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Economic Considerations in the Use of Electronic Computers

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(Based on a Talk to a Meeting of the American Management Association, New York, June 29, 1962)

Computer economics is, as it should be, a much-discussed subject these days. It can be a controversial subject, too. In the Federal Government we are in the position of being able to look back upon a broad base of economic experience in computer utilization. We believe our findings are most interesting and we welcome the opportunity to share them. I may give a broader than usual meaning to the word "economics" since in my personal judgment sound economics equates with sound management; thus, if the management of our computer resources is less than sound, it is to that extent uneconomical.

The Federal Government was the first organization to use both special-purpose and commercially-produced computers and today is the biggest single user. Our utilization of commercially-available computers began back in 1951 when the very first UNIVAC was installed at the Bureau of the Census. As of today there are more than a thousand computer configurations at work in the Federal Government in science, engineering, and administrative management, and in the business management of our operating programs. Many others are used in military-tactical operations and classified work. Our annual outlay for operating our computer equipment is estimated at over $3 billion. A sizable number of our computer-based systems have been in operation now for several years, although quite a few are relatively new.

The economic guidelines the Government now uses, described here, are *general* guidelines applied to the total Federal Government program of computer utilization. There can and will be cases where certain of these guidelines, no matter how stable or logical, may not be feasible to apply. And in view of the rapid developments in the computer field, we can be sure that some of today's economic guidelines will need modification tomorrow.

The Case for Utilization

One of the lessons we have learned well in the Government is that the use of computer equipment becomes truly justifiable only under certain circumstances. At this point in time, we have been able to identify three situations in which computer utilization seems justified.

First, is the situation in which greater speed in processing data is both a wish *and* a necessity. I stress the word "both" because although the *desire* for increased processing speed is a perfectly natural one, the *necessity* for compressing time and distance is not always apparent, except in the minds of those who desire it.

The *second situation* in which the use of computer equipment appears justifiable is one in which the complexities of data processing cannot be simplified, to the extent that simplification is truly required, without electronic assistance. Every system has its complexities. Many complexities can be simplified without the use of any form of automation. A great deal in the way of simplifying complex systems has been accomplished by the use of what might be called mechanical or electro-mechanical devices, such as adding or bookkeeping machines, the electric typewriter, and punched-card equipment. The electronic computer is a most effective means for simplifying the complexities of systems, but other means, which have been available to us for many years, also can effectively be used.

The *third situation* in which an electronic computer can frequently be justified is when the investment in computer equipment is substantially offset by the monetary or qualitative values we place on the beneficial results of its use. This is such a broad generalization that I need to reduce it to more specific terms by explaining the kinds of beneficial results I have in mind.

First, there is that kind of result which multiplies management effectiveness by improving the capabilities of executives to perform their managerial tasks. Executives generally are not informed as adequately as they should be. Much of the information they get is out of date when they get it. Some of the information they get is dangerous to use because of its inaccuracy. A great deal of the information the executive should have he doesn't get at all. Consider also the fact that the average executive gets much more information than he has time to use and some information he doesn't know how to use. So, when other means fail and we can employ the use of man's ingenuity and the computer to increase substantially the effectiveness of our executives at all levels, we have a sound justification for computer utilization.

A second example of beneficial results is the accomplishment of a higher degree of efficiency in our data processing systems and thus improving our effectiveness in using our resources of men, money, and materiel. This is another generalization, of course. In the Federal Government, we find organizations which with sound systems engineering are accomplishing as much as two hundred per cent of the volume of work that was handled before the installation of a computer, but are performing the increased volume with the same or a smaller number of people than they employed before.

A third type of beneficial result is the improvement of the quality, the timeliness, and thus the usefulness of the products and services provided by our data processing systems. With the help of a computer we can produce, for management's use, information that is up-to-the-minute and far more useful in other ways than was true under former systems. The result is that managers are now in a position of taking *timely* action on an *informed* basis in more situations than was ever before possible. This is one of the real plus values in using computers. I should point out, however, that this doesn't just happen; it isn't available off the shelf. It takes the ingenuity and resourcefulness of people, along with the capabilities of a computer, to bring it about.

And finally, one more beneficial result—one that has not so far been as evident as we would like, but one that seems destined to be by all odds the greatest payoff of all. This is the potential of the computer for introducing into our data systems the kinds of sophistication that heretofore were either out of reach or had not entered man's mind. Many people, in and for the Government, are researching for ways and means to capitalize on the seemingly unlimited possibilities for results of this kind.

This in capsule form is the case for utilization.

The Case for Economic Feasibility

Assuming we have a situation in which we are justified in acquiring a computer, I want now to present a case for economic feasibility in its use. We find that there are seven conditions which ideally speaking should prevail if we are to use computers economically. While I refer to these as "conditions", I could just as well speak of them as necessary elements in creating a proper economic environment for insuring a fair return on our computer investments.

The first condition is this: There should be a well-policed policy requiring that the functions or processes involved in the system to be automated should first be examined or re-examined and be established as indispensable to the accomplishment of the mission of the organization. The mere fact that something is being done or has always been done is not in itself a case for continuing to do it. One looks a bit ridiculous when, for example, he produces on a computer, in minutes, an end product that used to take weeks or months to produce, only to find the product could be dispensed with. But this happens. And it happens frequently, as you must know. When it does, the blame lies not so much with the people who man the computers as it does with management itself *and* with the systems engineers who were responsible in the first instance for considering the automation of a process, the value of which was suspect from the beginning. In the Federal Government, there is now a prevailing policy which provides that every function, process, or program that is considered by an agency to be a computer application shall be firmly established beforehand as having a distinct and useful place in the operations of that agency.

The second condition: Systems must be efficiently engineered. In designing systems that will involve the use of a computer we simply cannot settle for less than the best competence in systems engineering. As a matter of fact, in every case of ineffective computer utilization I have reviewed, the major contributing cause (and at times the only cause) was inefficient systems engineering.

What constitutes efficient engineering of a computer-based system? By "system," I do not mean computer hardware, but the functions, procedures, processes, and routines that the hardware is to be instructed to perform.

There are several basic principles which in my judgment apply. The *first* is that systems should be designed to process data at greater speed *only* in those situations where speed is truly essential and worth the price. When you use a computer to track a missile or to guide a satellite in orbit, speed is of the essence. In the name of science or security, we pay premium prices for speed. And we must. However, when with a computer we produce a document for a manager on the first Monday of a calendar quarter even though we didn't previously produce it until the third or fourth Monday, is this speed-up feasible? Is it worth the price? An answer to questions such as these isn't always in the affirmative. We have our share of people who can't seem to resist the fantastic speed of a computer. Substantial outlays of funds have been made to achieve speed for the sake of speed alone. Luckily for the taxpayer, these unjustified speed-ups are being minimized in the Government. This is another way of saying that our systems engineers are getting smarter. Certainly, speed is an important factor in a majority of our systems and at times is so important that the payment of a premium for speed is justified.

A *second principle* in computer systems engineering is that there should be a distinct and useful purpose for each of the products of the system. It is part of the job of the systems engineer to insure that the system shall produce only those end products that are usable *and* used by the people whom the system is designed to serve. This principle brings into sharp focus the concept of management by exception. We find that the computer opens the door to an even greater adherence to this concept.

A *third principle* which should be observed in systems engineering, if we are to use computers with the greatest wisdom, is that ordinarily it is not profitable to involve the computer solely or primarily with relatively simple housekeeping tasks such as payroll, financial accounting, personnel transactions, and general statistics. Don't misunderstand me. Housekeeping tasks make desirable computer applications. However, the use of the computer in the substantive and the usually more complex operations of an organization should also be considered. Usually they are harder and more complex. They may take more time. But we can more quickly produce a favorable return on our computer investment if we also concentrate our system engineering efforts in those areas of substantive operations which represent a substantial potential payoff.

A *fourth principle* in systems engineering is that we employ data processing cycles that are consistent with realistic management controls. For example, we have in the Government, particularly in the military departments, some very sizable and complex inventory control systems. There are inventory control points at each of which as many as several hundred thousand line items of supply are controlled centrally, with the help of computers, on a world-wide basis. This is an essential control in a vast system of this kind, but it raises questions about such things as, for example, how often those inventory records should be updated. With today's modern equipment it is entirely possible to update an inventory or a portion of an inventory on a daily basis. It is possible, of course, to update it less frequently, such as weekly or monthly. But what is the optimum frequency? This kind of decision should not be based solely or primarily upon equipment capabilities. The fundamental question is whether or not it is realistic to pay the extra price for daily updating when weekly, bi-weekly, or monthly updating of inventory records is sufficient for management purposes. The system can and should be engineered to be consistent with decisions of this kind; not primarily upon what the hardware can do.

The *fifth principle* in efficient engineering of computer systems is that the systems engineer must be able to foresee and to take or recommend actions concerning the potential impact of the new system. Experience shows that this impact is both substantial and varied. It will not take care of itself. Computer impact can be foreseen and measures can be taken to cope with it. The systems engineer may not be the person who will take the necessary measures. However, as the designer of the system, he should be able to point out what types of impact are to be anticipated and to suggest measures to deal with each. One kind of impact is organizational. We have seen in the Federal Government many examples of how the organizational structures of agencies have changed in substantial degree due to changes in systems because computers are used. Another type of impact of the computer is that it displaces people, sometimes in large numbers. By displacements I mean the shifts that become necessary among jobs and people; shifts that involve retraining, early retirement, transfers, perhaps a few promotions, and maybe some layoffs. Another type of impact involves shifts in traditional staffing requirements. Frequently, for example, low-graded clerks are being supplanted with higher-graded technicians. There are certainly training implications —training not only of the people who are going to operate the system, or operate the equipment that is used in connection with the system; also, the training of managers and employees to accommodate the innovations that the new system will bring about. There are changes in an agency's relationships with its clientele. There are potential shifts in policy, in regulations, and at times even laws must be modified. We find that a computer system often will pose certain peculiar or additional communications problems. Almost invariably, when a manual or mechanical system is re-engineered to be operated with a computer, a usual result is a vast job of converting masses of data on hand or in process to some different form in order that it can be accepted by the computer as input.

These are some of the types of impact that the systems man can foresee. If he does not, or if he does foresee these things and takes no steps toward coping with them, his systems engineering is less than efficient.

A *sixth principle* to be observed by a systems engineer is that his work in systems planning should take into consideration the added possibilities available to us today for integrating data systems of various types. In the Federal Government, we have already accomplished a sizable amount of systems integration. What used to be a series of closely-related systems, today in some instances has become a single system. Take for example our administrative systems—by this term I mean such systems as accounting, payroll, personnel records and statistics, and workload statistics. We are making some headway in combining these closely-interrelated systems into a single system. The results have been a sizable payoff in terms of tangible savings and a notable payoff in terms of improvement of the information furnished to management.

The *seventh and final systems engineering principle* is that it is to be expected of the systems engineer that he test adequately in advance the feasibility of major systems changes. We are often tempted to make a change in a system simply because it *can* be made. We need to pause and consider whether the change is feasible from every standpoint. The fact that we *can* make it is not in itself ample justification. Let me give you an example of what I mean. Under a manual or mechanical system of the past we may have audited completely only a small portion—say ten per cent—of certain vouchers, and made only a superficial audit or no audit at all of the remainder. Now, with today's computer equipment, it becomes relatively easy to audit all vouchers. But suppose we did? What about the follow-up actions required when the discrepancies revealed are increased tenfold? Will we have to put on extra staff to process the increased number of discrepancies? Is this economically feasible? If we got along for many years on the basis of a ten per cent sample, why increase the size of the sample? This is just one example of the various types of feasibility tests which any competent systems engineer will find worthwhile to make before recommending major systems changes.

I have spent a good deal of time on the efficiency of our systems engineering work, the second of the seven conditions I want to identify. This emphasis is deserved because the electronic computer can accommodate either an efficiently designed system or a poorly designed system. It is a "fast moron," ready to do whatever man wants it to do.

This brings me to the *third condition* leading to economic feasibility, which is this: Systems engineering work should be performed with a degree of competence that makes possible the design of systems specifications of the depth and quality that eliminate guesswork in computer selection. This audience is well-aware of the fact that there is a wide range in the capacities and capabilities of computers. To get a computer of *proper* capacity and computational capability, we need to spell out the requirements and objectives of the system in great detail. No other practicable method for selecting computers has as

yet been found. Recently the Director of the Bureau of the Budget, at the direction of the President, established the policy that decisions on the selection and subsequent acquisition of computer equipment must be based upon adequate systems specifications. This puts a high premium on the specifications themselves and an equally high premium upon the systems analysis and design work performed by systems engineers. When systems analysis and systems design are performed competently, the ground work has been laid for the development of meaningful systems specifications. Without these non-hardware-oriented specifications which spell out what we want the system to accomplish, we can only resort to guesswork in selecting the computer we need to assist us in accomplishing system objectives.

A *fourth condition* which should exist if we are to use computers economically is that after determining the type, the size, the capacity, and the competency of the computer we need, we then follow the practice of considering the several different methods by which computers can be acquired and select the method which is in the best interest of the Government. There are several methods of acquiring computers; I shall not belabor the lease versus purchase issue. Factually speaking, I should tell you that in the policies issued some months ago to the departments and agencies of the Federal Government, the Bureau of the Budget pointed out the several methods of acquisition and established criteria and guidelines for the agencies to use in considering each of those methods. Our policy guidelines are so designed that we anticipate that a substantial proportion of our computer equipment will from now on be purchased. We developed these policies only after long deliberation. We found that in the average computer acquisition transaction there is a point in time when (1) the one-time expenditures for purchase, plus accrued maintenance, and (2) cumulative rental payments, will equal each other. We call this a cost advantage point. With some configurations of equipment, this advantage point is reached in three years or less. In other cases it may occur in eight or more years. In instances where the cost advantage point is reached in six years or less, if a reasonable judgment has been reached that the equipment will continue to meet agency requirements, and if there are no major modifications of the system imminent, a set of conditions exists which would warrant purchasing the equipment.

The *fifth condition* is this: Every agency should operate under policies which insure that the contemplated period of productive use of the computer equipment will start upon acceptance and normally will be expected to last at least three years. On the question of prompt start, in today's environment we see only one cause for accepting computer equipment before the user is ready to put it to productive use; namely, inadequate systems planning. We were tolerant of this a few years back, but not now. As to the period of use, there can, of course, be the exceptional situation in which it is the lesser of evils to use a computer briefly, probably as a stepping-stone to another computer, the specifications for which can best be developed after a period of experimentation. However, these exceptional situations should be tolerated only rarely. We waited a long time for computers. They are plentiful now. When we are truly ready for one, or an additional one, or a different one, it will be ready for us. The three-year standard is not official, but I am prepared to argue that it is reasonable. The substantial amount of money an organization invests in a computer, in its operation, and in getting ready for its delivery, is in the aggregate so large in comparison with previous equipment costs that unless an organization can justify using a computer for a period of three or more years, there is room for doubt as to whether it should acquire its own computer at all.

The *sixth condition* to meet in assuring the economic feasibility of using computers is that possibilities for sharing unused computer time have been fully explored. We have found this to be a very fruitful area of exploration in the Federal Government. Experience has shown us that the practice of sharing unused computer time is logical, is economically feasible, and is really not complex or troublesome as some have thought. The Federal Government accomplishes a great deal of sharing and we are busily at work finding ways and means for doing much more. We are tending toward regional area sharing. We can do this both within and between Federal agencies.

