I will work for understanding of the diverse causes of disease, including the social, economic, and environmental. I will promote the well-being of mankind in all its aspects, not merely the bodily, with sympathy and consideration for a people's culture and beliefs.

I will strive to prevent painful and untimely death, and also to help parents to achieve a family size conforming to their desires and to their ability to care for their children. In my concern with whole communities I will never forget the needs of its individual members.

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NEWS AND COMMENT

Bell Labs: Computers Loom Large In Both Research and Operations

In the nonage of the computer, the people with worthwhile problems didn't know how to use the machines, and the programmers didn't have worthwhile problems.

This intentional overstatement of the predicament of researchers in the recent past was made recently by a member of the Bell Telephone Laboratories technical staff and implies that a new phase has begun in computer usage.

Transition to the new phase has not been abrupt, but its effects are conspicuous in an enterprise like the Bell system because not only is the computer being used more and more extensively as a research tool, but telecommunications equipment is becoming more and more computer-like.

At Bell Labs in recent years, there has been a strong, general effort to increase the interaction of man and computer. The labs have also been a stronghold of information and communications theory, which is particularly relevant to telecommunications, data processing and control, and is also being regarded with increasing interest as an instrument useful in exploring human behavior.

The new era is marked principally by the sharp reduction in the amount of expertise, vis-a-vis the computer, required of the person who wants to use the machine and also by progress in ameliorating the so-called time-sharing problem.

Digital computers, which were first used as high-speed calculators, proved adaptable for handling research data. In business, they were widely used for such routine work as billing and payroll operations and for more complex tasks like handling airline reservations. In industry the computer has proved a versatile and highly reliable control instrument which makes feasible the "automated" factory.

Computers, therefore, tended to be used for three fairly distinct purposes—research, business, and control. Scientists used computers to perform complex operations on relatively small quantities of data. In business, the computers generally performed relatively simple operations on large quantities of data. The control computer operated in "real time" determined by the steps in the process it was controlling.

The next step was the fairly obvious one of designing computers which were sufficiently fast and flexible to handle different types of functions simultaneously.

Necessity prodded invention here, as military systems—particularly those concerned with air and missile defense—were required to handle a great variety and volume of data very fast. The performance of parallel tasks on one computer or more is called a time-shared system (TSS).

In a lucid article on time-shared computer systems in the technically middleweight house organ *Bell Laboratories Record* for February, N. K. Poole defines such a system as a "'hardware-software' package allowing many different users with different goals simultaneous access to the computing system. The TSS is not a military control system, nor is it a computer. It is actually a method, a means through which the computer may be shared, for implementing control of the military system and serving support needs. If the TSS is effective, every user will feel that he is in complete control of the computing system when he is using it."

A smoothly functioning time-shared system permits simultaneous access by a number of users and insures that their problems will not conflict. When a priority program—for example, an urgent tactical problem in a military system—demands increased time, less important programs must be curtailed or delayed according to a preestablished order.

The new generation of time-sharing computers serve their patrons better in two main ways—they are easier to use and afford quicker "turn-around time," which is the period between the times a problem is submitted and results are obtained.

Computers have been made more accessible in a number of ways. Computer "languages" and math have been improved and simplified. Refinements now make it possible, for example, for the end product to issue from the computer in the form of graphs rather than as reams of statistics. Dialogues with a computer can now be conducted from a number of typewriter-like terminals, giving the researcher a deskside link with the computer. It is now possible to write a problem on a screen with a "light pencil" (in the appropriate computerese, of course) and to get a return response from the computer.

Acoustics Research

The use of computers appears to have permeated Bell Labs' very highly ramified research and engineering program to a remarkable degree. Acoustics research provides an interesting, although not necessarily typical, example. From the outset, Bell scientists and engineers have demonstrated an interest in acoustics that included a study of the physiology of speech so that speech might be encrypted for security reasons. Their direct practical interest has been in more economic word transmission. Inexorably heavier traffic made them seek means to transmit speech more speedily over noisier channels, without, however, the customer recognizing, or at least bridling at, the "degradation."

