AUTOMATED GOVERNMENT

How computers are being used in Washington to streamline personnel administration—to the individual's benefit.

By JOHN W. MACY, JR.

IN ANY EXAMINATION, whether in high school or college or in a civil service written test, it has never been considered cricket to show your paper to anyone else. In these days of automated examinations this same rule may be carried to the ultimate extreme: the only eyes that ever fall upon an applicant's civil service test may be his own. Even though the test may be sent across the continent, graded, and compared with the papers of other competitors, and even though the applicant may be hired and enter upon a lifetime career largely on the basis of this test, nobody but him need see it after he completes it.

This is one aspect of automation that bids to revolutionize personnel management in the federal government. Some may regard this feature as depersonalizing. But the truth is that mass examination scoring never was a highly personal activity. The automation of much personnel work of a clerical type may well serve to increase the personal attention managers can give to problems requiring human attention.

Automated examining techniques used by the U.S. Civil Service Commission may be both more advanced and more limited than the general public realizes. During fiscal 1966 the Commission's computer automatically scheduled more than 700,000 applicants to 1,000 examination points throughout the nation, computed the scores of those who took these nationwide examinations, and notified applicants of the results. On the other hand, these high-volume figures deal only with nationwide written examinations. In many instances, persons who apply for positions are not tested, but rather are evaluated by a team of experts in a specific occupation, and are graded solely on their previous training and experience.

For one of the 700,000 persons who applies for an automated examination, the initial action on his part is simple and easy. He files only a small card. In due course he receives an admission card, telling him to report at a specified date and hour at an examination point convenient to him. His examination has been scheduled by machine, and the time and location have been printed automatically. In the examination room, the competitor marks his answers to the questions by shading the appropriate block on a set of test-answer sheets. When the sheets are returned to the commission, computers then take over the next steps. Their output even includes a letter to the competitor notifying him of the test results.

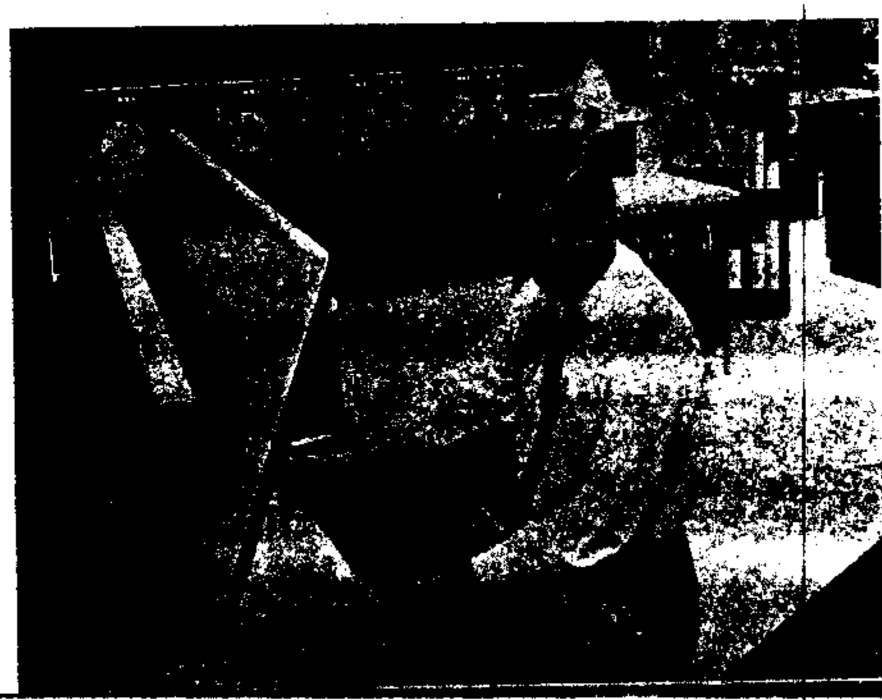
The notification letters roll out of the computer in one long sheet, are mechanically separated, and are finally stuffed into mailing envelopes virtually untouched by human hands. Not only is this process immensely faster, it is more accurate and requires substantially smaller expense than processing by hand. In addition, the computer is programed to check the validity of test results, to prepare studies showing how different groups of applicants performed on various sections of the examination, and to assist in establishing appropriate passing scores.

Automatic data processing has been applied to personnel management in the federal government for only about six years, yet the roots of the cybernetic revolution in government extend back to the 1880s. In fact, there is reason to think that the entire development of automatic data processing was initiated by an invention of a young Census Bureau employee appalled by the paper work of the 1880 tabulation.

Herman Hollerith was a young engineer working on the 1880 census. Seeing a need for something better than handwork on the mass of census statistics, he put together a tabulating machine that he called his "statistical piano." It was somewhat reminiscent of

A nation's records—nearly 6,000 miles of magnetic tape at the U.S. Internal Revenue Service's North Atlantic regional center contain records ranging from 15,500,000 tax returns to the payroll for 40,000 agency personnel. This is one of seven such data processing centers.

