfected by 1947, which made possible the minicomputers pioneered in the 1960s by Digital Equipment Corporation and Hewlett-Packard. Minicomputers marketed in 1968 cost around $20,000. Manufacturers of computers provided a market for semiconductors so that the Shockley Semiconductor Company was founded in 1955, Fairfield Semiconductor in 1957, and Motorola and others were making semiconductors in the 1960s. Intel was founded in 1968.

The makers of minicomputers did not want their market undercut by a transition to smaller and cheaper desktop-sized microcomputers. "In 1972 there were only 150,000 computers in the world."[3] Then, in 1974, the Altair microcomputer was introduced. Apple Computer Company began in a garage in 1976. The microcomputer revolution was in full force when IBM launched its personal computer in 1981, the PC-XT in 1983, and the PC-AT in 1984. Apple introduced its Macintosh in 1984.

Brain Research and Neural Networks

Very early in the evolution of computers and their software, the human brain was taken as a model. There are ten billion or so neurons in the brain, interacting with one another. In the U.S., Japan, and Europe, the example of the brain was used in the construction of artificial neural networks beginning in 1957. American interest was waning by about 1969, but research abroad continued. In 1982 a joint U.S.-Japanese conference on neural networks was held in Kyoto. The American Institute of Physics held its first annual meeting on Neural Networks for Computing in 1985. The International Neural Network Society was formed in 1987.

Analog, Digital, and Artificial Intelligence

In the early days of computers, office machines were digital; phone systems and many industrial computers were analog. (Analog represents a value as infinitely variable. Programs for digital machines are coded as numbers transformed into discrete electrical pulses. Digital systems utilize binary arithmetic in which bits are 1 and 0; bytes are groups of six or eight bits.)

Early in the evolution of computers, some researchers took as their goal the creation of machines that could think—in short, genuine artificial intelligence. They soon began to realize that many activities of the brain are more analog than digital; also, the mind is culturally imprinted. By the 1960s, AI researchers were trying to translate whole cultures into computer programs because, as Crevier has said, "you cannot define the most innocuous and specialized aspect of human usage without reference to the whole of human culture."[4] AI researchers were trying to implant "microworlds" into the minds of computers.

Semiotics and Deconstruction

Hypothetically, the whole field of semiotics, that is, the study of representation, could have been drawn upon in the effort to program microworlds. This was a field that dated in France from the ideas of Ferdinand de Saussure (1857–1913) and in the U.S. from the ideas of Charles Peirce (1839–1914). "For Saussure, all culture was structured as a language and hence as a mode of communication."[5] French structuralists such as Levi-Strauss built on the ideas of Saussure. So did the French post-structuralists such as Roland Barthes. According to deconstructionist Jacques Derrida, authors of texts always bias one term over another. "In this way subtle modes of manipulation are introduced in any form of writing."[6] Derrida said these modes should be deconstructed and revealed as hierarchy. According to Derrida, there is nothing but text in a variety of forms, no outside reality.

Software, Hardware, and the Problem of Microworlds

Writers of computer programs have to take into account the nature of their hardware. In the early days of AI research, the potentials of software were greater than hardware capacity. Then, within computers, speed was increased, memory capacity was enlarged, and the size of microprocessors was decreased to the level of nanotechnology so that hardware capacity ran ahead of the capacity of software to utilize it fully. Six years ago, the fastest computer was one thousand times weaker than the human brain. However, science is catching up with nature, and within another generation or so computers will have both the speed and memory capacity of the brain. In due time, computers can surpass us, given suitable software programs, which have a long way to go before they can duplicate the processes of the human mind.

Early efforts to improve computer I.Q. did not succeed because formal logic systems in the software for digital computers were literal minded. Symbol-manipulating computers possessed syntax but no semantics.[7] There seemed to be no way to instill the necessary microworlds into computers.

An early approach to computer language was the use of prototypes, but these were not complex enough, so the word "schema" was adopted. After the mid-70s, schema theory became a growth industry. D'Andrade concludes: "Cognitive representations—properties, prototypes, schemas, models, theories—make up the stuff of culture in the mind."[8] Building on German gestalt theory of perception, a new field of psychology developed to study categorization and prototypical effects.

In the early 1970s, AI researchers were giving up on the microworld approach to computer programming and were turning to more narrowly defined "expert systems," which could be commercialized as labor-saving devices. The LISP program language was developed for expert systems running on specialized machines. By 1987 Apple and IBM-compatible machines could do what specialized LISP machines could do.[9] Once more, hardware was leaping ahead of software.

Fuzzy Logic; Protein-Based Computers

Most systems in the world are complex. From study of complex systems a professor at the University of California-Berkeley developed the idea of fuzzy logic between 1964 and 1973. His concepts were used by the U.S. Space Administration, but not by early U.S. computer makers. They were taken up with keen interest by the Japanese. Remember that many of the brain's signals are more analog than digital. Cultural imprints in the mind do not work through formal logic. Fuzzy logic computers are much closer than digital computers to the way the human brain actually works.

An article in the March 1995 issue of *Scientific American* predicted that computers of the future may be hybrids of proteins and semiconductors. Not long ago someone was quoted in the *New York Times* as predicting that the future computer would be a tub of DNA. Bill Gates, head of Microsoft and the richest man in America, believes biotechnology is the wave of the future. In the 1980s a number of Japanese companies began full-scale research efforts to develop bio-chips. The Japanese Ministry of Trade and Industry announced a huge ten-year program in 1981 to develop advanced AI hardware and software. In the fall of 1984 the Moscow Academy of Science announced a similar effort. A protein molecule was developed from scratch in 1988.[10] Genetic engineering is advancing by leaps and bounds. Researchers have still not resolved the problem of instilling microworlds.