Now I come to the *seventh condition* which should prevail if the use of computers is to be economically feasible: namely, that we have provided to those who need it the orientation and training that is basic to effective computer utilization. The computer is still a relatively new tool. It has unfortunately been characterized as a mysterious device, beyond the understanding of the layman. I believe we have proved the fallacy of this in the Government. It is unquestionably true, of course, that *complete technical mastery* of computer hardware is hard to come by. But all of us need not be electronic wizards. To express educational needs in quantitative terms, for every hardware technician to be trained, there are thousands of others who need some lesser degree of orientation in the capabilities and limitations of computers.

In the Federal Government, it has long been recognized that the most fundamental problem in the utilization of today's modern data processing hardware is the educational problem. People are inherently honest and will not intentionally make mistakes in the use of computers if they know what mistakes can be made. People want to know how and how not to use computers. To meet this need, we have sponsored or conducted or financed the formal orientation and training of tens of thousands of Government officials and employees. In addition, there are today in the Government more than fifty thousand persons who are directly associated with the operation of computers, all of whom are receiving invaluable on-the-job training and experience.

These are the conditions which should exist (or should be created) if our use of computers is to be classed as being economically feasible. But I still have not stated the whole case for economic feasibility. In

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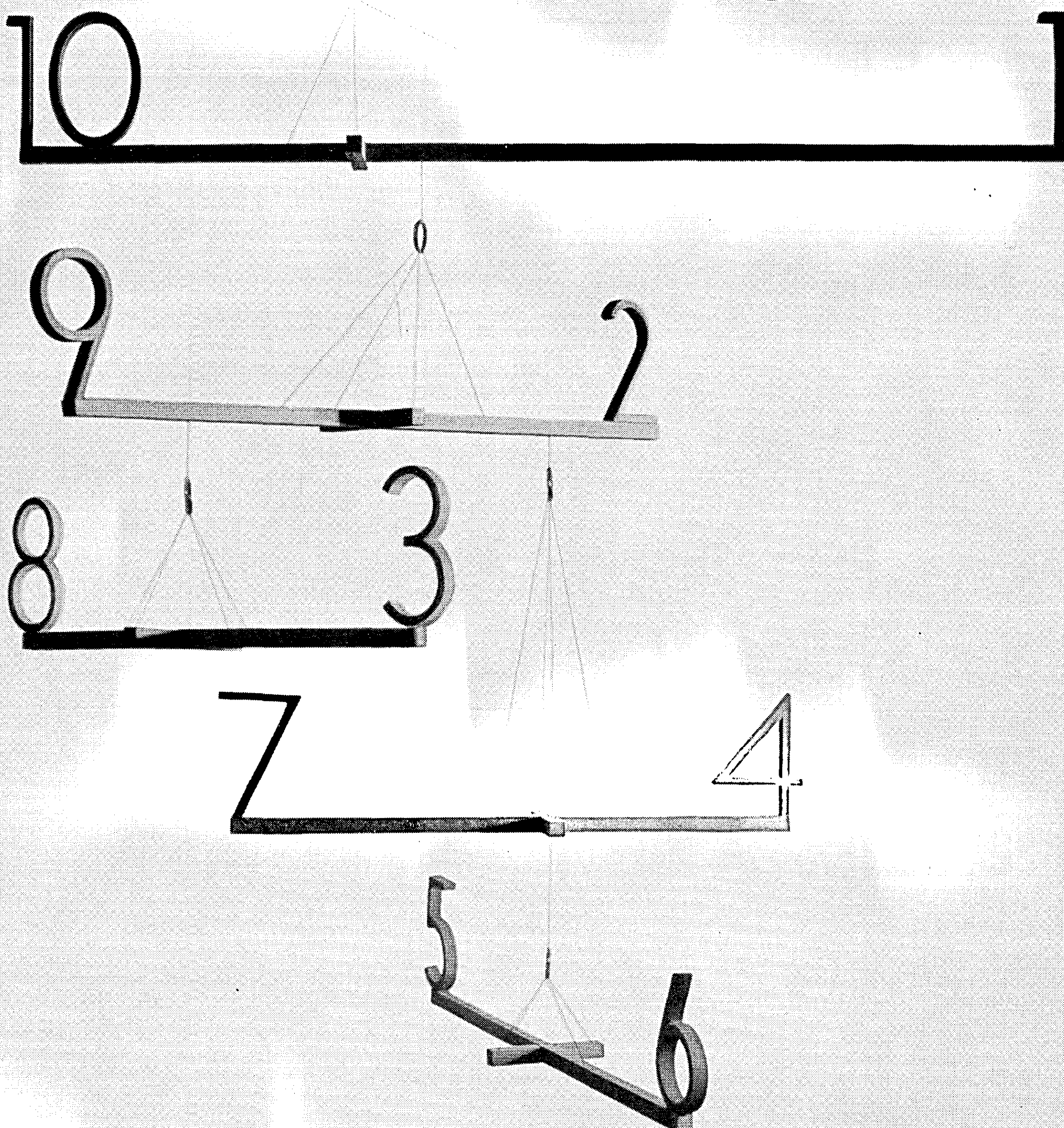

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connection with the conditions I have been describing there are a few additional considerations which need to be identified.

The *first* consideration is that while *rental* costs of equipment are quite useful for comparison purposes, they can be misleading when used for other purposes. Rental costs usually range from one-fourth to one-third of the total annual operating costs of computers. For example, a computer that rents for $100,000 a year would cost $300,000 to $400,000 a year to operate when all direct costs are considered. In our computations, direct costs include (1) rental charges, (2) the salaries of the personnel directly involved with the operation of the equipment, (3) supplies, and (4) service contracts. Direct costs do *not* include the costs of get-ready operations, i.e., the one-time costs involved in systems engineering, initial programming, site preparation, training, parallel operations, and the like. Another fact that we have discovered is that one-time (get-ready) costs usually are equal to at least one year's operating costs and sometimes as much as two years' operating costs. Therefore, when all costs are taken into account, it can readily be seen that a system that rents for $100,000 annually will by the end of the first year have accounted for operating expenditures of $600,000 to $1,200,000.

A *second* consideration which has a bearing on the economics of computer systems has to do with the source that you tap to obtain the systems engineering services needed. There are those who contend that the systems engineers who perform most successfully are those who are on the payroll of the agency rather than on loan or under contract. In terms of long-range planning, especially in business management uses of computers, this is conceptually sound when the organization is large enough to support its own permanent staff of systems engineers. But considering the complexities of a large proportion of our systems, plus the fact that the kinds of expert knowledge needed in computer systems design may be in short supply in some organizations, an outside firm having the expert knowledge required might on occasion be needed either to provide the systems engineering or to coach on-board personnel in how to design systems and how to develop systems specifications.

A *third* consideration which can have a bearing on the economics of computer systems is the perennial question of centralization versus decentralization. The new-born tendency to centralize operations, because a computer makes it easy to do so, is understandable and can be quite logical; much of it is going on. But this not *always* is the appropriate answer. Sometimes a mix of centralization and decentralization is desirable. In a case like the social security program of the Federal Government, for example, the maintenance of the records of persons entitled to social security annuities eventually is completely centralized in Baltimore. However, the monthly payment of social security benefits to annuitants who have retired is decentralized to regional offices throughout the country. This, at least for the present, appears to be a far more practicable arrangement than to centralize all social security functions in one location. Another point to bring out in connection with this question of centralization is that centralized processing of data with prompt feedback to the field need not prohibit stages or phases of data processing at the field level. An example of this is in the centralized inventory controls in the military departments which do not unduly restrict inventory managers at the supply station or at intermediate levels of command.

A *fourth* consideration worthy of note is communications. It has become quite evident that communication with and between computers is sometimes as important as the computers themselves. This factor, of course, relates to the previous one concerning centralization since we have found that partial rather than total centralization sometimes becomes more meaningful when we perform a substantial portion of data processing operations at the field points where data ordinarily are generated and where the results of data processing are most useful. But this becomes possible in some cases only because a means for the high-speed transmission of information between the centralized and decentralized offices is provided.

The *next* (fifth) consideration is equipment obsolescence. You may be surprised to learn that obsolescence of hardware is deemed to be a relatively unimportant consideration in the Federal Government. The experts say that no computer has ever worn out. Some have been turned out to pasture. Some have been cannibalized. Some are donated for use as training devices in university laboratories. But many of the first computers ever built are still functioning.

There are several types of obsolescence. There is what we call functional obsolescence, that is, a function has changed, or equipment needs were incorrectly estimated, to the extent that the computer on hand cannot any longer perform the function effectively. There is technical obsolescence, that is, the competence of the computer in terms of capacity, speed, or computational capability is short of the needs for a particular application. There is economic obsolescence; in other words, a newer or different computer model of the same or later generation will do the same or more work for less money. The reason why we can and do classify obsolescence as something less than a predominant factor in selecting computer equipment is that in the Federal Government there are so many current users and an equal or greater number of prospective users. Shifts of equipment become possible.

A *sixth* consideration is compatibility—compatibility of equipment and of techniques for its use. This admittedly need not be a major consideration in the thinking of a one-computer organization. But in the Federal Government, where one department may have two hundred computer configurations which include forty different main frame models produced by twenty different manufacturers, we have had our share of compatibility problems. Our *in*compatibility bill undoubtedly has been tremendous. However, by a unity of effort within the Government, by virtue of the efforts of the American Standards Association, and with some cooperation from equipment manufacturers, progress in minimizing the incompatibility problem

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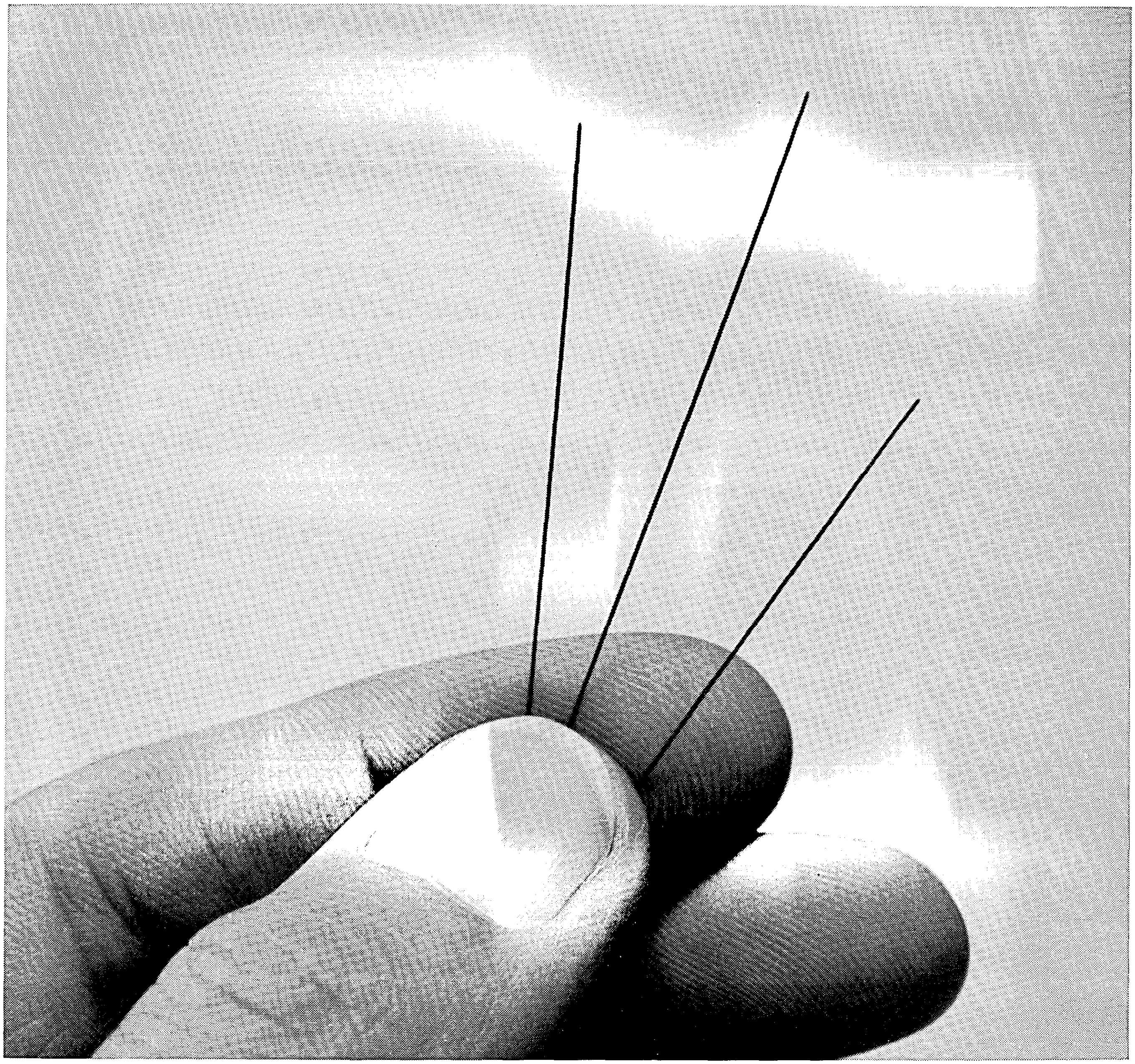

Computer Simulation of a National Economy

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It is unusual today to find someone who is at a loss for words on the subject of spurring on the United States economy. Questions such as "Should there be an across-the-board tax cut?", "A lowering of security purchase margins?", "Greater tax incentives for buying capital goods?", "A change in the tariff policy?", "Reduced foreign aid?", "Increased defense spending?" are heard frequently. Both the pros and the cons of each answer are defended stoutly by economic experts and others. In fact, the divergence among economists, to whom citizens might hope to turn for guidance, often causes one to recall the Elizabethan merchants with their prized, custom-built, pocket watches, who prompted Alexander Pope to remark:

"Men's opinions are like their watches;
None go just alike, yet each believes his own."

A main shortcoming in the hodgepodge of opinion is a well-defined, accurate model of the workings of the United States economy which would allow officials to predict reliably the results of decisions on economic policy.

Fifteen years ago the idea of an analytic model of a large national economy would have seemed absurd. It was then "evident" that there were just too many variables, too many interrelationships involved, for any usable solutions to be developed. However, with the advent of the automatic computer, a tool has been developed which offers the power to provide a simulation of a national economy sufficiently accurate to determine economic policy. This report will discuss some of the initial work in this important possible application of computers.

Early Economic Simulations

The initial simulations in the economic field were microeconomic simulations, that is, simulations of the individual firm, or of a limited economic sector. These included work on the shoe leather and hide industries, the copper market, an electrical parts firm, and a young growth company. Today, however, simulations are being conducted on a macroeconomic scale, on the scale of a national economy. At Stanford, Alan Manne is performing work on the Mexican economy. In New York, a group of mathematicians, economists, psychologists, and political scientists have formed the Simulmatics Corporation. This firm simulated by means of a model of the electorate the 1960 presidential campaign; at present it is conducting simulation studies of Latin America economies. And while at the Center for International Studies at Mass. Inst. of Technology, Edward P. Holland (now with the Simulmatics Corporation) conducted a pioneering macroeconomic simulation study on the economy of India.[1]

Simulation means the development of a mathematical model of a physical system in which the interrelationships of the mathematical variables in the model accurately follow the interactions of the physical variables in the system. When this condition is fulfilled, then one can theoretically observe the entire life history of the physical process under an almost unlimited number of initial conditions. For example, with a reliable model of the U. S. economy, one might determine the economic effects of a 10% across-the-board tax cut during the next year, or the next five or ten years, and this could be observed in only a few hours running on a large computer.