Business tax returns are being processed nationwide for the first time this year in the U. S. Internal Revenue's seven regional service centers. Honeywell 200 computers, such as this one, are used to check the returns.



John W. Macy, Jr., is Chairman of the Civil Service Commission.

a player piano, in that it used a roll of punched tape to feed instructions into the machine. People who, then as now, condemned the civil service for a lack of imagination and innovation, must have been looking the other way. Even the inventor may not have realized what he was starting, but in the 1890 census Hollerith's device was credited with saving two years of work and $5,000,000. Later it became the foundation for a phenomenal business—the company now usually referred to by the initials IBM.

The government also pioneered in the development and use of electronic data processing. One of the first completely electronic computers ever built was called ENIAC, for Electronic Numerical Integrator and Calculator. It was produced by the War Department and the University of Pennsylvania, working together in 1946 to solve problems in ballistic research. In 1951 the first commercial computer, UNIVAC I (Universal Automatic Computer), was installed in the Census Bureau, some three years before a private company put a UNIVAC into operation. The government received good value from its investment in UNIVAC I, running up more than 73,000 hours of operational use on the machine before retiring it to the Smithsonian Institution in October, 1963.

When first developed, the digital computer was used merely as a large and very fast calculating machine, or for complex accounting and statistical purposes. In government, priority was given to its employment in the primary mission of the agency by which it was used. By the early 1960s, however, the Department of Agriculture was using computer facilities for centralized personnel management data processing purposes. Its MODE (Management Objectives with Dollars through Employees) system is a large-scale centralized personnel record-keeping and reporting operation, utilizing a computer in New Orleans. In addition to records and reports, the system computes the pay checks for Agriculture's 100,000 employees throughout the nation.

The Veterans Administration, with 156,000 employees, was the second large agency to install a centralized, automated personnel system. This system, called PAID (Personnel and Accounting Integrated Data System), operates at Hines, Illinois. PAID encompasses general personnel management statistics and reports, career development and training records, a file on employees' length of service, payroll information to permit computation of checks by the machine, and information on the authorized number of positions as compared with the number of employees on th[...] system also contains a "suspe[...] personnel matters to be brou[...] certain dates.

Twenty-two agencies of t[...] ment now have automated [...] systems covering 1,500,000 fe[...] ployees. Systems covering an [...] 500,000 are being developed.

The Civil Service Commi[...] entered this field in admini[...] government-wide retirement [...] Through an automated proced[...] 000 retirement accounts are m[...] with an annual increase of 45[...] annuitants.

Three years ago a 5 per ce[...] in all current annuities was [...] by Congress. This necessitat[...] putation of the annuity for ev[...] on the retirement rolls. The [...] such a task was required it to[...] The added workload was aug[...] a stream of letters from Co[...] justifiably wanting to know [...] constituents were not rece[...] higher retirement checks. B[...] thanks to the wondrous capa[...] computer, 630,000 annuities [...] computed in just ten days, [...] started flowing out before c[...] and inquiries began pouring in[...]

The system is now being [...] pute deductions for Medic[...] for those annuitants who are [...] ing Social Security benefits[...] completed management stud[...] ment and insurance operatio[...] that over the next decade [...] $3,000,000 can be saved thro[...] automation.

Increased automation is [...] pected. But it is time to ask [...] questions about these system[...] they should be doing for us [...] personnel systems put into [...] the past few years are basical[...] keeping and reporting system[...] a serious mistake to think o[...] offices primarily in terms of [...] reports.

Personnel management is [...] concerned with finding the be[...] people to fill vacancies, insu[...] mum utilization of manpower [...] improving working conditions [...] by improving work—and provi[...] employment opportunities t[...] zens, not only at the poin[...] into the service, but throu[...] promotions, and full career de[...] Seen from this perspective, [...] of personnel operations is jus[...]

As we advance, the quest[...] is this: Which parts of t[...] computer do better—and wh[...] do better? We know that a [...] management is actually cle[...] making, though we have of[...] it in the past with the word [...] It requires the identification [...]

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facts and the selection of predetermined actions on the basis of those facts. This a computer can do beautifully.

In scheduling civil service examinations, for example, our computer makes "decisions" of this kind by the thousands. Why should the time of a man or woman be devoted to such work with less accuracy and little satisfaction? We have other work for men and for women, in which they can do a far better job using the huge data resources of the computers. This work involves decisions on personnel planning, the matching of men and jobs, the forecasting of manpower needs, and the important decisions of career-planning.