Actor Theory; Parallel Processing

Marvin Minsky, in *The Society of Mind*, moved away from pure logic as the explanation of how the mind works. He said minds are made up of a billion entities he called agents. The idea of multiple cooperating minds within a mind has been gaining ground in psychology. There is also a new branch of computer science known as Actor Theory: multiple computers talking to each other about specific topics. As microprocessors reach their limit, parallel processing offers vast new potential.

New Connectedness: Telephones Go Digital; Linked Area Networks; the Internet

Early desktop computers were lonely fellows, each one isolated from the others. Then changes in telephony made possible new networks of connectedness. During the 1960s, digital technology was added to analog phone networks in the U.S. to provide new features and reduce costs. Digital switching was introduced in the 1970s. PBX systems were computerized in the late 1970s.

At the same time, since the end of World War II, copper phone wires have been gradually replaced by a combination of fiber optic wiring (which has much greater bandwidth than copper) for main high-density arteries and microwave radio for low-density traffic on relatively short spurs off of digital fiber arteries. Fiber optic cables have been laid under the oceans linking much of the world, though significant parts of Africa have been left out (developing countries have turned to microwave phone systems). The world is interconnected not only by wires, but also by satellites. Rupert Murdoch's GEO satellite is said to reach 38 nations in Asia and the Middle East.

Inside the U.S., companies are turning rapidly to use of Linked Area Networks. Thus, coordination of team efforts is possible despite spatial dispersion. We now frequently hear the word "virtual" applied to corporations, universities, law firms, even surgical operations—meaning the activities are linked by modern communication technology, not by interface relations in contiguous space. Both the structure of organizations and of communities are changing. We have also seen what a role CNN can play in international diplomacy and war.

Not the least part of the story of new interconnectedness has been the evolution of the Internet. The U.S. Department of Defense developed packet switching in the late 1960s. By 1970 the first packet-switched computer network in the U.S. connected four different universities. By 1972 there were 40 different sites and the core technologies for computer networking were in place. By 1983 networks were cropping up everywhere. Now the Internet has over 10,000 networks scattered across the globe. Estimates of numbers of users have run as high as 40 million. In 1993 the number of subscribers was growing by over 25 percent a month. Reams of paper have been used up in analyses of the social, cultural, institutional, geopolitical, and economic impact of the Internet.

The Graphical Interface Revolution, Digital Confluence; New Space-Time Relationships; Virtual Reality

In 1963 graphical computing was invented simultaneously at M.I.T. and the Stanford Research Institute. ". . . [I]n 1983 the graphic interface revolution was the software equivalent of the PC revolution."[11] A pixel is to graphics what a bit is to information. The word "pixel" is a condensation from the words picture and element. When programs learned to digitize pictures and sound, by 1984 CD-ROMS were being developed. In 1991 there were proposals in the U.S. to change HDTV from analog to digital; in 1993 Europe voted to abandon analog HDTV in favor of a digital future. In October 1994 the FCC gave approval to let Bell operating companies enter into the information and entertainment industries.

Digital confluence between music, video, film, and computers has led to large-scale mergers of phone companies, cable companies, film companies, publishing companies, and others. It would seem that the individual is in danger of being tyrannized by those at the control towers of digital confluence. However, there is another side to the story. Negroponte comments: "In the post-information age, we often have an audience the size of one . . . information is extremely personalized."[12] The individual's relationship to his machines is not passive but interactive. TV will become a random access medium. Through the technology of virtual reality, the individual can bring far-away places into his home. He can relate to anyone in the world in real time, or can organize his information inputs to suit his own taste and convenience. In short, he has new individualized command over both space and time. Moreover, for every giant conglomerate there is a new array of cottage industries.

Frontiers of Research: Complexity and Chaos Theories; Cyborg Anthropology: a Role for Comparative Civilizations

The new technology has been a boon to academic research in a variety of disciplines. As Derek Gregory points out in his new book, *Geographical Imaginations,* scholars in the field of geography suddenly have a whole new agenda stimulated not only by the experiences of digital confluence and the socio-economic-geopolitical consequences of that confluence, but also by the new metaphors of the post-modern world. A new branch of anthropology called cyborg anthropology studies boundaries between humans and machines.

There are analogies between what is happening because of computers and other paradigmatic changes. The new scientists of complexity emphasize instabilities and fluctuations, not stable structures; nonlinearity, chaos, "patterns and possibilities, rather than fixed elements, explanation rather than prediction."[13] The new view of the physical world sees "webs rather than structures, and connections and transgressions instead of neat boundaries isolating pristine systems." Escobar says that "fractals, chaos, complexity, nomadology . . . perhaps dictate a different dynamic and arrangement of life: fluidity, multiplicity, plurality, connectedness, segmentarity, heterogeneity, resilience."[14]

All of the new approaches—technological, scientific, institutional, cultural—signify a civilization in the process of transformation. We need to study these transformations more closely, observe differences of response in different parts of the world, apply our new insights and methods to studies of past civilizations, and perhaps help computer programmers develop "civilized" microworlds for computers.