Because of such difficulties as "room boom," which still presents problems with amplified "speaker phones," Bell researchers were leaders in the study of sound in reverberant settings. Consequently they were asked to pitch in to help with the famous acoustical difficulties of Philharmonic Hall in Lincoln Center in New York City. Through sophisticated methods of acoustical testing and measurement studies they established physical parameters for Philharmonic Hall and several other concert halls and made useful comparisons by computer simulation.

At Bell Labs, the computer center is increasingly the heart of operations. The three major facilities in New Jersey—Holmdel, Murray Hill, and Whippany—all have computer centers which are tied into a system. (Human factors still count. At Holmdel the computer center is on the route to lunch and there is a tendency for people to drop off problems at the center on their way to eat. The computing center at Murray Hill does not get a big lunch-hour rush and is able to relieve Holmdel of part of its peak load.)

About computers, Bell Labs people display an in-on-the-ground-floor-attitude reminiscent of Democrats who supported Kennedy before the West Virginia primary.

In 1940, for example, George Stibitz, a Bell Labs technical staff member, built a "complex number calculator" using telephone relays for logic elements and a teletype tape control, and produced one of the earliest nonmechanical digital computers.

The electronic computer in recognizable form did not appear until the end of World War II. The relevance of these early machines was appreciated by those at Bell Labs, and they were put to use for network calculations. Research in solid-state physics and related development work at the labs in the postwar period contributed conspiciously to transistorization and the consequent emergence of the really big computers.

Use of computers in research rose steadily during the middle and late 1950's at Bell Labs, and since 1962 the total number of hours of computer use —allowing for changes in equipment— has grown at a rate of 50 percent a year.

In 1961 it was deemed advisable to start charging departments for computer use in a way that showed up in their budgets. But the policy has been anything but to discourage use of the machines. An "open shop" policy prevails in respect to use of computers. Courses in computer science are readily available and it is a point of pride that some 1400 people, among the 14,500 Bell Labs employees, are "programmers." To keep things moving at high speed, three small computers at Murray Hill are used to convert punch card data to tape to be fed into the big machine in order to reduce turn-around time.

Significantly, Murray Hill's representative on the committee which sets policy for the Labs' computer facilities is from the systems research group. The aim of systems research is the exploitation of new knowledge and technology for the Bell system, and according to E. E. Davis, Jr., executive director of research, communications system division, "The most virile systems area is stored data, the computer."

Systems researchers are concerned with two kinds of inputs: (i) the needs of the system not only immediately but in the future, and (ii) basic science, developments of new devices such as lasers, monolithic and integrated circuits, and computer uses.

In reflecting on computer use by the labs, systems researchers were struck by the similarity of problems encountered in using a computer system for research with the problems of the telephone system at large. The time-sharing problem was a common factor.

Owing something to serendipity, then, is the new electronic-switching system (ESS) which has been under development and is entering the awkward age between testing and operational use on a broad scale.

The heart of this system is a "central processor," a computer-like device which can handle 100,000 telephone calls an hour, about twice the number a large electromagnetical exchange can cope with.

Triggered by dial pulses, high-speed memory and logic circuitry calculate the best switching path for a call. A connection is made in a few millionths of a second, the circuit is scanned constantly and kept open during the call, and then the path is reopened virtually instantaneously when the call has been completed. Operating instructions and translations, on magnetized memory cards, are relatively easy to alter.

Western Electric will manufacture the central processors and other equipment for ESS. This will make the company a major manufacturer of computer-like machines. Because of the consent decrees under which Western Electric, as the manufacturing arm of the Bell system, operates, however, the company is, in respect to the computer market, very much in the situation of the child who was admonished to hang his clothes on a hickory limb but not go near the water.

Bell Contributions

Bell Labs' accomplishment in computer technology has been reinforced by a strong interest among many on the technical staff in information and communications theory. As with the computer, there is a lot of local pride about the Labs' contribution to the development of the theory, particularly that by Claude Shannon. For his papers in the late 1940's, Shannon is regarded at Bell Labs as the Columbus of information theory.

For the Bell system, the chief practical reward from Shannon's insights was probably his generalization on how to compute the maximum speed of transmission of error-free information over a given communications system.

Information theory has by now diffused into a collection of theories, but all owe a debt to the original proposition that a quantitative measure can be given to the content of information.