For proper decisions in these areas we must have integrated information systems. This will require the use of information across departmental boundaries. It is here that current efforts to standardize symbols and codes will pay dividends. Direct tape-to-tape feeding of data from one department to another may become common. These systems will mesh well with developing plans for an executive-level staffing program which will be designed to locate the best possible man for any given top-level assignment, no matter where in government he may be serving.

The computer's ability to search its perfect memory and pick out records of individuals with specific characteristics has been applied in the search for candidates for Presidential appointments. A computerized file containing the names and employment data of some 25,000 persons, all considered likely prospects for federal appointive positions, is searched electronically. This talent bank, with its automated retrieval system, broadens the field of consideration for the President in critical decisions of leadership selection.

Throughout the government, one of the great responsibilities is to provide true equality of opportunity in employment. To know where we have failed to provide it, where we have succeeded, and how best to plan, we need a multitude of data. Through head-counts we know only that a certain number of Negroes, for instance, were on the rolls in certain grades at a certain time in the past, and now we can count that there are fewer or more. But these data do not reveal whether the people in certain jobs came from lower jobs or from outside the government. They do not assist us in recommending training or evaluating it. They fail to give us the management information required to do a conscientious job in creating conditions that will make a reality of equal opportunity.

To obtain additional and more accurate information, a new effort has been initiated in this area. By means of a voluntary racial designation prepared by

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PLUG-IN INSTRUCTION

Computers, harnessed to teaching machines and television, promise a new era in universal public education.

By PATRICK SUPPES

CONTRARY to the expectations of many, the computer may make classroom teaching more, rather than less, an individual affair. And in doing so it will facilitate learning at a speed and depth of understanding that now seem impossible to achieve.

The theme of individualizing instruction is very old in education. Psychologists long ago documented the fact that individuals differ in their abilities, rates of learning, and even in their general approaches to learning. And educators have concluded that, ideally, the most effective teaching is that which is tailored to the needs and abilities of each individual. But the costs of providing individual instruction in a society committed to universal education are prohibitive. Meanwhile, administrators and teachers continue to struggle with the problem by such means as grouping students with roughly similar abilities, and following the concepts of the ungraded classroom and of team teaching.

Surprising as it may seem, the burgeoning technology of computers may offer one of the best means of providing individual instruction at reasonable cost. A handful of experiments throughout the country already are exploring the varied possibilities of this new type of individualized instructional technology.

Computer-based teaching systems, designed to aid the teacher in the individualization process, consist of a variety of student operated instructional devices. These learning machines are not to be confused with the large class of so-called "teaching machines" of recent years—frequently identified with the educational process of programed learning. Typically, these mechanical devices dispense instructional material in a fixed sequence of small, easy-to-take steps of one or two sentences, usually followed by a question. All students traverse the same sequence regardless of differences in background and aptitude. With computer-based teaching devices, however, the student will study

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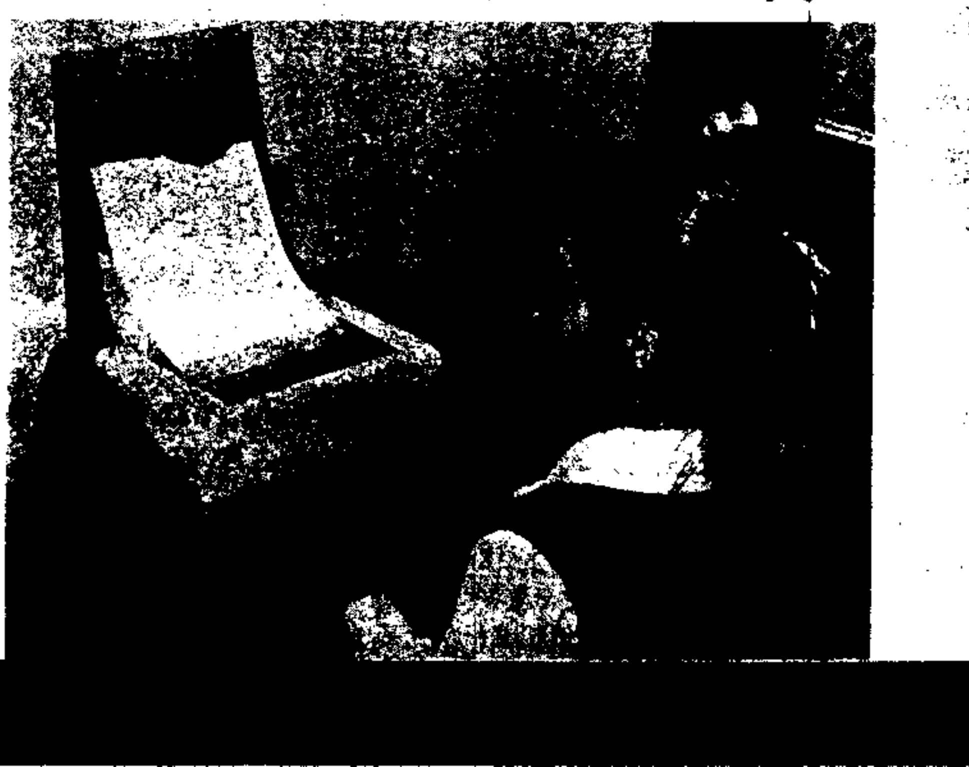
Professor Suppes is Director of the Institute for Mathematical Studies in the Social Sciences, Stanford University. This article was adapted from *The Computer in American Education*, to be published this fall by John Wiley & Sons.