Difficulties of Model Building

Simulation of the entire economic life of a nation however, is a complex and subtle process. The economic relationships are uncertain; motivations are hazy; rational behavior interacts with the irrational; the governmental sector competes with the private; etc. Nor is this situation any simpler in the underdeveloped countries of the world. The poor nations have not reached the point of self-sustaining growth. They face no problems of overabundance. They often have a per capita income less than one-fourth of that in the U. S. Population pressure is already severe, and increasing. Most of the population ekes out a subsistence living on the farm. Those few who can save, spend their money on non-productive consumer goods. If industry does exist, it tends to be precariously centered around some export product. It is vulnerable to fluctuating exchange rates, and the winds of changing global demand. More discouraging still, economic growth seems bounded by a vicious circle in which a low inducement to invest results from a small buying-power—which results from a small real income—which results from the low productivity of capital—which results from the small amount of capital used in industry—which results from a low inducement to invest—and so on.

How can a computer-based simulation permit understanding of so complex a situation? In order to find this out, we will look at the study by E. P. Holland more closely.

Principles Behind Model Established

The first task facing Holland's group was unrelated to computers. This was the obligation to formulate an underlying theory for the study. After all, what Holland hoped to do was to express the policies by which an underdeveloped nation could reach the "take-off point" for economic growth. This necessarily meant that he could not characterize economic development as social or psychological in nature, as many observers do. Nor could he accept the hope that somehow the principle of laissez-faire would mold economic development beneficently and resolutely. Rather, Holland had to accept the proposition that certain programs and policies have an effect on economic growth. The task was to discover what these programs and policies were in view of the various determinants of, and obstacles to, economic development.

This point led Holland to a technical study, one whose complexity required the use of a digital computer. For, having admitted that planned economic policies have measurable consequences, Holland had to distinguish between the immediate and the long-range effects. He had to determine the broad effect of any policy on economic growth. He needed to transcend the short-term or myopic approach. He needed a model which would include all the relevant economic sectors, a model which could handle interactions and time delays, irreversibilities and non-linearities. He needed a dynamic model to study the development of a growing economy.

Requirements of the Dynamic Model

Once the need for a dynamic study became recognized, Holland decided that he could not ignore many aspects of growth, or assume the autonomy of certain sectors. He faced the fact that because he was dealing with economic relationships in which the magnitude of a variable depends on the magnitude of many other variables, he could not turn his simulation into a simple syllogism in which a given relation R leads to a definite conclusion C. A study of an entire economy would involve feedback loops that could not be handled simply because of the time delays and non-linearities. Yet he could not use mathematical techniques applicable to conditions which end in economic equilibrium. Holland, therefore, sought a new, dynamic simulation approach to fit his study.

Previous Models Examined

Holland first examined the dynamic models previously devised to explain the business cycle to see if they were relevant to the problems of economic growth. The existing models were not usable, he decided, for they neglected crucial factors such as foreign commerce, or failed to make adequate distinctions among various kinds of goods. But the older models did serve as a theoretical basis for Holland's work.

Holland's first inclination was to adopt the techniques of automatic control system design. However, the engineer usually tries to make his system linear, with the result that engineering techniques are often inapplicable to the non-linear economic variables. Limited aspects of the engineering approach were useful, however, such as the block-diagramming of feedback relationships. But, Holland's group found that pencil-and-paper mathematical solutions did not have the sophistication needed to describe the economic system. The alternative then became clear: Holland could try to analyze an economic model on an automatic computer.

Holland had available to him the results of various analog simulations. These included the 1957 study by A. W. Phillips[2] and other studies on business cycles and inventory fluctuations. On the basis of these studies, Holland attempted a simulation using a general-purpose analog computer. This computer was initially used to simulate dynamics of missile flight, and it could handle such non-linearities as multiplication of variables, square roots, and time delays. Using this equipment, Holland interconnected various units to correspond to the model and the disturbances to which the model would be subjected. The parameters for both the policies and the disturbances were set at appropriate values, the system was activated, and the run continued until sufficient time elapsed, or until some variable exceeded its limits. The resultant time-graphs, recorded from voltage signals, gave such information as imports, exports, sector prices, and national income over time. Each run took Holland less than a minute, after which he could analyze the results, decide on necessary parameter changes, and then make another run.

The overall results of the analog simulations can be briefly stated: they failed. Holland could not get the results needed with the semiabandoned analog equipment he had at his disposal; so he turned to the well-equipped digital computer facility at M.I.T. for help.

Uses Dynamo Compiler

Of course, not all was clear going as soon as Holland decided on digital computers. Dynamic simulations on the digital computer require computation after computation for a series of finite time periods. At each point, variables must be computed from other variables. The running program for the model involved 3,750 machine instructions. This made checking difficult. Fortunately, Holland was able to use "DYNAMO," a special generating program developed at M.I.T. This compiler permitted the programming of the dynamic economic models as mathematical equations. This meant that Holland was able to place the 426 equations of his economic model directly on punched cards for introduction into the computer. This made checking much easier, and also avoided the long set-up operations involved in using the analog computer.

Choice of Indian Economy

The model that Holland used was simulated on the IBM 704 at M.I.T.'s Computation Center. At first, Holland planned to use arbitrary parameters, but this notion was rejected for the more practical one of selecting numbers which are relevant to an actual nation. Because the Center for International Studies at M.I.T. had done work on India's economy, Holland's group chose to simulate that economy. They proceeded to sift through the masses of statistics to get consistent economic parameters. No claims were made for the absolute accuracy of the statistics. All Holland asserted was that the problems represented would be close to those facing India.

In order to refine the model used in the simulation study, Holland distinguished between economic sectors on the basis of their production functions, and the different uses of their products. For example, Holland assumed that one could use a single description for the consumption habits of the entire population. The result was an economic model consisting of sectors, relationships, and controls. The sectors included the agricultural, the export, the power-using, etc. The interactions included short-run supply curves, a fixed demand for food, and other demand and supply relationships. The controls included profit-seeking in certain sectors, and government regulation in others.

Eight runs in total were made on the computer. Varying time histories of Gross National Product at real prices, GNP at current prices, consumers' price index, investment, production of various sectors, imports, exports, and balance of payments were all included. Holland states that, on the basis of these eight runs, he was able to graph a sample history of India for a twenty-year period. He could gage the effects of various policies on the exchange rates, on the balance of payments, on the rate of inflation, on GNP, on per capita income, and on gross real investment in various sectors.

Some of his conclusions were startling. The computer runs showed, for example, that certain variations would make the balance-of-payments problem insoluble. Similarly, in certain circumstances, public overhead capital could be excessive. However, Holland has minimized the policy value of this study. He asserts that his was a theoretical analysis, rather than one intended to supply policy makers with the facts on which to base decisions.

Despite Holland's reserve, this pioneering study is a source of optimism for many observers. The defenders of computer-based simulation hold that digital techniques will supply an accurate, long-range view of the effects of an economic policy. They maintain that many five-year plans neglect beneficial policies which require more than five years to reach fruition. In addition, some computer specialists hold that the increased accuracy of computer-based simulation techniques will mean a greater role for the expert in economic planning and a diminished role for the ideologue. They foresee a time when computer-equipped international agencies will indicate the best policies for international economic development. Ultimately, they foresee the removal of economic growth from the arena of political conflict.

There is no confirmation at present that these predictions will be realized. Computer-based simulation of national economies is still an embryonic art, one which will require, as Holland himself points out, a good deal more of empirical research, data gathering, and theoretical advances. Yet this art offers the hope of being a significant factor in promoting a world less torn by economic discontent and hardship.

[1] Holland, E. P., B. Tencer, and R. W. Gillespie, "A Model for Simulating Dynamic Problems of Economic Development," Center for International Studies report C/60-10, Massachusetts Institute of Technology, Cambridge, Mass., July, 1960.

[2] Phillips, A. W., "Stabilization Policy in a Closed Economy," *The Economic Journal,* June, 1954; and "Stabilization Policy and the Time-Form of Lagged Responses," *The Economic Journal,* June, 1957.

ECONOMIC CONSIDERATIONS

(Continued from Page 12)

has been made. More progress is on the horizon. And, as many of the companies know, efforts in the direction of standardization of both hardware and software are opening the door wider and wider to increased possibilities for the Government to accept from private industrial firms magnetic tape, paper tape, or punched cards in lieu of tons of hard copy reports. This should offer economic advantages to you and to us.

I cannot avoid mentioning equipment vulnerability as another consideration. In industry as well as in Government we have reached or are approaching the point where our ability to continue the performance of our missions rests largely upon the uninterrupted operation of computers. It takes more than just people to keep those machines going. What happens, for example, when power failure, fire, flood, sabotage, or interruptions in communications networks occur? What do we do until the machines are again operational? Go back to manual processing? That is possible, of course, in time—but not always practicable. Use a similar or identical computer operated by some other organization? Perhaps, but this works well only if both computers have intentionally been acquired and programmed with this in mind.

The answer to the vulnerability problem seems to lie both in preventive measures and in standby measures that have been well-planned and adequately rehearsed. In the Government we have published fire prevention standards for computers and other electronic gear; for computer systems on which we depend for our security, well-protected standby equipment usually is in place; duplicate tape libraries when necessary are maintained in least-vulnerable depositories; and a task force currently is developing guidelines for additional measures needed to protect the computer equipment upon which our continued operational existence is so dependent.

The final consideration is as important as any of the points so far made. In a way, it might be thought of as a summation of previous remarks. Simply stated, it is this: a *hardware*-oriented approach to data processing is just about the most dangerous approach one can employ. We can speak from experience. Being caretakers and spenders of tax dollars, we in the Federal Government dare not take unnecessary risks in hardware selection. Moreover, we don't have to. Our approach is systems-oriented, not hardware-oriented. Our Government-wide policies on computer utilization make it quite clear *first,* that no system, function, or process in the Government shall be considered for automation on a computer unless it has been established or re-established as being essential; *second,* that any system, or major subsystem, or combinations of systems being considered for automation on computers will be subjected to critical analysis in depth and then be engineered in a fashion that insures optimum efficiency and operational effectiveness; then *third,* and not before, consideration of the selection of specific hardware becomes timely. From this point on, as was true from the beginning, we still maintain the systems-oriented approach but we open the door, as we must, to hardware influences. Actually, since a computer is simply a means to an end, there is nothing at all new in what I refer to as a systems-oriented approach. Under this approach you may not make hardware selection decisions as soon as you would if you used the hardware-oriented approach. But you can be sure that you will get the computer you really need if in fact you need one at all.

Obviously, we prefer it that way. And the substantial returns we are now getting on our computer investments make us think we will keep it that way.

HANDWRITTEN NUMERALS RECOGNIZED BY NEW IBM SCANNER

An experimental machine that can recognize handwritten numbers in a variety of styles and convert them automatically into computer code was recently demonstrated by International Business Machines Corp., at Tufts University, Medford, Mass. The front cover picture shows the experimental electronic reader of numerals.

The reader recognizes numbers handwritten in a variety of styles, sizes and positions. E. C. Greanias of IBM's Advanced Systems Development Division is shown here writing numerals on a card for entry into the reader. An oscilloscope at the left displays the machine's identification of the previous card's numbers. By giving an input system the ability to recognize handwritten figures equal to the perceptive powers of the person who performs this recognition today, future machines will reduce the cost of processing the large quantities of handwritten numerical information generated in business and government.

The reader is being evaluated in tests conducted jointly at Tufts University by the Advanced Systems Development Division of IBM and the university's Institute for Psychological Research. The reader has demonstrated its versatility with the varied handwriting of students, housewives, sales clerks and other subjects. Evaluation is still underway. IBM has announced no plans to market this experimental model commercially.

The development of this device is motivated by the need to eliminate a great amount of the costly clerical time presently used to prepare information for input to a computer. For the last fifteen years, the principal means of entering information into a computer has been the manual depression of a key on a punching device. This punches a hole in a card which can be translated into electrical impulses, or into polarized spots on a magnetic tape. Transforming source information into computer language is one of the slowest steps in data processing today. During the past several years, large efforts have been made to speed this step.

Optical Scanning

One of the first efforts in this direction was the development of equipment for optical recognition of characters. Although patents were issued for character sensing devices as early as 1928, machines for commercial application of this technology were not developed until the mid-1950's. Then optical scanners for fixed printed characters were announced by the Farrington Manufacturing Co. and several other American firms.

In optical scanning, the characters are viewed by a photo-sensitive device that reacts to light reflected from the character. It converts these light signals into electrical impulses that correspond to black and white portions of the character. Although many laboratories have been working in the field, only a moderate number of optical readers are in practical operation today.

Magnetic Character Recognition

Also in the 1950's, magnetic methods of character sensing were developed at the Stanford Research Institute, General Electric Co. and elsewhere, largely in response to the needs of the banking industry. In magnetic character sensing, a pickup head responds to the magnetic field that is associated with the magnetic properties of the ink used to print the characters. An advantage of this method is that magnetic fields are able to penetrate thin layers of dirt or ink overprinting.

Optical and magnetic character sensing are designed for special applications and require that information on source documents be mechanically printed in characters of fixed fonts and in some cases, special shapes. The "readable" symbols in these methods do not include handwritten letters or numerals.

"Reading" Hand-Recorded Symbols

In attempts to develop new data entry mechanisms a challenging problem has been that posed by handwritten symbols. A great deal of information is recorded in this form. But because of the great variety of individual styles, it has been extremely difficult to accommodate data processing equipment to information in handwritten form.

Mark Sensing

A start was made during the 1930's with the development of the principle of electrical mark sensing. A method was developed for reading graphite pencil marks on documents by detecting the conductivity of the graphite. This principle has been used in card machines and test scoring machines for applications in market surveys, public opinion polls, inventories, utility meter-reading, school census reports, production control and grading of examinations.

Constrained Handwriting Numeral Reader

Another step towards this goal was taken with development of an experimental constrained handwriting numeral reader. A model of this reader built by J. L. Masterson of IBM's Advanced Systems Development Division scanned a double character image with a rotating mechanical disk. Among the constraints on handwriting imposed by this method were that the numerals must be written within guide boxes on standard punch cards and must not touch guide dots positioned in the boxes.

An evaluation of experiments with this numeral reader indicates that subjects conformed easily to these constraints and the machine had a low rate of errors. One hundred college students, after 30 minutes of instruction, wrote 56,616 numerals, of which only 120 were unreadable or misread.

Handwriting Reader in Tufts' Experiments

Recently E. C. Greanias of IBM began development of a reading technique that would impose minimal restraints on people writing information for machine processing. It hopes to allow tolerance of various common shapes and maximum tolerance of character positioning on documents. The latter factor is important for machines designed to handle both printed and handwritten information on the same document.

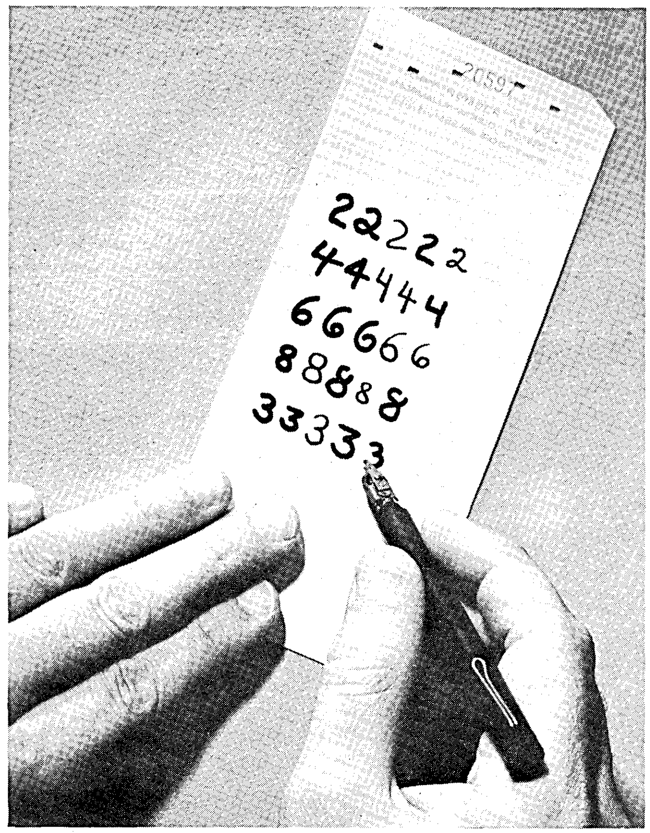
In developing this experimental reader, Mr. Greanias made use of a basic principle formulated by Dr. Walter Sprick of the IBM Research Laboratory in Germany. It was a means of generating voltage wave forms analogous to the outline of a character, which can then be analyzed to determine the character's identity.