The proprietary familiarity with information theory that seems to be a part of the Bell Labs atmosphere may well add to the impression the visitor is likely to gain there of a widespread assumption that telecommunication is on the edge of a cybernetic revolution, one that will effect a dramatically greater extension of man's senses and reasoning power and work deeply significant changes in human society.

The vista that some scientists and engineers at Bell Labs see before them is sketched in this excerpt from a speech titled "Some social meanings of communications science and technology" by W. O. Baker, vice president for research of Bell Labs, which he gave at Georgetown University earlier this year.

. . . We must remember first of all that telecommunications represents an extension of man's senses, in contrast to his muscle. Much of our industrial and scientific revolution has been concerned with easing man's physical burdens and with multiplying vastly his ability to do mechanical work. Only comparatively recently, and particularly through the discovery of modern communication methods (including especially electrical communications but also involving rapid printing and certain other graphic arts), has it been found that physical science, that is, the behavior of elemental matter (and the energy, often in the form of waves, that is associated with it), can be coupled with the most subtle organic, vital qualities of mankind. These include his speech, hearing, certain of his reasoning processes, such as his ability to do logical, mathematical operations and to remember. Even more recently, indeed, even his senses of heat and cold and to a limited degree that of touch have been approximated by inorganic sensors, like thermistors, strain elements, and piezoelectric devices.

The philosophic imports of these dicoveries, which were really first dramatized by Bell's operation of the telephone, are just now being interpreted by such students as Professor Marshall McLuhan. These men are realizing that the whole concept of man's relation to his universe, even to inanimate nature, is being revolutionized through the extraordinary circumstance that it turns out that electrons and other charged particles (and also neutral atoms and molecules in audio systems) and the electromagnetic waves which permeate all the universe can be adjusted to exquisite fineness and controlled by man-made devices and systems. Most wonderfully, this is in a way which joins directly with his speech and hearing and seeing and sensing, and even certain elements of his thinking. And all at once we see that this strikes at the center of how one is human. The communications and organization and interactions of people and societies are deeply affected by this linking of physical effects with functions of the nervous system. Already it is clear that value scales of this technology diverge considerably (and we are not indicating whether they are up or down), but they are clearly dependent on different judgments and principles from those applied to things which extend to man's muscle, through energy conversion and machines. In the first place, the extension of man's muscle is a vastly more specific process, usually, than communications, or the extension of his senses, especially through telecommunications, where complex communities and groups are inevitably involved. . . .

Intimacy with computer-based research and technology breeds an expectation of things to come which makes many of the most matter-of-fact scientists and engineers talk like visionaries. At the same time, those who know computers best are most emphatic about the inherent limitations of the computer and do not ascribe to it any "humanoid" potential as monster or messiah.

The degree of difference in potential between old and new instruments is so great, however, that initiates, interestingly, do tend to slide into the use of anthropomorphic terms. An example is the feeling inspired by the new central processing equipment for ESS. The processor is really composed of two companion units, paired so that one monitors the other, shares work with it when necessary, and diagnoses ills and prescribes treatment for the other unit. One member of the technical staff concerned with the development of ESS evinced his feeling and turned a neat phrase when he called the processor "a large immortal machine."

—John Walsh

Information Services: A Guide to Federal Offerings

A variety of methods for disseminating scientific and technical information have been developed by organizations concerned with what is referred to as the "information explosion." Information handling services, many of them computer-oriented, are expanding rapidly but are still in a relatively young stage, and the overall system has not yet developed any great degree of rhyme, reason, or clear-cut jurisdiction. Outsiders generally refer to the services as "information retrieval," a casual label that tells only half the story. Information specialists divide the field into two parts: (i) "information retrieval," to designate the raw material, such as statistics, technical measurements, and research data; and (ii) "document retrieval," to refer to reports, articles, books, and other documents. Government agencies and private organizations alike are promoting the development of these services, and federal agencies, in addition to disseminating their own material, are cooperating in many of the nongovernment efforts. The result is an evolving system which, though still in an embryonic stage, can be extremely useful to the researcher who has some idea of where to look. The following is a primer on some of the information and document disseminating services available directly from the various segments of the federal government, what they purport to offer, and how an individual researcher can make use of them. The list is by no means complete, and in addition to these resources, the individual can take advantage of the services of many information centers operated under federal contracts or grants by professional societies, industrial organizations, and colleges and universities across the country.

The information seeker will find