Working at a teletype keyboard, this fifth-grader types out the answer to a problem sent by telephone line from Stanford University. The teletype booth is placed in a corner of the school classroom, and each youngster spends about five minutes a day working on a drill at one of five levels of complexity. As each child works through a drill, the computer records his total time, correct or incorrect answers, percentage of problems correct to date, and the total time in the program.



Government

Continued from page 25

employees themselves after employment, reliable information now can be fed into computers where it can be confidentially stored and used.

Most federal managers need more knowledge of computers in order to best use their capacities. With this in mind the commission last year established an ADP Management Training Center in Washington. More than 2,300 federal employees have attended its sessions.

There seems no doubt that increasing use of computers in government, accomplishing many of the clerical tasks by machine, will affect the skill requirements and the "occupational mix" of government service in the future. The Civil Service Commission has made an extensive study of this question, and is giving it continuing attention. Employee displacement has not been extensive; with intelligent planning an agency can prevent hardship for the employees affected.

An outstanding example is furnished by the Internal Revenue Service, which has done an exemplary job of minimizing the impact on employees in its extensive ADP conversion program through advance planning, and intensive retraining and placement efforts. This is the kind of personnel job no computer can handle.

This seems to me to be the answer to those who fear that computers will de-emphasize humanity. Far from it! By removing the clerical decisions and the mass of paperwork details the computer may well free the mind of man for more worthy use.

Already it has heightened the need for imaginative and innovative managers who can grasp ideas, think in broad, philosophical terms, and apply such terms in decisions relating to public welfare. It has forced a finer degree of quantitative precision in executive judgment. It has liberated the manager to give his mind to greater scope of creativity. Rather than degrading the worth of the human being, the computer has placed a premium on man at his best.

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WHITHER PERSONAL PRIVACY?

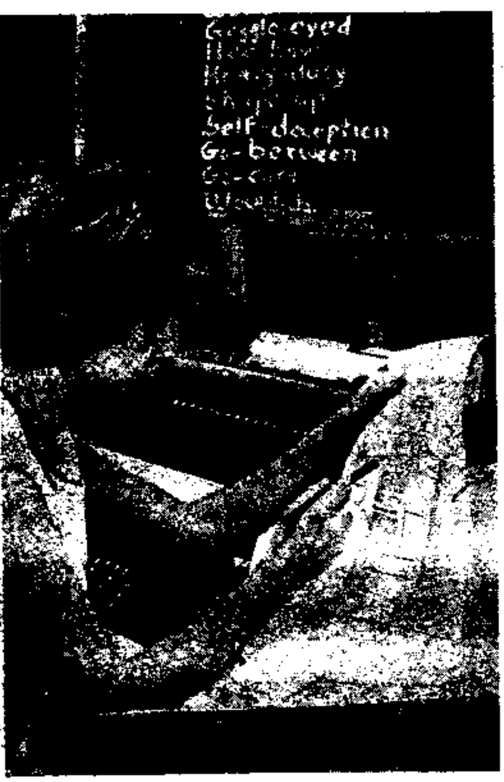
Computer technology may enlarge Man's liberty or inhibit it; new rules must be made; new questions answered.

By JOHN LEAR

BETWEEN my resignation as an editor of the slowly dying *Collier's* and the inauguration of *SR's* Science and Humanity Supplement, I was for a short while a minor adviser to Thomas J. Watson, Jr., son of the founder of the International Business Machines Corporation. My experience there contradicted two popular beliefs about IBM.

The first belief was that all IBM employes were required, as a condition of employment, to wear white shirts on the job, stay sober at home, and maintain upright on their desktops identical copies of a small sign bearing the personal command of Thomas J. Watson, Sr.: THINK. I wore light blue shirts, drank cocktails at lunch, and put the THINK sign on the windowsill of my office whenever my secretary put it back on my desk; yet I had a standing invitation to young Tom's sanctum.

Automatic type composition by the IBM 1130—"a computer can do only what it is told to do."