Constraints on Handwriting

Other than that groups of numerals be written within a box on ordinary IBM cards, the constraints imposed by the experimental reader are that writers must avoid: embellishments such as curlicues and "tails"; excessive slanting; large breaks or holes in the lines that compose the numeral; writing too small or too large beyond a reasonable range following more than 3-to-1 tolerance; and running numerals together. If erasures are made with reasonable care, these do not affect machine performance.

Components of System

The experimental reader system, labelled the MARK I, consists of the scanning and recognition unit; a buffer; and a 514 Reproducing Punch. The buffer stores numerals received from the scanning and recognition unit until 25 numerals are received, then feeds these to the 514, which reads out each batch of 25 numerals and punches out this data by code on ordinary IBM cards that become the output of the system. The present reading



-- The numerals shown illustrate some of the variations people make when writing numerals with respect to style, size, thickness and position on the paper. All of these variations can be read by the experimental electronic reader. At its present level of development, the experimental reader has recognized 98.5% of these handwritten numerals written by subjects in the experiments conducted at Tufts University.

speed of the MARK I is 300 characters per minute when the handwritten input numerals are reasonably spaced.

Recognition Method of the Line Follower

The recognition scheme employs serial scanning with a high resolution flying spot scanner to determine the essential contours of the patterns. These contours are identified by generating and analyzing voltage waveforms that correspond to the character shape. Recognition criteria are defined in terms of simple descriptive components that clearly state the allowable shapes for each character. Simple means are provided to accommodate large variations in character registration and size. Other features make it possible to accommodate a variety of character stroke qualities, ranging from thin hard lead pencil lines to fuzzy lines made with fountain pens on poor paper.

Computer analysis and simulation programs were written to provide statistical summaries of the contours that occurred in a limited number of sample characters. These samples were collected under uncontrolled writing conditions and were scanned and recorded with an experimental scanner. Each contour of the sample character was identified in terms of its shape, duration and relative position within the character. The statistical summaries were used to design logical criteria for the recognition of each character type. The recognition criteria that appeared most promising in the simulation studies were built into the experimental reader with a relatively small number of conventional circuits. These design characteristics provide good simultaneous tolerance for registration, size, orientation and shape of numerals.

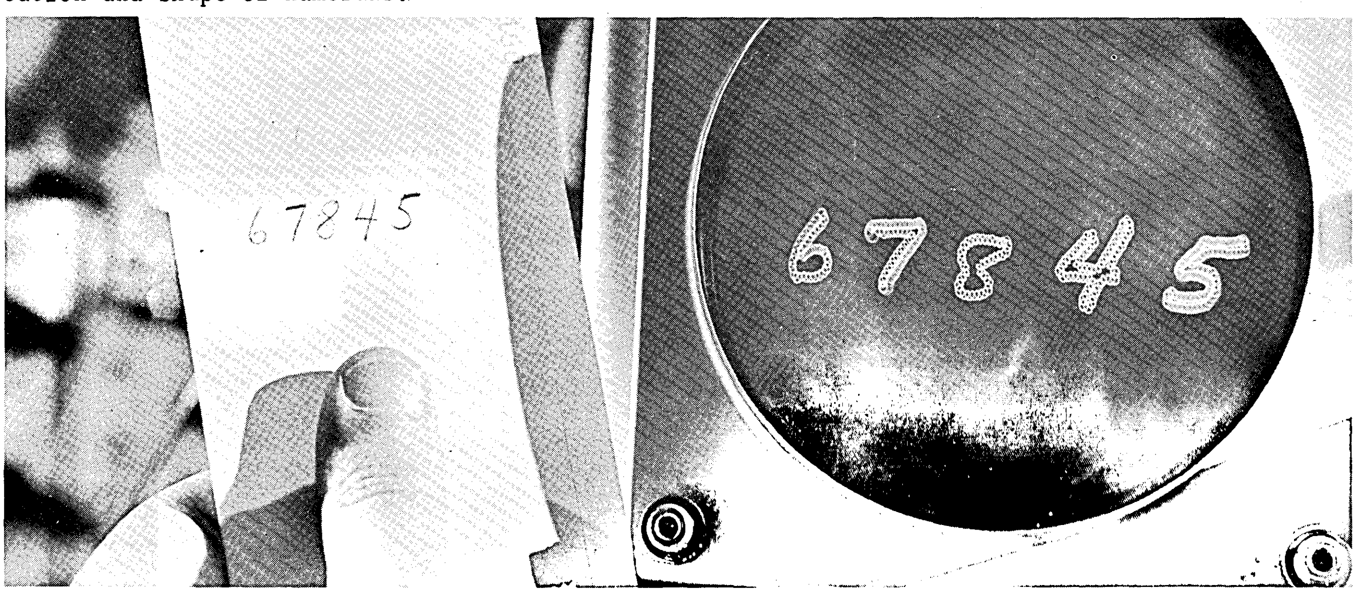
Test Results

Approximately 150 subjects have participated in evaluation tests at Tufts. Using a regular lead pencil, and allowed to make erasures, they have written more than 100,000 numbers on IBM cards in a variety of ways -- copying random numbers, adding columns of figures, writing from a sitting, standing position, etc.

Purpose of the current series of experiments is to determine how well the experimental reader performs when people have been trained to write "correctly", and how much tolerance for variations in character shapes should be provided in the next version of logic for the machine. The logic (circuitry) of the experimental handwriting reader was developed on the basis of a sample of 3,000 numbers handwritten by a group of 30 people with no constraints placed on their style.

To date 98.5% of the handwritten numerals have been read correctly. The majority of the numerals that were not read correctly were written by only 10% of the subjects. Of the numerals written by the other 90% of the subjects, the reader correctly identified 99%, rejecting 1% as "unreadable" and mistaking .07% for the wrong numerals.

IBM feels that the next step will be to develop a logic providing the best possible match between the machine reading capability and the handwriting of the much larger sample (approximately 200) subjects participating in the present experiments, who have received an average of 15 minutes instruction on such things as avoiding excessive flourishes and gross distortions in their writing.



-- The display on the oscilloscope shows the number that has been presented to the logic circuits of the experimental reader for recognition. A card bearing 67845 has been placed in the experimental reader. The reader's logic guides the scanning beam on a moving circular path around the written characters to detect the line edges and extract the information required for recognition.

AUTOMATIC FABRICATION OF ELECTRONIC CIRCUITS USING DOT PARTS

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The electronics industry has played a leading role in the automation of other industries, and electronic computers today are widely used in various types of automatic fabrication. Yet, the electronics industry itself, except for the fabrication of component parts, is still essentially unautomated. Inevitably, this situation will change -- perhaps in the next few years, certainly within the decade.

The automatic production of electronic circuits will be greatly increased with the use of electronic parts in the dot or pellet configuration. These parts are meeting increasing acceptance in a number of development laboratories. Dot parts are cylindrical in shape with diameters from 0.05 inch to 0.25 inch having a uniform thickness of 0.03 inch. They are particularly suited for semi-automatic or fully automatic assembly.

Early Automation Efforts

Attempts have been made in the past to devise machines for automatic assembly of electronic equipment. The more successful machines are designed to install electronic parts with axial leads onto printed circuit boards by bending the part leads and inserting them into holes. Electrical connections are then made to the printed circuit board by dip soldering.

To conserve space, construction using flat printed circuits is being superseded by the "cordwood technique" in which electronic parts with axial leads are "log-piled" vertically between two wafers. Attempts have been made to automate this process also. A promising machine for assembling cordwood modules was developed by Hughes Aircraft several years ago, but a production version of the machine was never built. Today cordwood modules are assembled by hand with electrical connections made by dip soldering or welding.

The chief problem encountered when using these machines has been that of handling components with various sizes and shapes, and leads of various diameters, materials, and conditions of straightness. The parts tend to jam in magazines and in the transporting mechanisms, particularly if the leads are not straight. Machines for straightening leads are therefore required. The operation of bending leads is difficult also since the leads are of different diameters and of different materials, some soft, some springy. The ability to solder leads has been another variable which has been difficult to control and which severely affects the dip soldering operation. In the welded cordwood technique this problem has been by-passed at the expense of adding much hand labor to the process and introducing, in turn, variables in the welding of leads.

Dot Parts

The use of dot electronic parts avoids the mechanical problems encountered in handling parts with axial leads. The dot part is designed with automation in mind; it presents a promising possibility for automation. The geometry of the part and the termination material is rigidly controlled; there are no wire leads to cause difficulty.

The extremely small size of the dot part plus its uniform thickness of 3/100 of an inch makes it ideal for microminiaturization.

Fabrication of a microminiature module with dot parts is relatively simple. First, round holes are punched or drilled into a substrate material such as epoxy-glass. The dot parts are then bonded into the holes with epoxy cement. Using an alternate technique, the parts are mounted between two plates and a plastic material is poured around them. The resulting product, using either technique, is a card-shaped module 0.03 inch thick and possibly several inches on each side. All components are mounted within the substrate[1] with all terminations exposed and flush with the substrate surface. Electrical connections are made by applying conductive adhesive[2] to both sides of the substrate. A silkscreening or stenciling process enables many connections to be made in one operation. Figure 1 shows a typical dot circuit, a digital delay line module measuring 3 x 5 by 0.03 inches and containing some 300 electronic parts.

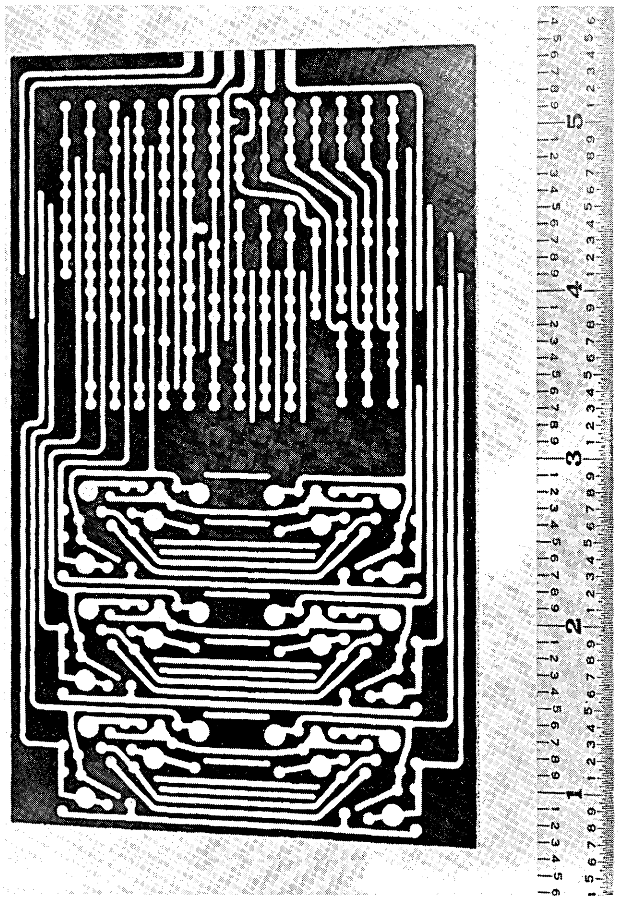


Figure 1. A Typical Dot Circuit

The advantages of the small size of dot parts are realized only after their installation in a circuit. Prior to assembly, the small size is a disadvantage. Identification of the parts is a problem since even color coding is impractical. Handling by the user, and by the supplier as well, is quite difficult. Parts simply cannot be handled readily by hand nor even by normal-size machinery. This problem involves not only installing the part at the production line, but also all handling of it from the time the part is made, through inspection, packing, shipping, receiving, unpacking, testing, transfer into stores, transfer out of stores, and so on.

1 Module geometry is discussed in paper entitled "Microelectronic Connections", Proceedings of 3rd International Electronic Circuit Packaging Symposium, August 1962.

2 Conductive adhesives are discussed in paper entitled "Evaluation of Conductive Adhesives", Electro-Technology, January 1962.

Standardized Handling Methods

Handling problems may however be solved by mounting each dot part in a 2.5 by 1.25 inch card (Figure 2). These cards provide means for handling and identifying the part all the way from time of manufacture until final installation in an electronic circuit

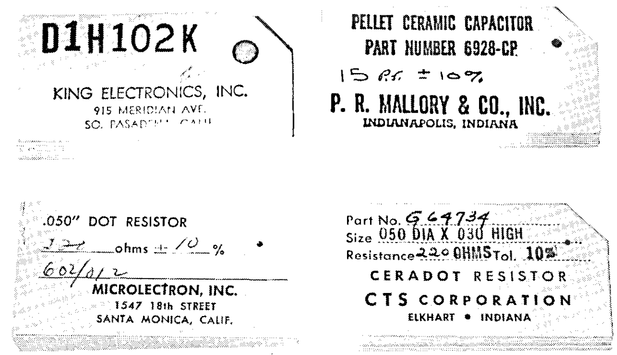


Figure 2. Dot Parts in Standard Cards

and permit positive control of parts. In addition, the cards facilitate quality control inspection, spare parts inventory, and many other aspects of the use of components.

Several thousand dot parts will fit into the palm of the hand. It is not difficult to visualize several thousand components being dropped on the floor and, if they are, it is unlikely that all of them could be found. The cards prevent such accidents and offer, as well, a means of record keeping. Serial and lot numbers, inspectors' stamps, and similar information may be recorded directly on the cards. Besides providing a simple means for identification and handling, the card also provides considerable protection for the part.

As soon as the parts are mounted on standardized cards, many possibilities for automatic and semiautomatic production become evident.

With the use of cards, standard magazines (Figure 3) are possible regardless of the component diameter, which is a variable. The magazine is a simple solenoid-operated device which can be incorporated as a standard item in many different automation arrangements. The standardization of method lowers the cost of automation machinery and thus hastens the day when such machinery can be economically justified.

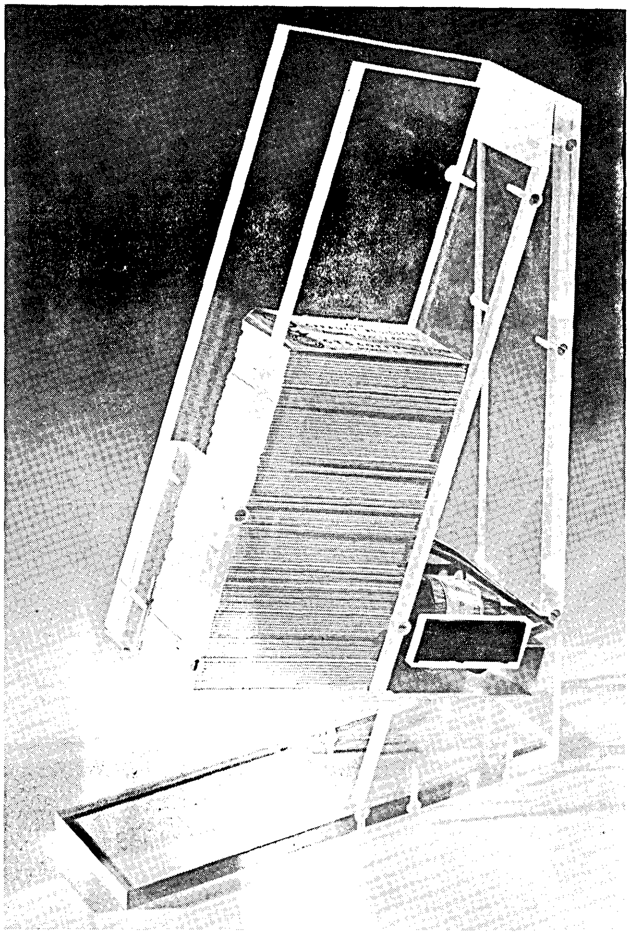


Figure 3. Dot Magazine

With the card magazine as a basic element, numerous automatic or semiautomatic systems of fabrication can be devised. The relative ease of controlling the cards makes possible considerable flexibility in design of these systems.