The second of my working conditions that ran against supposed IBM tradition had to do with that then-new phenomenon, the so-called "giant brain," or high-speed electronic computer. IBM has sold an enormous number of electronic computers. According to legend, a loyal IBM salesman would leave his wife if necessary to clinch another sale. The truth about IBM computer sales, as I experienced it, was that an immense share of IBM's sales investment went into persuading eager customers *to delay the purchase of computers.*

Delaying was sound business practice because a computer can do only what it is told to do; it must follow instructions literally; until the instructor himself is sure where literal pursuit of a long series of tiny steps will lead, turning the task over to a computer can be dangerous. The machine may complete its assignment before its owners realize that the outcome isn't really the one they seek.

The period of my IBM experience dates back roughly a dozen years. At that time, computers could do only one thing at a time, in sequence. Computer programers—the people who break everyday English into binary arithmetic messages (consisting entirely of numerical zeros and ones) comprehensible to the machines—were such valuable individuals that IBM allowed them to sit at the computer control consoles as long as necessary to figure out flaws in the translation process. Since then, the speed of the machines has risen, the size of components has shrunk, and computer sophistication has grown to such a state that a machine can do a number of different things at a time, not necessarily in sequence.

As a result, the computer's time is worth upwards of $300 an hour—too valuable to be wasted by a programer's head-scratching; and each programer now must figure out unexpected problems in a separate place while the computer goes on with other people's problems. In other words, it is now possible for wrongly instructed computers to make more disastrous and far-reaching mistakes in a shorter time than ever.

Paul Baran, of the RAND Corporation in Santa Monica, has studied this dilemma more searchingly than most observers of the phenomenon.

"As we pass through life," he reminds us, "we leave a trail of records, widely dispersed and generally inaccessible—except with a great deal of effort and diligence. Beginning with a birth certificate, we accumulate hospital and medical records. We become deductions on our parents' income tax. In school, we generate records of our grades, attendance, IQ tests, personality profiles, etc. (Automated teaching will add to this record keeping. The volume of data recorded per child may be expected to increase even more markedly.) After school we start accumulating employment, social security, and selective service records. We may get a driver's license. Most of us will apply for marriage licenses, and some of us will collect divorce decrees which will end in voluminous court records. If we are lucky, we will be able to avoid having arrest and jail records.

WE move from job to job in a mobile economy creating moving-company inventory records of our goods. Even as we move from place to place we leave behind short records of our airplane reservations and, for some reason, every hotel makes a ritual of acquiring and preserving the alleged names and addresses of its guests for posterity. This is only a partial list. Think of all the records you leave as you go through life.

"Behind all this creating of records is the implicit assumption that they will some day be of use. In order to be of use, there must be some means of interrogating the files to resurrect the information sought. . . .

"An Internal Revenue Department investigator might wish to have immediate access to the tax returns of each of the associates of a man who is being audited, in order to check on consistency of financial relationships.

"A company may wish to have rapid access to its personnel files to know whether to give a good reference to a former employee.

"A doctor may wish to trace the entire medical history of a patient to provide better input into a diagnostic computer.

"The Veterans' Administration may wish to examine a man's complete military record and *possible other* previous medical records to see whether the ailment claimed as being service-connected really is service-connected.

"A lawyer for the defense of a man will wish to search for jail and arrest records, and possibly credit records of *all* witnesses for the plaintiff.

"Professional licensing boards may want to delve into *any* records to determine if an applicant has an unblemished character.

"The military in filling extremely sensitive positions may even wish a record of all books borrowed by a prospective

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applicant to insure that his interests are wholesome and he possesses the proper political bias desired.

"Today it is difficult to gather such information about a prospective examinee. If one went through direct channels and asked most sources for their records about a person, he would most likely be rejected, if for no other reason than that the information is not available—cheaply. Even if the records were publicly available, the investigator would have to spend a great deal of time and effort delving through to discover pertinent data. Today, as a practical matter, if one wishes to obtain certain information about a person, he hires a private detective who charges a great deal of money and expends a great amount of time obtaining a little information available from a portion of these potential records. The price for a fishing expedition for information is high and most of the fish are inaccessible."

HAVING thus summed up "the pleasant past," RAND analyst Baran looks into the future through a three-step review of established processes of computer storage of information. STEP ONE: Manual records are kept by human clerks. STEP TWO: Some of the clerks are eliminated by putting all the records into a central computer file with read-out of the records controlled from a single point. STEP THREE: Information is read into and out of the file from a large number of different points.

Baran envisages connection of one remote-access computer with other similar computers, and through this, "danger of loss of the individual's right to privacy as we know privacy today." "The composite information data base may be so large and so easily accessible that it would permit unscrupulous individuals to use this information for unlawful means," he warns. "Modern organized crime should be expected to have the financial resources and skills necessary to acquire and misuse the information."

He expresses concern not only over the possible creation of "automated blackmail machines" but over the potential addition of "inferential relational retrieval techniques" now being developed which, "when fully refined, could determine relationships of any person, organization, event, etc., to any other person, organization, or event." Noting that "humans, by their day-to-day necessity of making decisions on totally inadequate evidence, are innately prone to jump to conclusions when presented with very thin chains of inferred relationships," he predicts an increase in the already growing practice of unearthing defaming information about candidates for political office.

The Baran forecast of computer hazards is fortified by the studies of another RAND researcher, M. R. Maron.

"Consider," suggests Maron, "what could happen as machines are used to make decisions about people. For example, consider a situation where a computer is programed to decide who should get a security clearance from the government, or who should get an education loan, or whether someone's driver's license should be suspended, or who should get a passport, or who should be accepted for the Peace Corps or the Job Corps, etc.

"As larger files [of machine-language data, stored in computer memories, linked cross-country by telephone] become accessible there will be a natural tendency to use machines for the automatic selection (or rejection) of people according to some pre-programed set of criteria. Supposedly these criteria will have been carefully thought out before programing the machine. Even so, the implications are dangerous.

"In such a mechanized situation, how does an individual get an opportunity to 'tell the system' that its selective criteria don't apply to his own special case? Each individual is different, each has certain extenuating circumstances, each has information which he believes to be relevant to the selection decision and which the system does not consider relevant. And so on. If an individual does not have the opportunity to be judged on the circumstances of his own special (individual) situation, *then he is being treated as a machine!*

"Will there be a tendency in the future to create an environment where we treat each other as machines; *i.e.*, where there is no opportunity to 'change the system's mind'? How can we create a society where we treat our citizens as people and not as machines? How can we create a society where each individual has the opportunity to explore and unfold his own special potentials—to realize what he is?

"These questions lead to further questions—to questions about who we are and what it means to be a *person*. And this brings us to the problem of *values*. What kind of a life do we want? What kind would we value—ought we to have? How can we create a society that fosters those actions and goals that we value? How define and explicate values? How measure and compare and rate values? How select among competing values? How can we estimate the impact of computers on our values?

"And if our projections into the future suggest that we are heading toward a future society which is not conducive to a 'good' life, what can be done to isolate the trouble spots and to influence those changes that will prevent the possible 'evils'? Such analysis of future prospects implies prediction, evaluation, and then some attempt at control. Can the process of control be made democratic so that a small professional élite does not dominate in influencing the shape of the future?

"Finally, there is the problem of time—the time that it takes to initiate and complete corrective action. Given an analysis of the impact of computers on society and given some corrective action that must be taken in order to avoid some future situation, how long a time lag will occur between corrective action and modification of the situation?"

The positive cultural potential of computers was emphasized last January in a report to President Lyndon B. Johnson by The National Commission on Technology, Automation, and Economic Progress. Although this report dissented from the "almost . . . commonplace [opinion] that the world is experiencing a scientific and technological revolution" of sufficient power "to make our economic institutions and the notion of gainful employment obsolete," it proposed serious consideration of development of a computerized "system of social accounts" capable of analyzing accurately in advance the benefits and costs of any socio-political experiment. Such a system theoretically could grapple competently with complex problems such as water and air pollution, urban blight, the transportation tangle, integration of the Negro into American society, and the continuing spread of crime.

The Presidential Commission report

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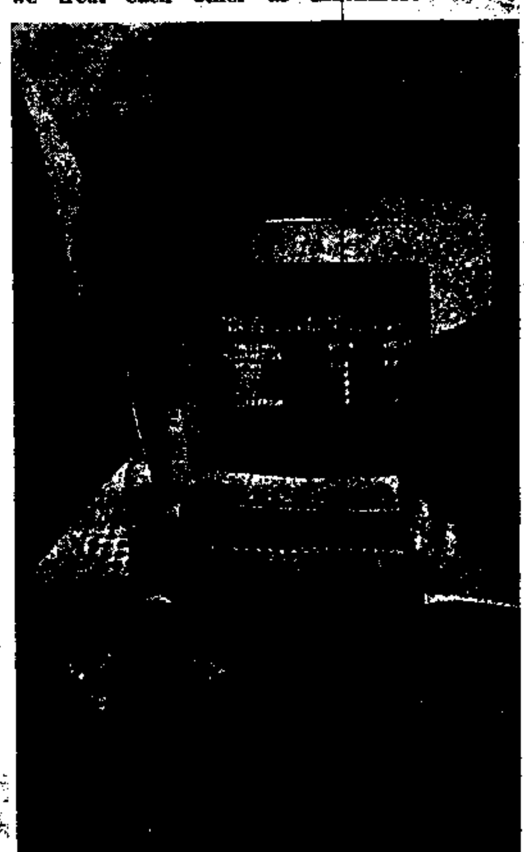
Sales records being checked electronically—"Will there be a tendency in the future to create an environment where we treat each other as machines?"