Semiautomatic Dot Assembly

In the design of assembly devices, either automatic or manual, the elimination of errors is a major objective. A semiautomatic dot assembly system has been devised (Figure 5) which eliminates an important class of errors by removing the burden of deciding from the operator. In addition, this system makes the assembly task easier and more rapid.

The system is programmed by means of a tape of plastic impregnated paper or fabric. This tape (Figure 4) is divided into frames,

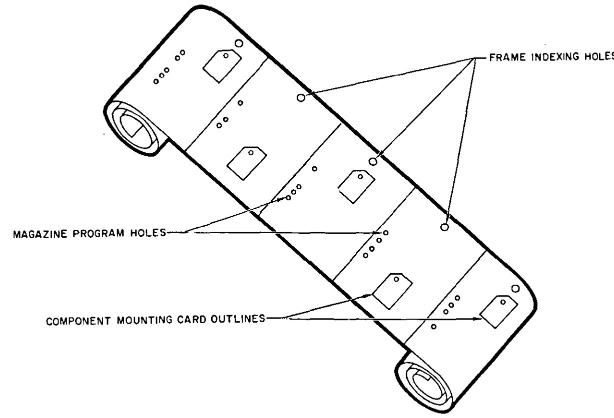


Figure 4. Program Tape

one for each dot part. Each frame has an indexing hole at the side and a row of program holes to control the magazine. In addition, each frame outlines the position of the component mounting card and shows a hole at the component part position.

At a typical assembly station (Figure 5) the programming tape moves across the workbench. The substrate, on a small carrying tray, is mounted in a recess in the workbench so that the program tape passes directly over the surface of the substrate.

The cycle of operations to install one dot part is as follows:

a. The operator presses an advance button.
b. A motor drives the tape to the next frame, automatically stopping at the correct position by sensing the indexing hole.
c. A magazine program reader device reads the magazine program holes in the top of the frame and generates a signal.
d. The signal actuates one of the solenoid-operated magazines which drops the selected component part card onto a constantly moving belt. The belt delivers the part to the operator.
e. The operator places the card within the component part mounting card outline and, by means of a small tool, pushes the part into the substrate.
f. The empty card is discarded and the operator presses the advance button, causing the program tape to advance to the next frame.

When all component parts are installed, the tray holding the substrate passes to the next station for bonding of the parts into the substrate and application of the conductive-adhesive circuitry.

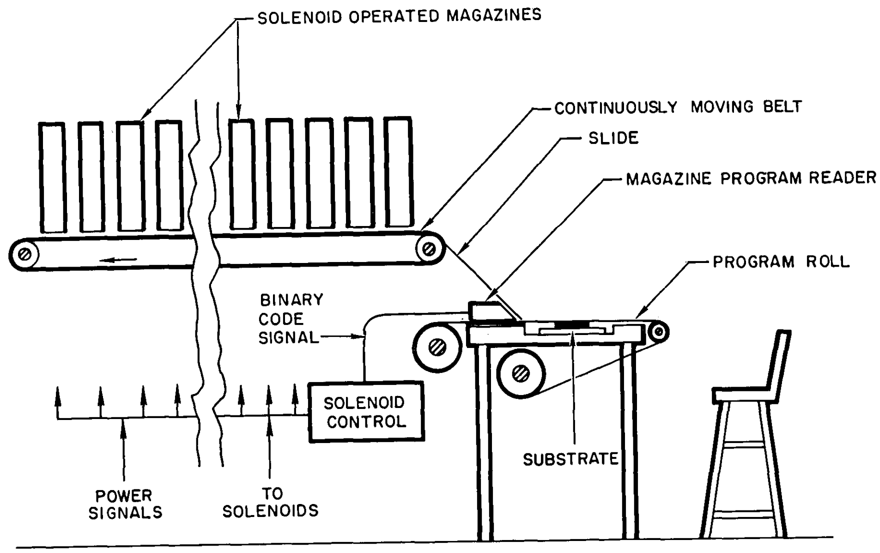


Figure 5. Assembly Station

If the substrate-with-holes or "swiss cheese" technique is used, the bonding is accomplished by filling the space between the parts and walls of the holes with an epoxy adhesive. Ideally this should be a batch process in which many such bonds are made at once. To prevent a residue of epoxy on the terminals, it is advisable to mask the terminals with a material which readily dissolves in a solvent. This masking may best be done before mounting the parts in the magazines. All residue can be removed from the terminals, after cure of the bonding material, by dissolving and washing away the masking material. If the masking material is colored, its complete removal is apparent by visual inspection.

If the molding technique is used, a "swiss cheese" tool or template is used in lieu of the substrate. The template is needed to transfer the parts to a mold and position them for the molding operation.

When bonding and molding operations are complete, the circuit connections are made by silkscreening a conductive adhesive pattern onto the substrate and part terminals. This also is a batch process with hundreds of connections made in one or two operations.

Automatic Dot Assembly

With the addition of only a few machine elements, the semiautomatic assembly system can be made fully automatic. The semiautomatic system utilizes manual dexterity to accomplish actual insertion of dot parts into the substrate or template. The dot parts can be inserted automatically if desired by adding an X-Y coordinate positioning table, driven by punched cards or magnetic tape, the required number of solenoid-operated mechanical gates, and a solenoid-driven punch.

The substrate may be mounted on an inclined table which is automatically positioned along X and Y coordinates with respect to a chute, which is fixed. Punched cards or magnetic tape command the table to assume the correct position and actuate the solenoid-operated gates.

A card containing a dot part, previously dispensed from its magazine, is released by gate No. 1 and is carried to the assembly table by the moving belt and chute. When the card is in position over the substrate, the punch drives the dot part into position in the substrate. To accomodate tolerances, the table should oscillate 0.005 inch in a multi-directional pattern. When the punch senses that the component is in place, the discard gate lifts and the empty card slides free.

The table then repositions itself and gate No. 2 lifts so that the next scheduled card is placed in a position of readiness at gate No. 1. This feature eliminates delay in transporting the dot part card from the magazine to the chute.

This automatic assembly system should be able to install one dot part every 2 to 4 seconds without error. This represents from 8,000 to 16,000 parts in a normal working day.

Other machinery, of course, can be devised to handle and install the dot parts. If a more-completely automatic assembly is desired, the cards can be notched so that the identity and magazine address can be established at the time the part is received. Thus, magazines can be filled automatically from storeroom stock. Stock inventory and purchasing, similarly, can be handled automatically.

Further, incoming inspection and testing machines may be devised. Reject parts
(Please turn to bottom of page 24)

"ACROSS THE EDITOR'S DESK"

NEWS of Computers and Data Processors

New Firms, Divisions, and Mergers

IBM TO ESTABLISH RESEARCH LABORATORY IN JAPAN

International Business Machines Corporation of New York will establish a small basic research laboratory in Japan, which will be operated as a branch of the recently organized subsidiary, IBM Research Laboratory, Inc.

The aims of the laboratory will be to advance basic research in specialized areas, and to establish and maintain contact with the scientific community in Japan and the Far East.

INFORMATION FOR INDUSTRY, INC. ACQUIRES INFORMATION RETRIEVAL CORP.

Information for Industry, Inc., of Washington, D.C., specialists in information processing, has acquired full ownership of Information Retrieval Corp., Washington, D.C., which will now be operated as a wholly-owned IFI subsidiary.

The subsidiary has developed, and will market this fall, an electronic Command Retrieval Information System (CRIS), providing search, storage, retrieval, and reproduction of data.

IFIP ESTABLISHES ALGOL COMMITTEE

The International Federation for Information Processing (IFIP) has established a committee to develop and refine an algorithmic computer programming language. The committee, to be called the Working Group on ALGOL, was authorized by the March meeting of the IFIP Council in Munich, Germany, to act as part of the IFIP Technical Committee #2 on Programming Languages.

Professor Dr. W. van der Poel of the Hague, Netherlands, was appointed Chairman of the Working Group on ALGOL. The original authors of ALGOL accepted an invitation from IFIP to join the Working Group and to continue their activities under IFIP auspices.

IFIP represents the interests and accomplishments of twenty professional EDP technical societies from twenty different nations.

COMPUTER INSTRUMENTATION CORP. FORMED

Richard O. Endres, who resigned as President of Rese Engineering last April, has formed a new company, Computer Instrumentation Corp., A and Courtland Sts., Philadelphia 20, Pa. The new organization has purchased the magnetics test equipment line of products from Rese Engineering, and will continue design, manufacturing and sales operations of these products without interruption, and in full cooperation with Rese Engineering, at the same address.

Automatic Fabrication of Electronic Circuits
(Continued from page 23)

can be stamped with reject reason, packed, and shipped back to suppliers, all by standard machinery. Only the instruments connected to the test probes (depending upon electronic part checked) and the reject reason stamps need vary.

Considering the difficulties in automating electronic equipment production in the past, the use of dot parts mounted on standard cards offers a great advance. This technique appears to offer more probability of success than a number of other methods now under consideration.

NEW INSTALLATIONS

COMPUTER FOR NUCLEAR PLANT

The first major installation of a process computer at a large nuclear plant is planned for this fall. The Big Rock Point Nuclear Power plant of Consumers Power Company in Michigan will be generating nuclear information as well as nuclear power.

A 40,000-word, G-E 312 process computer will be used to monitor the reactor power level, thermal-hydraulic performance of the nuclear core, the neutron exposure of each segment of the fuel, instruments and reactor vessel. It will also be used to develop methods of maximizing fuel burnup by scheduling of control rods. The information obtained will be used to improve plant operating efficiency, to simplify fuel inventory and plant management and to improve the power producing capacity of nuclear fuel.

The computer system will include the G-E 312 central processor, an input-output unit, a computer control console, two operator control units, four logging and "on-demand" typewriters, and three punched paper tape units.

BATTERY DISPLAY UNIT DELIVERED TO FRANKFORD ARSENAL

A research and development model of a unit for displaying a field artillery battery has been delivered to U.S. Army, Ordnance Corps by California Computer Products, Inc. of Downey, Calif., for test and evaluation.

The display unit is designed to present visually at a field artillery battery location specific fire commands and gun orientation data. It is part of an over-all artillery fire control system which includes the Gun Direction Computer, M18 (FADAC), and a digital console for artillery fire control. Fire request data are fed into the control console and computer by a gunnery officer at the fire direction center. Specific commands are then generated and processed through the console and transmitted to appropriate gun batteries. The total system is designed to provide completely automated integration of fire control data, making possible specific artillery response to target requirements in a matter of seconds.

MINING RESEARCH CENTER TO INSTALL COMPUTER

The U.S. Department of Interior has announced that a high-speed computer will be installed in September at the Mining Research Center of the Bureau of Mines at Denver, Colo., Federal Center.

The equipment, a GE-225 general purpose computer, will be leased with option to purchase. It will be used by the Bureau of Mines in developing advanced techniques for mineral evaluation and rock behavior. The system will be manufactured by General Electric's Computer Department, Phoenix, Ariz., and will consist of a central processor with an 8192-word core memory, card-punch and reader for handling 100 and 400 cards per minute respectively, card-punch controller, and an on-line printer operating at 900 lines per minute.

The computer service will be available to Bureau of Mines research scientists throughout the nation on an "open shop" basis for programming specific problems. Computer time will also be provided, upon request, to other bureaus and offices of the Department of the Interior. An hourly rental rate will be established to pro-rate costs, both for bureau stations and other Interior Department agencies using the facility.

NIMBUS GROUND STATION DELIVERED TO GODDARD

The first command system ground station for a Nimbus weather observation satellite has been delivered to Goddard Space Flight Center by California Computer Products, Inc., Downey, Calif., prime contractor for the Nimbus program.

The equipment, designed for either mobile or fixed use, consists of a control console and three rack modules. It is completely self-contained in all functional elements, and includes self-checking equipment. It is fitted to store commands in advance for automatic transmission to the Nimbus satellite as it passes overhead. The transmitter is monitored independently within the ground station. All transmitted data are recorded for verification by operating personnel. Provision is made for direct transmission under manual control should it be necessary to supersede the automatic transmission system.

COMPUTER FOR SPACE LAUNCHING VEHICLE

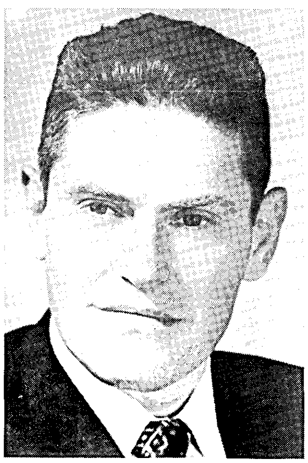
Elliott-Automation Ltd., 34 Portland Place, London W1, England, has announced that the de Havilland Aircraft Company of England has decided to install a National-Elliott 803 computer to help with the development work for the proposed European Space Launcher Organization.

Blue Streak, originally designed as a long range ballistic missile, is now to be used as the first stage launching vehicle for the European Space Launcher Organization. This involves an enormous amount of computational work upon the design of the present vehicle which will later be adapted to carry 2nd and 3rd stages of European design. Only automatic computing methods can cope with the amount of development work to be done within the currently planned five year period. Among the mass of calculations are some, such as performance, and orbit selection, which can only be done by a digital computer. When flight trials start, the post-firing analysis will be fed to the 803 computer to help confirm the satisfactory performance of each round.

PEOPLE OF NOTE

EUGENE LEONARD ELECTED PRESIDENT OF DIGITRONICS CORPORATION

Digitronics Corporation, Albertson (L.I.), N.Y., has announced the election of Eugene Leonard as President of the company. Mr. Leonard, formerly Vice President in charge of Engineering, was one of the original founders of Digitronics and created the Dial-o-verter System for the high-speed transmission of data over telephone lines.



He succeeds Albert A. Auerbach who has resigned to resume activities in the field of bio-physics, but will continue to serve on the Board of Directors.

RYAN NAMED PRESIDENT, BENSON ELECTED BOARD CHAIRMAN

George M. Ryan has been elected president of Benson-Lehner Corporation, succeeding the company's founder, Bernard S. Benson, who advances to chairman of the Board of Directors.

Mr. Ryan, a former general manager of Benson-Lehner, rejoined the company last November as executive vice president. In the interim he served five years as systems manager of Friden, Inc.

Mr. Benson founded Benson-Lehner with Dr. George F. Lehner, University of California psychology professor, in 1950. Under his leadership the company, with headquarters in Santa Monica, Calif., has grown into a widespread business with service centers throughout the world and manufacturing subsidiaries in England and France.

MANAGING DIRECTOR OF EUROPEAN OPERATIONS

Stanley L. H. Wilson has been appointed as managing director of European operations for the Guidance and Control Systems Division of Litton Systems, Beverly, Calif.