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defined the phrase, "system of social accounts," to include mixtures of systems analysis, simulation, and operations research in proportions required for particular cases. Systems analysis and operations research are now in wide employment in military planning and extraterrestrial space exploration. Simulation techniques are part of current plans for global weather observation and forecasting.

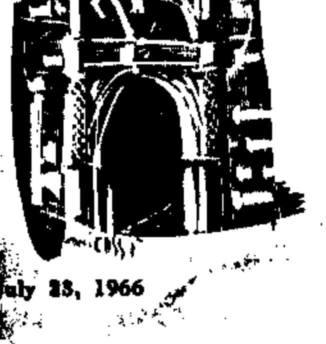
How close are we to a workable "system of social accounts"?

One of the best informed men on earth on the subject of computer development is Dr. Cuthbert Hurd, chairman of the board of Computer Usage Company, Inc. In addressing the National Automation Conference of the American Bankers Association in Chicago last month, Dr. Hurd observed that no computer manufacturer today markets an "operating system" flexible enough to apply all the diverse talents of computing machines to any complex problem.

"I suppose," Dr. Hurd told the bankers, "that as much as 200 man years of effort might be required to produce a modern operating system, costing say $5,000,000."

If such a system were to be perfected, Dr. Hurd said, "it is still unclear whether proprietorship [of the system] could be maintained under the existing patent or copyright laws."

There are two ways, then, to state the challenge of computerized society. One was succinctly put in a recent issue of *The American Scholar* by Lynn White, Jr., professor of history at the University of California in Los Angeles: "Must the miracle of the person succumb to the order of the computer?" The other statement comes from Paul Baran: "What a wonderful opportunity awaits us to become involved in such problems as to exercise a new social responsibility."



THE NEW WORLD COMING

Tomorrow's computers will revolutionize business, education, communications, science—in ways only dimly foreseen.

—Honeywell.

Computerized composition—books for the blind now can be translated into Braille by computer 100 times as fast as with standard methods.

By JOHN DIEBOLD

It is an extraordinary era in which we live. It is altogether new. The world has seen nothing like it before. I will not pretend, no one can pretend, to discern the end; but everybody knows that the age is remarkable for scientific research into the heavens, the earth, what is beneath the earth; and perhaps more remarkable still is the application of this scientific research to the pursuit of life. The ancients saw nothing like it. The moderns have seen nothing like it until the present generation . . . The progress of the age has almost outstripped human belief.

THOSE WORDS were not spoken today—though I choose them to set today in perspective—but were used in 1847 by Daniel Webster when he opened a new stretch of railroad track in New Hampshire. A greater parallel exists between that era and our own than we normally realize. In that earlier era, science first began to be applied on a wide scale and out of that process came an entirely new society—an industrial society. Out of it, too, came problems, many of which still plague us. When we look back at that great technological upheaval, the real significance of those then-wondrous machines is the human and social change that accompanied their industrial use.

Just as yesterday's innovations proved to be moments in history—way stations leading to newer technology—so today the conception of the computer which we have learned to accept is becoming a thing of the past. Up-to-date systems are no longer glassed-in, carefully isolated accounting machines. Instead they perform an almost limitless variety of functions, and vary with individual requirements.

For example, the newest computer systems may appear as input/output units in individual desks; small television-like screens with keyboards and copying devices. When you ask a question you see the answer almost simultaneously on the screen. If you want a copy of the answer, you can make it immediately. The heart of the system is a switching center rather like the telephone system. Computers, storage elements of many varieties, and many other devices used as part of the system are accessible as you need them, connected through the switching center to the terminal unit at your fingertips. Thousands of people may use such systems at the same time, and each need know no more about the operation of the system than the average person knows about the telephone. In the next decade the typical computer system is going to be of this kind.

Another radical change stemming from these new computer systems involves the relationship between man and machine. One no longer need carry data down to a computer center, or go through a laborious process of getting it into the machine and then waiting for results. Each technological development is moving us toward an easier, more productive relationship between man and machine. Already, for example, a computer can transpose a rough design into exact specifications. If an engineer makes a free-hand drawing of a bridge on such a system's television-like screen, the computer will convert the drawing into exact engineering specifications, will calculate and display materials and stress, and show the design in whole, in part, or in any perspective, in immediate response to the engineer's requirements.

LOOKING ahead, we see important changes in technology such as chemical memories; fluid and pneumatic systems that have instantaneous response; ability to store images, graphs, drawings and photographs, and to transmit them around the world. All these will be important elements of future computer systems. Graphic elements and the ability to communicate with TV screens are already becoming influential in progress being made in computer design. Yesterday these elements were undreamed of.