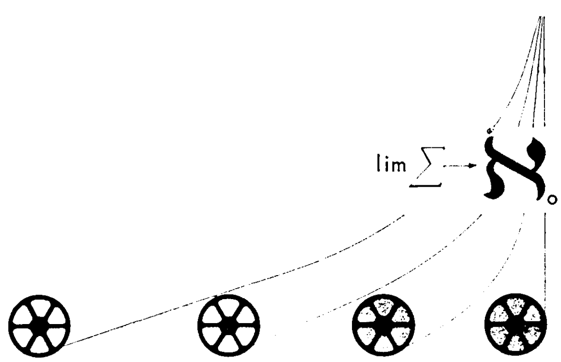
Mr. Wilson joins Litton Systems after a long career in the Canadian aircraft industry. His headquarters will be in Hamburg, Germany, from which he will manage a group of European firms producing LN-3 inertial navigation systems for F-104G fighter planes being manufactured in Europe.

PACKARD BELL ELECTRONICS; PHILCO CORP.

Dr. Wendell B. Sell has been named as group vice president of Packard Bell Electronics, replacing Dr. S. Dean Wanlass who resigned in June. Dr. Sell will direct Packard Bell's Technical Products Division, Computer Division and Physical Sciences Corporation (a 60% company-owned subsidiary).

Dr. Sell, a graduate of the U.S. Military Academy, spent 14 years as an army engineering officer. He was a pioneer in the use of early radar for anti-aircraft and anti-missile fire control and in 1945 became Chief of the Radar Branch, Army Field Forces. Prior to joining Packard Bell, he was vice president and general manager of the Marquardt Corporation's Pomona Division.

Dr. S. Dean Wanlass has been elected a vice president of Philco Corporation, Philadelphia, Pa., and appointed general manager of the Computer Division.



NEW CONTRACTS

COMPUTER SIMULATION OF MAKING CLINICAL DECISIONS

A Carnegie Institute of Technology psychology professor has received a grant of $18,000 from the National Institute of Mental Health for research on "Computer Simulation of Clinical Decision Making".

Dr. Benjamin Kleinmuntz, who will conduct the study, says there are relatively few diagnosticians who excel in interpreting objective personality tests. He hopes to discover how some of the expert interpreters of tests think during the process of making clinical decisions. He plans to tape-record their decision-making and then to program the Carnegie Tech Bendix G-20. The ultimate goal is to "teach" the computer to become a more accurate decision maker than the experts who were originally programmed. Dr. Kleinmuntz believes this is a realistic goal "because the computer, once it is properly programmed, does not make the types of careless errors to which humans are frequently prone". He also believes that the computer can be used as a tool for mass processing of thousands of personality tests at phenomenally high speeds.

ARMY CONTRACT TO CALIFORNIA COMPUTER PRODUCTS, INC.

Frankford Army Arsenal has awarded a contract to California Computer Products, Inc., Downey, Calif. for over $1 million for the production of 92 FALT units and spare parts. The FALT (Field Artillery Logic Test) units are to be used to check out FADAC (Field Artillery Digital Automatic Computer) equipment in the Army's automated field artillery control system.

LIBRASCOPE RECEIVES AIR FORCE CONTRACT

General Precision's Librascope Division, Glendale, Calif. has received a $1.9 million letter contract from the U.S. Air Force to produce automatic navigation computer systems for the newly developed C-141 jet-powered transport aircraft. The contract provides for production of nine computer systems.

The lightweight computer system will provide automatic navigation and data-processing capabilities for the turbofan freighter. The computer system, called the AN/ASN-24(V), consists of a digital computer, a converter chassis, and control/display panels.

The computer will receive data from an array of navigation instruments, rapidly compute the position of the aircraft, then relay the data to the aircraft crew on cockpit displays.

HALF MILLION POUND CONTRACT FOR ROUMANIAN AUTOMATION

The Roumanian Petroleum and Petro-Chemical Industries have awarded a contract for a half million pounds to Elliott-Automation Ltd., London, England. This contract provides for supplying very advanced types of electronic and computing automation equipment.

ASTM BUYS TERMATREX RETRIEVAL UNIT

A Termatrex information retrieval system has been ordered from Jonker Business Machines, Inc., Gaithersburg, Md. by the American Society for Testing Materials. The order is for 300 indexes to identify chemical compounds from their X-ray patterns. The system enables the analytical chemist to identify chemical compounds by matching the X-ray pattern of an unidentified chemical compound with the patterns of all known compounds.

STUDY PREVENTION OF MID-AIR COLLISIONS

The Federal Aviation Agency has awarded a $300,000 contract to Sperry Gyroscope Co. of Great Neck, N.Y., to study a proposed mid-air collision-avoidance system.

The FAA and Sperry revealed that successful flight tests were concluded earlier on one of the system's main components, a specially designed antenna that sets up a "question-and-answer" link between aircraft.

The system Sperry proposes would warn a pilot well in advance of an impending collision from any direction and prescribe a proper escape maneuver. This information could be fed directly into the plane's automatic pilot which would then execute the escape maneuver. The system employs interrogator-transponder techniques to automatically exchange altitude and velocity data, and measure range and bearing information between aircraft.

The Sperry system, if successful, could be used also as a pilot warning instrument in which range and relative bearing is displayed directly to the pilot for his evaluation.

SATELLITE CONTROL CONTRACT

A $3,710,000 contract for integration of computer programs for U.S. Air Force satellite control has been awarded System Development Corporation, Santa Monica, Calif. The program calls for SDC to integrate and systematize existing computer programs involving satellite guidance, stabilization, command control, telemetry, payload, and data reduction.

SINGLE INTERPRETIVE SYSTEM FROM THREE LANGUAGES

The Datatrol Corporation, Silver Spring, Md., has been awarded a contract by Advanced Scientific Instruments, Inc. of Minneapolis, Minn., to produce a single interpretive system for the ASI-210 computer which will accept computer programs written in any of three source languages, and implemented on another computer. The new system to be produced for the ASI-210 will function at least 50 times faster than on the previous computer.

CONTRACT FOR NEW NASA SCIENTIFIC AND TECHNICAL INFORMATION FACILITY

Documentation Incorporated, Bethesda, Md., has signed a $1.2 million contract with the National Aeronautics and Space Administration (NASA) for the first year of operation of the first, completely-integrated technical information center dealing in the space and aeronautical sciences.

The facility, which will be located in Bethesda, Md., will operate under the technical direction of NASA's Office of Scientific and Technical Information. It will report scientific data on space to NASA, its prime contractors, and other designated organizations and individuals in many countries. The latest in communications, data acquisition and documentation equipment and techniques will be employed to accomplish two major functions:

1. Worldwide acquisition, organization, processing, filing and reporting of space information for quick availability by users.
2. High-speed retrieval and dissemination of needed information.

The center, which will be known as the Scientific and Technical Information Facility, will be completely computer-oriented. Equipment will include an IBM tape 1401 system with random access memory. The facility will process data on magnetic computer tape and distribute sets to each of the nine NASA centers throughout the country, so that an individual or organization can contact the closest center for immediate information service. Each center will have the same interrogation capability as the Bethesda facility of NASA headquarters.

NEW YORK TIMES SIGNS CONTRACT WITH SIMULMATICS

Simulmatics Corporation, 501 Madison Ave., New York, N.Y., under contract to The New York Times, has begun preparations to devise a high-speed computer operation to assist Times political reporters in tabulating and analyzing returns for the coming elections in November. Analytical focus will be on the New York gubernatorial and senatorial elections and selected Congressional races throughout the country. Using this as a major operational test, Simulmatics will subsequently set up for the Times a computer model for analyzing the Presidential race in 1964.

Computing Centers

DATA PROCESSING EDUCATION CENTER IN MEXICO

Construction of a data processing education center for the Caribbean Area organization of IBM World Trade Corporation, has begun at Cuernavaca, Mexico. Completion of the center is expected by January.

The primary role of the center will be to provide comprehensive instruction for the area's business executives and government officials in the applications of data processing systems and equipment. It will also serve as an instruction center for IBM employees. The staff members for the center will be drawn from personnel of IBM Mexico.

HONEYWELL EDP SERVICE BUREAU OPENS IN CANADA

Honeywell Electronic Data Processing, Wellesley Hills, Mass., has opened its first Canadian computer service bureau. The Ottawa Service Bureau is equipped with a large-scale Honeywell 800. It is located in the Canadian headquarters building of Metropolitan Life Insurance Company, Ottawa, Canada. Metropolitan has contracted for use of "prime time" on the computer, but Honeywell reported that the capability of the equipment is such that time is available for use on a contract basis by other businesses and industries in Eastern Canada.

NEW APPLICATIONS

FALL ELECTION PREDICTIONS BY NBC, C-E-I-R, AND RCA

C-E-I-R, Inc., Washington, D.C., will again conduct research activities, construct a mathematical model of key sectors of the electorate, and program the data for Radio Corporation of America's electronic computer support of National Broadcasting Co.'s television election coverage next November. This same group, in the Presidential election of 1960, enabled the RCA 501 computer to predict, early Election Day evening, results that were correct within tenths of a percentage point of final tallies.

Information from key points around the nation will be fed directly, on line, to the computer, using the newly developed RCA DASPAN electronic data communications network.

The six areas of interest that will be subjected to a running analysis as the election returns are fed in are:

1. Composition of the House of Representatives
2. Composition of the Senate
3. The New York gubernatorial race
4. The California gubernatorial race
5. The Michigan gubernatorial race
6. Comparison of the congressional vote this year with that of the previous off-year election in 1958.

Dr. Jack Moshman, who devised the sensitive and accurate "key precinct" analytical system which correctly predicted President Kennedy's victory, will head up the research team.

In the 1960 electorate model, several hundred key precincts throughout the country were selected beforehand as giving early, accurate information on trends. As the "unknowns" of the actual election returns came in and were compared against the previously researched information, the model produced statistical projections that were later proved extremely accurate. A conceptually similar system will be devised for the 1962 election. The prediction of six separate elections and trends, however, involves considerably greater complexity in forecasting than the single national race.

GSW PIONEERS IN DATA PROCESSING

Great Southwest Warehouses, Arlington, Texas, with 650,000 square feet of floor space, is at last doing what warehouses throughout the country have attempted to do for the past 20 years. They are fitting a variety of demands to a data processing system and are coming out with all the answers. This has been accomplished by application of the theory of control by exception to the various problems posed to the warehouse by customers who use the facilities. A composite system has been designed to meet all needs that could be demanded by the customers; then the exceptions to the needs are deleted from the composite system to suit the particular needs of the customer.

Currently GSW handles products of over 500 national manufacturing firms and keeps on inventory, in large quantities, these varied products. Upon order, GSW ships these items to customers in the specific quantity ordered. Through the use of the IBM data processing center at GSW, the following things are accomplished: 1) the order is written; 2) billing is made to the customer; 3) the freight bill is issued; 4) billing is made to the storage account; 5) the bill of lading is made along with other shipping documents; 6) the freight rate is determined; 7) an activity report on the items shipped is kept up to date; 8) a perpetual inventory control is maintained; 9) all charges are billed where necessary; 10) billings are summarized so that charges can be credited with revenue; and 11) information is collected to better analyze efficiency, and to determine occupancy ratios.

The capabilities of the data processing section will soon be used in the computing and issuing of payroll checks to over 300 GSW employees, and keeping records for the general accounting department of the company.

CHECK PROCESSING FIRM MAKES OUT REPORT CARDS FOR NEW JERSEY SCHOOL SYSTEM

Automatic Data Processing, Inc., East Paterson, N.J., specializes in preparing weekly payrolls for small and medium size business concerns. Clients include brokerage houses, Broadway shows, an airline, hospitals, -- and others whose employees number from 50 to 4000 persons.

But the most unusual request in its 13-year history came from the Glen Ridge, N.J., school system. Four times a year one whole school day was wasted because each teacher spent that day marking report cards for every student who came into his or her classroom. They asked ADP Inc. to take over making up the quarterly report card lists for the 780 students in the junior and senior high schools in this district.

ADP devised a report-card marking process by which the teacher was able to do the marking at home simply by entering the grades on a student's roster listing. ADP would then pick up the rosters, have the marks transcribed, computed, and tabulated, producing reports for the student, the school office, the principal, and the student guidance officer.

The electronically computed system of making up report cards has saved teachers four instruction days a year.

Another report compares grades in a particular subject area for the entire group of students, and indicates via a curve how one class compares with another. The school board compares the teachers' markings according to the curve against the established college-entrance marking standards.

FARM EQUIPMENT MANUFACTURERS HAVE INVENTORY CONTROL SYSTEM

The James Mfg. Co., a division of Rockwood & Co., Fort Atkinson, Wis., has developed an inventory control system which provides them with the complete status of any of 16,000 stock items in less than 30 seconds.

The job is being done on an IBM 305 computer and RAMAC disk file. The disk file can retain and put to use in a split second any of five million digits of information. Its magnetic disks rotate at 1200 rpm. By keying in the disk location of a particular part, the computer will print out pertinent data such as the quantity on hand, number ordered, number reserved for customers' orders, and a minimum stock level. At a predetermined re-order point, the system will automatically issue a restock order.

Daily "explosion" of customer orders is one of the uses being made of the IBM equipment. As orders come in each morning, they are coded on punched cards for communication to the computer. Each order is then "exploded" by the machine, a process of breaking it down into component parts. Stock levels are then adjusted accordingly. The computer also is programmed to prepare a "shortage" card denoting an item for which there are more orders than stock available. Other important inventory data which the system prepares is the daily and the weekly stock status reports. These reports give management closer control over all phases of the business.

The company also finds time on its computer to do other jobs, such as payroll, labor distribution, and bulk tank calibration.

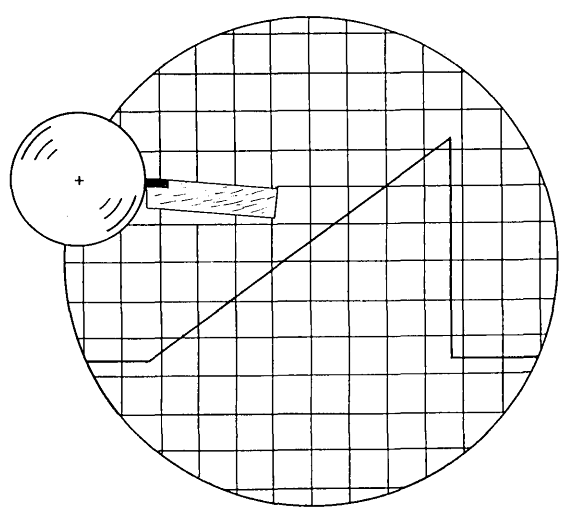
"CRITICAL PATH METHOD" TO BE USED IN BUILDING ST. LOUIS ARCH

A scientific technique known as the "Critical Path Method" will be used in programming the construction of the St. Louis Saarinen Arch. McDonnell Aircraft Corp., St. Louis, Mo., and MacDonald Construction Co. cooperatively are employing this program designed to keep cost in both time and money at a minimum.

The Arch, an architectural symbol of St. Louis as the "Gateway to the West", is planned for completion in time for the St. Louis Bicentennial Celebration in 1964. Construction will require approximately 2000 individual tasks or activities.

A network chart, showing the relationship of each activity to those immediately before and after, is the "nerve center" of the Critical Path Method. Information from the network, fed into the computer, emerges in the form of "output reports" with a variety of critical information. An expected completion date is computed, based on the time estimates provided. The report lists activities which lie in the "critical path" in which a delay in completion time would affect the over-all project. Subsequent computer runs will list manpower requirements; cost information will be developed to enable analysis of overtime or additional manpower costs in expediting phases of the project; periodic computer runs will report completion percentage and schedule status of the project; and areas requiring management action will be immediately pinpointed.

The CPM technique can be adapted rapidly to the changing conditions of the construction industry. Bad weather could curtail certain activities while others continue. This would shift the "critical path" and the computer would quickly determine the revised priority activities.



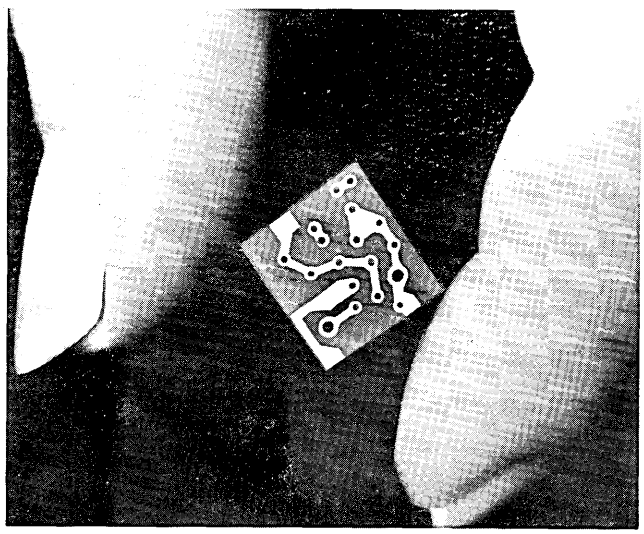
NEW PRODUCTS

MINIATURE PRINTED CIRCUIT

R G Circuits Co.
15216 Mansel Ave.
Lawndale, Calif.

A new series of miniature printed circuits has been produced by this company for installation in digital counters, proximity fuses, hearing aids, miniature amplifiers, guidance mechanisms of missiles, satellites, torpedos, and a wide variety of other instrumentation equipment where space and reliability are critical factors.

Each printed circuit may contain plated-through holes, overlays of nickel, gold or tin, or, if required, be solder-plated. It is printed on epoxy glass laminated material as thin as .004 inch and meets all Mil Specs MIL P-13949B.



RATIO COMPUTER FOR FINDING LENGTH OF RED-HOT STEEL BEAMS

Navigation Computer Corporation
Valley Forge Industrial Park
Norristown, Pa.

A digital, special-purpose ratio computer for industry has been developed and produced by this company. The computer counts pulses from two transducers, adds a correction factor to one of the counts, multiplies the other one by a scaling factor, and finds the ratio of the corrected numbers. Its accuracy depends only on the accuracy of the transducers. Self-checking features allow verification that the machine is performing each function correctly.

The Ratio Computer is being used in a finishing mill to find the length of red-hot steel beams. Another potential use in industrial measurement and control is flow metering requiring high-accuracy control.

MAGNETIC TAPE ADAPTER

Electronic Engineering Company
of California
Box 58
Santa Ana, Calif.

A magnetic tape adapter has been developed by this company to provide IBM 1401 computer users with read/write ability from the GE/ERMA computer system or GE 210 to IBM format and vice-versa.

The EECO 754 magnetic tape adapter operates as a program-control input/output unit of the IBM 1401 computer. Data may be edited or updated during the conversion as programmed by the IBM 1401. Complete ERMA and IBM error-detection circuitry are provided. All data translated to and from the EECO 754 is in IBM coding and format. All normal functions of the IBM 1401 are available to process data.

NEW TINY HIGH-SPEED MAGNETIC-REED SWITCH

Radio Corporation of America
RCA Electron Tube Division
New York 20, N.Y.

A tiny low-cost, magnetic-reed switch has been developed by this company. It can replace conventional switching devices in many areas of electronics.

The hermetically-sealed dry reed switch may be opened or closed in one millisecond (including contact bounce) by either a permanent magnet or an electromagnet. The reeds are enclosed in a small glass capsule. The device, named Minireed, weighs less than 0.3 of a gram. Its length is 0.85 of an inch, excluding leads, and it has a diameter of 0.135 of an inch.

Among the applications for these switches are: telephone, teletype and computer switching; missile check-out systems and radar data processing.

SOFTWARE NEWS

BANK COMPUTER CENTER SERVICE

The Harris Trust and Savings Bank of Chicago, Ill., is the first Chicago bank to perform data processing accounting services on its own equipment for correspondent banks. EPOCH is a registered service mark of Harris Bank, standing for "electronic posting operations for correspondents of Harris".

The new EPOCH service is now working for four Chicago area banks, and will soon be serving an additional six. The service is given for a fee to correspondents of the Harris, located within a 100-mile radius. Work received from the correspondent banks by the Harris by 8:00 p.m. is completed and delivered to the correspondent by 6:00 a.m. the next morning.

EPOCH performs all functions connected with the handling of checking accounts including fine-sorting checks in account number order, batch proof lists, trial balance and journal showing transactions, current balance in all checking accounts, a complete overdraft report, stop-payment report, and additional management and control reports. It also furnishes the correspondent bank its customers' monthly checking account statements and a monthly analysis of the profit or loss on each checking account of the correspondent.

WIZ -- TIME-SAVING COMPUTER PROGRAM

A new time-saving computer program for solving complex engineering problems has been announced by General Electric Company's Computer Department, New York. WIZ, as the new program is called, is described as a computer program, or compiler, for automatically translating algebraic expressions into computer language for solving engineering problems. It was specially designed to be used with the GE-225 computer system.

Computer solutions are obtained with a minimum amount of accessory equipment -- the computer itself, a card reader and a card punch are all that is needed. The engineer jots down a series of algebraic statements in WIZ sentences; these are then punched on cards; punched cards are fed to a card-reader which automatically transfers the instructions to the computer; and the computer translates the WIZ instructions into computer language. The computer delivers the results on new punched cards seconds after the last card is read. The routine established for a given type of problem is stored in the GE-225 library.

DIFFERENT PROGRAMMING LANGUAGES WITHIN THE SAME JOB: IBJOB PROCESSOR

A single computer programming system that permits IBM 7090 and 7094 computer users to process several source languages as part of a single job has been developed by the International Business Machines Corp., White Plains, N.Y.

The IBJOB Processor, as the system is called, provides an effective common communication facility for languages as varied as FORTRAN IV (FORmula TRANslating language for scientific computations) and COBOL 61 (COmmon Business Oriented Language, 1961 form). It can be stored on either IBM 1301 disk files or 729 magnetic tapes. The ability to use ultra-high speed Hypertape units also will be added to the new processor, which is designed to grow with the installation. The single basic monitor (IBSYS) may be adapted to new input-output devices as they are introduced.

ALCOM, EXECUTIVE, AND PERT PROGRAMS FOR BENDIX G-20

Three major programming packages for the Bendix G-20 computing system have been distributed to user installations, bringing major systems for the machine to a total of nine.

The new packages are:
- -- ALCOM, Bendix version of the international algebraic language, ALGOL
- -- EXECUTIVE, master routine for administering memory location, hardware control, etc., of operating programs
- -- PERT, critical path method for large-scale project scheduling.

Software previously distributed to G-20 users includes: linear programming; 650 simulator; sort/merger routine; symbolic assembly routine; PAR and SNAP. Other routines such as the GATE compiling system are available, and work is proceeding for an additional 25 software programs to be released within the next three months.

Computer Study of Orthogonal Latin Squares of Order Ten

E. T. Parker, Ph.D., UNIVAC Division of Sperry Rand Corporation, Univac Park, St. Paul 16, Minn.

1. The Problem of the 36 Officers

In the early Eighteenth century, or before, interest developed in a mathematical puzzle called the Problem of Thirty-Six Officers. According to the puzzle, there are six officers in each of six regiments. If we call the regiments A, B, C, D, E, and F, and the ranks general, colonel, major, captain, lieutenant, and sergeant (a, b, c, d, e, f), exactly one officer is a major in regiment E; exactly one is a general in regiment C, and so on, for all 6 times 6 equals 36 possibilities. Then the problem is to arrange the 36 officers in a square of six files and six rows, so that every file and every row contains exactly one officer of each regiment and exactly one officer of each rank.

For example, if we had Nine Officers, and wished to arrange them in a three by three square, we would have the solution:

Aa	Bb	Cc
Bc	Ca	Ab
Cb	Ac	Ba

In this solution the officers have been arranged so that each file and each row contains one and only one officer of any regiment A, B, C, and one and only one officer of any rank, a, b, c.

2. The Mathematician, L. Euler

In 1782 the Swiss mathematician Leonhard Euler (pronounced "oiler") wrote a long paper on the topic. He considered the problem for sizes other than six; for example, size five calls for twenty-five officers of five regiments and five ranks to be arranged in a 5-by-5 square. Euler showed easily how to solve the problem for every odd size. With effort he also solved the problem for any size an exact multiple of four; that is, 4, 8, 12, 16, etc. He obtained the easy result that there is no solution for size two. Then he experimented at length with size six; and, admitting that he had not exhausted all the possibilities, he asserted his conviction that there is no solution for size six—that is, no solution of the Problem of the Thirty-Six Officers. He then made the further conjecture that no solution is mathematically possible for size twice any odd whole number—2, 6, 10, 14, 18, 22, etc., indefinitely. A conjecture is an intelligent *guess* not in conflict with known facts; Euler did not claim to have any mathematical proof of his second conjecture. Whether or not his second conjecture was true set a challenge for mathematicians for over 150 years.

3. Some Definitions

The solution of the problem for size three may be divided and displayed as follows:

A	B	C		a	b	c
B	C	A		c	a	b
C	A	B		b	c	a

Each officer is assigned a constant position in the three-by-three array. The capital letters A, B, and C label his regiment. The small letters a, b, c label his rank. Note that the square array of capital letters on the left has each letter appearing once in each horizontal row, and once in each vertical column; this fits the requirement on arrangement of the officers by regiment. Likewise the array of small letters on the right, corresponding to ranks, has these same properties.

Either of the two above square arrays is called by modern mathematicians a *Latin square of order three;* this terminology is used because Euler displayed the arrays with ordinary Roman (Latin) letters. Mathematicians use the same term Latin square even if digits or numbers are used rather than letters.

The two Latin squares in this example are said to form an *orthogonal* pair, meaning that each capital letter is coincident in position once and only once with each small letter; for example capital C with small a in the center. This property of orthogonality corresponds with the requirement that there be exactly one colonel of regiment C, etc.

A solution of the officers problem of size four, or a pair of orthogonal Latin squares of order four is as follows:

0	3	2	1		3	1	0	2
2	1	0	3		2	0	1	3
3	0	1	2		0	2	3	1
1	2	3	0		1	3	2	0

The rather haphazard arrangement of symbols has no bearing on the validity of the solution; and use of digits in place of letters is perfectly acceptable.

4. Further Developments

In 1901 G. Tarry proved that there is no pair of orthogonal Latin squares of order six, and accordingly no solution of the Problem of Thirty-Six Officers. His method was the elimination of all possibilities, using considerable mathematical sophistication in order to handle numerous large categories as single cases. Euler's first conjecture for order six 119 years before was correct.

Through the first quarter of the present century the existence problem for orthogonal Latin squares of various orders remained a mathematical recreational puzzle, although an element of dignity had been given to Latin squares by Euler's having studied them. Then between 1930 and 1935 two independent developments elevated greatly the significance of orthogonal Latin squares in both applied and theoretical mathematics.

Statisticians studying experimentation, particularly Sir Ronald A. Fisher in England, discovered that a small number of values of three or four different variable quantities could be evaluated most efficiently in a single experiment if the experiment is designed according to a Latin square or a pair of orthogonal Latin squares. That is, one might test in a single bunch of plantings, instead of three, which of five strains of hybrid corn bears best, which of five fertilizers is best in terms of cost, and which level of irrigation among five choices is most effective.

Simultaneously among another school of mathematicians it was discovered than an affine plane of order n is equivalent to a set of n-1 mutually orthogonal Latin squares of order n. Several Latin squares (of the same order) are called *mutually orthogonal* when every two different ones in the given family are orthogonal. By definition, an *affine plane* is a class of *points* such that it may be arranged in certain special classes called *lines* with two axioms satisfied: (i) Any two different points are contained together in exactly one of the lines; (ii) For any line L and any point P not on L, there is exactly one line containing P and containing no point of L. Axiom (ii) of course is Euclid's parallel axiom. As is clear from the definition, an affine plane is an abstraction from the familiar plane of the geometry of Euclid; the concept was introduced at the beginning of this century by the German mathematician David Hilbert.

An affine plane is said to be of order n (n an ordinary positive whole number) if every line of the plane contains exactly n points; in this situation the total number of points in the plane is n^2.

The main unsolved problem in affine planes is whether any such plane exists of order *not* an exact power of a prime number—a *prime number* is a positive whole number such as 2, 3, 5, 7, 11, or 13, not exactly divisible by any whole number between one and itself. The first order for which it has not been determined whether an affine plane can be constructed is *ten*.

The mathematicians who study orthogonal Latin squares developed their interest from either statistics or abstract geometry and algebra; sometimes it is hard to guess which background a researcher was exposed to in his training.

With Tarry's proof for order six as evidence, it was generally believed that Euler's second conjecture was true. In fact, two or three papers were published in which the conjecture was claimed to be proved; however, errors were found in all these proofs.

Further experimental evidence for the truth of the conjecture seemed to be obtained when mathematicians at the University of California at Los Angeles programmed the SWAC computer to search for pairs of orthogonal Latin squares of order ten. In some dozens of hours of running, no example was produced by the computer. It was extrapolated than an exhaustive search for all Latin squares orthogonal to a fixed Latin square of order ten would require a half trillion hours of SWAC time.

5. Disproof of Euler's Second Conjecture

In 1959 Professors R. C. Bose and S. S. Shrikhande of the Department of Statistics, University of North Carolina, and the writer of this article, obtained a very general *disproof*[1] of Euler's second conjecture. They constructed (that is, described *how* to construct) a pair of orthogonal Latin squares of every order 10, 14, 18, 22, 26, etc. The methods were theoretical and, surprisingly, not very deep. No computers were used in this work. The writer feels that several people in the '40s and '50s were close to the result, but gave up too soon, believing that the conjecture was true.

6. Search for Orthogonal Latin Squares of Order 10

More recently the writer has programmed the UNIVAC[2] 1206 Military Computer to search exhaustively for all Latin squares (of order ten) orthogonal to a fixed Latin square of order ten. (The fixed Latin square is presented to the computer as input data.) This is the problem mentioned above for which the SWAC was programmed. Two major surprises came as a result of this work. The running time per input Latin square is only 28 to 45 minutes; this is a factor in speed of one trillion (or 10^{12}) over that obtained on SWAC. Of course, there is no such ratio of basic speeds between the two computers.

The second surprise is that pairs of orthogonal Latin squares of order ten are quite common; out of 33 computer-generated random Latin squares of order ten, 21 have completions to an orthogonal pair. Thus Euler guessed wrong by a large margin, and the evidence from earlier computation demonstrated only that the search is of large magnitude.

The writer however, has found the effort a little disappointing, because his attempts to produce three mutually orthogonal Latin squares of order ten have all failed. Some mild experimental evidence for nonexistence of such may perhaps be claimed. To prove this will require radically faster computers—or better, a new idea.

7. Programming the UNIVAC 1206

As is often the case, the large memory of the modern computer made feasible a radically different organization of the program. (UNIVAC 1206 has 32,768 words of core memory; SWAC has 256 words of electrostatic memory and 4,096 words on a drum.) SWAC was programmed to proceed across rows, filling out digits not in conflict with requirements; unfortunately, there are literally trillions of ways to complete three rows, and very few of these starts can be completed to solutions.