Work is being done on language translation by machine. Some document-translation is already on a regular production basis—in fact, people are now attempting to digest articles by machine. This work is still in its beginning stages and there are many problems to be overcome. But the history of this technology is that what seems impossible today becomes an accepted part of our lives tomorrow.

Development of voice recognition by computer, while rife with problems, also is yielding results. Despite all the difficulties, voice-recognition equipment can be purchased today. No serious forecast about computer systems in the 1970s can omit voice recognition systems with several-thousand-word vocabularies. If this sounds unpromising, remember that only a few years ago people used to have two- and three-day meetings to discuss the problem of keeping records on magnetic tape. How naïve that seems to us now. Today, we already have machines that learn (they are called heuristic machines), that devise their own route to a goal or solution; machines that recognize patterns; and machines that can devise their own strategies—for example, winning at games with the men who design them.

Adding tremendous impetus to the technological explosion is the fact that, as computer capabilities are increasing, costs are decreasing. Between 1963 and 1972—a single decade—there will be a decrease of 85 per cent in the cost of completing a typical data-processing job. During this period, the cost of storage by magnetic tape will go down by 97 per cent; the cost of image storage by 96 per cent; and communication line costs, because of increased speeds of transmission, will decrease by 50 per cent. These changes in economics will

The author, who generally is credited with coining the term "automation," is head of the Diebold Group, Inc., management consultants.

mean that we will be able to do more with information technology than we now can even imagine.

Let me turn now to the problems of putting these machines to work.

NOWHERE is the turn toward technology more obvious than in the *way* we manage. When we first started to apply computers to business operations in 1954, we went through a very difficult experimentation period and were faced with the most puzzling kinds of problems. We have largely emerged from that period, however, and today we are using computers in business for almost everything conceivable—and much that was not just a few years ago. Senior management has begun to realize that the application of this technology is too important to leave to technicians, and that dramatic things can be accomplished if people who know the objectives of a business will take the responsibility of putting these new capabilities to work. When this happens, you find remarkable achievements.

But along with this progress have come new questions and problems. There are, for instance, union negotiation questions. Throughout the country, a number of owners of newspapers have been willing to stake the very existence of their enterprises on the right to install a computer to prepare punch-tape to drive linecasting machines. Just over the horizon, it is clear that this entire process will be bypassed. Is it worth risking an enterprise on a process that is disappearing?

There are many similar questions. What kind of men, for example, should be trained as managers in the new technological environment? How do we create an atmosphere that is conducive to creative people—for more and more of our businesses must be staffed by highly educated and creative personnel? These are only a few of the problems we face.

Most important are the human aspects. They are related to every problem we have in this field: questions of fear and uneasiness when faced with technological changes; questions of education; questions of identification with an enterprise, with a profession.

But along with the question of how we manage are questions concerning what we manage—of new areas of business opportunity. Here, I will speak of four main new entrepreneurial opportunities. The first is the obvious one that has already taken form – the industry that supplies the systems and the equipment. It is already a multi-billion dollar industry, and this is only the beginning.

The second example, as yet nonexistent but about to bloom as an important basic industry, is the data utility field. This is analogous in some ways to the electrical utility industry: It is cheaper for many people to use a central utility than for each individual to have his own generator. The same economic reasoning applies to the data utility industry, where many people can use a machine simultaneously. The technology of real-time processing, time-sharing, and communication will allow this to happen. Small and medium-sized businesses—and for some purposes large businesses—will just plug in for data processing as we now do for electricity.

The third example is the one now being called the inquiry industry—in some ways, the publishing field of the future. This will allow the sale of proprietary data over a communication system in answer to a query placed by the customer. The possibilities are unlimited; practically any information can be provided. We have already started to see the purchase of publishing firms by electronic companies, and this is just the beginning. There will be major changes in ownership in this area in the near future as businesses begin to position themselves to offer such services.

THE fourth example is an industry of computer-based educational systems. As technology allows a dynamic or "alive" relationship between a student and a machine system that answers questions as they are posed and discerns gaps in a student's basic grasp of a subject, the much-heralded but until now disappointing teaching machines (better, I think, called learning machines) will begin to mean something. Such systems are already at work in some industrial situations—IBM's Maintenance Training being a good example. Other precursors can be seen in mentally handicapped children's use of computer-driven typewriters to help them overcome some of their handicaps.

If there is one salient fact about information technology, it is that it is going to produce enormous social change. As the quality of life is changed, as the rate of learning, information, travel, and communications all change, we will see a major change in living patterns, in hopes and desires. In short, a complete new environment will exist.

Computers in medicine—at the Heart Disease Control program field station in Washington, D.C., electrocardiograms can be received by phone and analyzed by a computer in less than a minute.

(Left) Technician monitors wave patterns on miniature oscilloscope.

(Above) Dr. James K. Cooper of George Washington University Medical School studies an analysis typed out in numerical form by a teleprinter.