The writer programmed the 1206 to generate initially and store in efficient format all possible sets of ten positions of the input Latin square which might be occupied by one digit in a Latin square orthogonal thereto. Such a set of ten positions, one in each row, one in each column, and containing each digit once, is called a *transversal*. A typical Latin square of order ten has 800 to 1000 transversals; the list is easily stored in a large memory. Almost all the computer time was used in handling the list; generating it is very fast. (Far too many comparisons are required in processing the list to carry out the job by card sorter.)

The writer spared no effort to save microseconds by efficient and tricky programming. In order to avoid losing contact with the precise sequence of instructions, all coding was done in absolute octal.

A few time-saving devices incorporated into the program will be described briefly: The central task carried out by the computer is the exhaustive enumeration of lists of ten transversals, no two having a cell in common. (1) The class of all transversals of the input Latin square was subdivided into ten lists, one for each cell of the first row; the ten lists were assigned separate segments in memory. (2) Since the decision whether a transversal may be adjoined to a partial solution is the same process for each of the ten lists, the standard programming procedure would be to write a single loop to perform a phase of this sequence. By using much more program memory and complicating the program considerably, the writer cut running time to about one-third by writing strings of essentially identical loops. The gain was twofold—only when pre-setting for counts were any addresses written into instructions; up to six B-registers on the 1206 Computer could simultaneously reference memory addresses of transversals in the partial solution. (3) Each transversal was represented in memory by three 30-bit words, broken into nine 10-bit zones; these zones correspond to rows 2, 3, . . . , 10 of the Latin square. Exactly one 1-bit entered in a zone indicated which cell of the particular row is on the transversal. Thus rows could be handled three at a time in computer words. Further, by *adding* the words for a partial solution of the transversal problem, those cells not allowed on the next transversal are designated by the 1-bits in only three words. The decision whether a transversal can be adjoined to a partial solution thus requires comparison of only three pairs of words for 1-bits in like positions. (4) Each time a start of three transversals is generated, sort out those acceptable transversals in all remaining lists, then process the shorter lists. Comparison of programs with and without feature (4) indicated a gain of a factor three in speed.

8. A Ten-by-Ten Computer-Produced Example

An example of the UNIVAC 1206 Computer's work is displayed below. The first Latin square below is one of the random examples produced by the computer. Below it, entitled "Second," is an orthogonal mate thereto generated on the computer. This random pair of orthogonal Latin 10-squares is totally unlike the examples obtained in 1959 by purely mathematical methods.

First

2	1	9	6	7	0	4	8	5	3
0	4	5	9	3	1	2	6	8	7
5	7	2	3	0	9	8	4	1	6
1	0	6	5	2	4	7	9	3	8
3	6	1	2	9	8	0	7	4	5
8	5	0	1	6	2	9	3	7	4
7	2	8	0	4	3	6	5	9	1
9	8	4	7	1	5	3	0	6	2
4	3	7	8	5	6	1	2	0	9
6	9	3	4	8	7	5	1	2	0

Second

4	0	3	9	1	8	6	7	2	5
1	4	5	2	7	6	3	8	0	9
3	6	8	4	2	9	5	1	7	0
8	3	1	6	0	7	2	5	9	4
6	5	2	7	4	1	9	0	3	8
9	7	4	1	6	5	0	3	8	2
5	9	6	0	8	2	7	4	1	3
7	2	9	3	5	0	8	6	4	1
0	1	7	8	9	3	4	2	5	6
2	8	0	5	3	4	1	9	6	7

[1] Technical papers are in Proceedings of the National Academy of Sciences, Vol. 45 (1959), pp. 734-737 and 859-862; and Canadian Journal of Mathematics, Vol. 12 (1960), pp. 189-203.

[2] Registered trade mark of Sperry Rand Corporation.

Round-Up of Marketing News

I. GENERAL ELECTRIC REVIEWS ITS POSITION IN THE COMPUTER FIELD

Lacy W. Goostree, Manager of Marketing
General Electric Computer Department
Phoenix, Arizona

An all-out race for data-processing markets is shaping up among the big five computer manufacturers. International Business Machines Corporation is in the lead, Sperry-Rand second and General Electric, Minneapolis-Honeywell, and Radio Corporation of America neck and neck for third place.

Stakes in the race are high. The 1960 market for hardware alone, including military, was $1.5 billion, with prospects for a $4 to $7 billion market by 1970. In general-purpose business and scientific computers, 1961's market reached $1.1 billion.

This year (1962) the same market is expected to be $1.5 billion, with an estimated additional billion dollars for services. The "hardware" includes peripheral equipment as well as central processors.

General Electric feels it is benefiting from its experience as the world's largest business computer user and as a result is going after the manufacturing industries in a big way. (G.E. has more than 100 computers installed and operating throughout the Company.) General Electric has approximately 8,000,000 man-hours of experience in applying computers to its own data processing problems.

Following several years of single market concentration in which it captured a good share of the banking business, General Electric is attempting to make inroads into diversified markets.

The Company's blue-ribbon entry in the race is its GE 225. The mainstay of its present product line, the 225 general-purpose, all-transistorized computer is in competition with IBM's 1401-1410. The 225 is used in diverse financial, scientific and production chores across the nation.

General Electric introduced the 225 about a year and a half ago. Since then 40 have been shipped, with some 100 more on order. Many of the installations are within the Company, since the 225 was sold internally prior to public announcement. Sales in 1962 are expected to double.

General Electric has spent the last six years preparing for this effort. Although the Company has been making special-purpose computers for years, primarily for the government, it was not until January of 1956 that it announced the centralization of its computer activity into one Department.

Since that time, General Electric shipped the banking industry's first large-scale, all transistorized commercial computer, the Bank of America's ERMA (Electronic Recording Method of Accounting) system, in 1958. During this development, the Computer Department also developed the E-13B type font, which was approved by the American Bankers Association as standard for Magnetic Ink Character Recognition (MICR). Today over 60 per cent of bank checks now used are encoded in magnetic ink.

Thirty ERMA systems, similar to the GE 210, are now in operation in 13 Bank of America sites throughout California, processing more than 2,500,000 checks and deposit slips nightly. The Bank recently purchased two more 210's to handle its increasing load.

The closing months of 1961 saw orders for 16 such systems, most of them from existing users. Forty-five large banking systems have been shipped to date.

The Company moved its Computer Department from Syracuse to Phoenix in December of 1956; a group of computer-experienced employees began working in rented office space in downtown Phoenix. In December, 1959, it moved into a new 204,000 square foot building. Today, it is expanding into a multi-million dollar addition to that building.

In Sunnyvale, California, scientists and engineers recently moved into a new Computer Laboratory where advances in the computer field will be developed.

General Electric split its computer business into two separate areas about a year ago. The industrial process control computer business was transferred from the Computer Department to the Industry Control Department. Industrial process computers are thus manufactured in a separate facility about two miles from Computer Department Facilities in Phoenix.

In addition to expanding in Phoenix, General Electric is also opening computer centers—known as IPC's (for Information Processing Centers)—in key metropolitan areas. Two are now operating in Phoenix, one in Chicago and one in Washington, D. C. Additional centers are scheduled for opening this year in Schenectady, N. Y., Sunnyvale, Calif., Dallas, Tex., and New York City.

New hardware is in the offing. The next step will be toward the third generation computers, with small (Bendix G-15 price class) and large-scale (IBM 7090 to Stretch range) systems. The latter will definitely employ magnetic thin film. The department is determined to deliver tested software with the hardware.

New peripheral equipment also is in the works, including high-speed card readers and punches and optical character readers. The Computer Laboratory is digging into magnetic thin films, cryogenics, electroluminescent photo-conductive devices, and thermoplastic recording. The latter is expected to be the mass storage medium of the future.

While General Electric was building competence in engineering, applications and manufacturing of computers, it also was quietly planning an expansion of its marketing activities.

A year and a half ago, there were some 20 field salesmen serving the banking and internal company market. With availability of new products, an intensive sales-training program was initiated. New salesmen were put through 13 to 20 week programs precisely tailored to the needs of the individual. Today more than 150 salesmen are working out of 29 sales offices throughout the country. Fifteen of these have been opened over the past year. The training programs are continuing.

There is no doubt General Electric is serious about the computer business. Ralph J. Cordiner, chairman and chief executive officer of the Company, is putting special emphasis on the Company's investments in five "relatively new and more difficult technologies" which he expects will boost employment and earnings for General Electric in the 60's. The five: atomic power plants and other new energy conversion processes; stationary gas turbines and commercial jet engines; industrial automation; space; and computers.

Although the first large-scale commercial computer was put into use in 1953, more than 10,000 computers are operating today throughout the United States. Although the industry growth rate has been phenomenal, General Electric's rate of growth in the computer field over the past three years substantially exceeds that of the others in the "big five." What computers are doing today is childlike when related to what they will be doing 10 years from now. And, in the race for expanding markets, manufacturers will have much to do toward broadening the use of computers and improving their capabilities.

II. FIRST QUARTER COMPUTER ORDERS FOR THOMPSON RAMO WOOLDRIDGE EXCEEDED ALL OF 1961

Thompson Ramo Wooldridge Inc. computer orders for the first quarter of 1962 were greater than for all of 1961.

The most significant gains were announced in the first-quarter bookings of TRW-130 type military "stored logic" computers, which were more than double total orders for 1961. No actual figures were released.

TRW's computer line includes both military and commercial systems for control, logging and analysis, and automation production. Computers are in the medium size class and sell in the range of $85,000 to $400,000 per complete installation.

Current orders for computer installations, according to Dr. Ramo, are for automobile traffic control, automation of the nation's largest power station, and process control systems for the steelmaking, gas refining and petrochemical industries, both in the U. S. and overseas.

TRW-130 type military computers are being installed on many major programs such as TRANSIT, and the Atlantic Missile Range Radar chain for real time data processing. TRW-130 is an all solid-state medium-scale core-memory computer.

Recently introduced is the TRW-340 core-drum control computer, which claims to offer in one system high-capacity storage, high speed, and system expandability without expensive equipment replacement costs.

The Company presently has 28,000 employees; annual sales for 1961 were at $409 million. These figures also include TRW's work in the missile, ordnance, automobile and aircraft fields.

III. DRESSER INDUSTRIES' SIX MONTHS SALES UP

Dresser Industries, Dallas, Texas, have reported net earnings for the first six months of the 1962 fiscal year were $3,647,000 on sales of $114,957,000. This compares with net earnings of $3,397,000 on sales of $108,-629,000 for the comparable period a year ago.

Although sales increased in the second quarter of the current year, there was a slight decline in earnings, stemming in large part from price weakness in a number of the Company's principal product lines, primarily in the area of capital equipment. The backlog of unfilled orders as of April 30, 1962 was $53,374,000 nearly seven per cent above a comparable $49,984,000 of a year ago.

IV. LABORATORY FOR ELECTRONICS, INC., REPORTS ON FISCAL 1962

Henry W. Harding, President
Laboratory for Electronics, Inc.
Boston, Mass.

Gross income of $61,482,000 for the fiscal year ended April, 1962, is reported by Laboratory for Electronics, Inc. This figure is approximately three per cent below last year's consolidated sales figure of $63,494,000.

Net income after Federal income tax, and after a $432,000 provision for loss on foreign investments, was $102,000 compared with $2,095,000 for fiscal 1961.

Gross income in the LFE Electronics Division was approximately the same as last year. Profits were substantially lower, however, mainly because of losses in the computer products business, a reduction in the profit margins on Doppler navigation equipment for the F-105, and acceleration of research and development expenditures.

The backlog at the year-end was $31,107,000, up from $26,822,000 last year. Mergers have broadened our industrial and commercial product lines, lessening our dependence on government contracts.

V. AMPEX REPORTS RECORD SALES

Ampex Corporation, Redwood City, Calif., has reported record sales of $84,106,000 for the fiscal year ended April 28, 1962. This is a 20% increase over the previous year.

Among the new products introduced during the past fiscal year, were high-speed core memories for computers and advanced magnetic recording devices for instrumentation, video and audio applications. Reflecting increasing expenditures on research and development, Ampex plans to introduce more than 25 new products during fiscal 1962, bringing product diversification to a new high.

A building program to modernize and enlarge facilities at the company's Redwood City headquarters was inaugurated during the year. Two new buildings totaling 150,000 square feet are expected to be completed for occupancy by mid-1963. An expansion program to accommodate rapid growth at the corporation's Computer Products Company in Los Angeles also was undertaken.

VI. IBM REVENUES SET NEW RECORD

International Business Machines Corp. has reported that revenues and earnings for the second quarter of 1962 have set an all-time record. They also declared that revenues for the first six months of 1962 were also a record.

Second quarter net income rose to $60,044,018 as compared with $52,032,770 for the same quarter last year. Gross revenues from sales, rentals, and services increased to $478,478,773 as compared with $422,101,-019 in 1961 second quarter.

The previous earnings record for a quarter was set in the first three months of 1962 when IBM earned $56,264,982 on gross revenues of $453,226,278.

VII. BIG FIVE COMPUTER VENDORS FACE-TO-FACE

Patrick J. McGovern, Assistant Editor

Elsewhere in this issue Lacy Goostree, the computer marketing chief for General Electric, describes the all-out race for the data processing market among the leading five computer builders. Therefore, when these five—I.B.M., Sperry-Rand, R.C.A., Minneapolis-Honeywell, and G.E.—all send top-level sales-minded executives to participate in a discussion around the same table, one has good reason to suspect a real Donnybrook is in the making.

This unlikely event occurred recently at the American Management Association Briefing Session on Computer Economics at the Hotel Astor in New York in June. Presumably, the seventy-five or so executives who attended this session had rather immediate thoughts about renting, leasing, or purchasing a computer for their firms. One suspected that there could hardly be a more select audience to which a main frame vendor would desire to report the Company's thinking. Surprisingly enough, very little in the way of a direct sales pitch was presented by any of the manufacturers. However, what they did say, raised many eyebrows.

C. Garrison, Jr., the Director of Marketing for I.B.M., started off the discussion by describing results of an independent survey of computer users. When asked, "What factors influenced most strongly your choice of a computer?", the queried users responded most frequently (and not unsuspectedly) that they chose the computer that offered the greatest anticipated pay-off in clerical savings. Other reasons given, in order of frequency, were:

— the reputation of the manufacturer
— maintenance factor
— comparison of costs
— purchase prestige
— product support
— compatibility with existing systems
— error-checking characteristics

Ninety per cent of the users reported that they had realized the savings estimated in the original computer study. However, many of the users expressed dissatisfaction with the "warm-up time", the period between the initial installation of the computer and when the company first began to get usable results. The users reported, however, very little net unemployment in their companies due to the introduction of EDP.

When asked, "What would you do if you could do it all over again?" the users' responses included:

— let the union in on the decision
— start with a centralized rather than a decentralized system
— stronger emphasis on employee training
— allow for later introduction of new technical developments

The two principal complaints voiced by the users were (1) the lack of well-trained technical people as manufacturer's representatives, and (2) the tendency for computer vendors to oversell the application of EDP to a customer.

K. McCombs, Finance Manager of G.E.'s Computer Division, followed with some complaints of his own about computer customers. He said that many of them were known to lead the manufacturer on to the point of doing a complete systems study of the potential customer's operation, they would then find that the systems study revealed so many ways of improving the company's operation immediately, without a computer, that they lost their interest in the manufacturer's hardware.

He also said that the customer must be ready to develop a capable in-house staff to run the computer installation. Consulting firms and the manufacturer's staff can help, of course, but, Mr. McCombs emphasized that the customer will never be satisfied with his computer installation as long as he has to hang onto their apron strings for technically competent people. The customer needs to have his own personnel understand both the information flow pattern, and the microscopic structure of the software package.

Ed McCollister, the EDP Division Marketing Vice President for R.C.A., drew the audience's attention back to the remark by C. Garrison that 90% of

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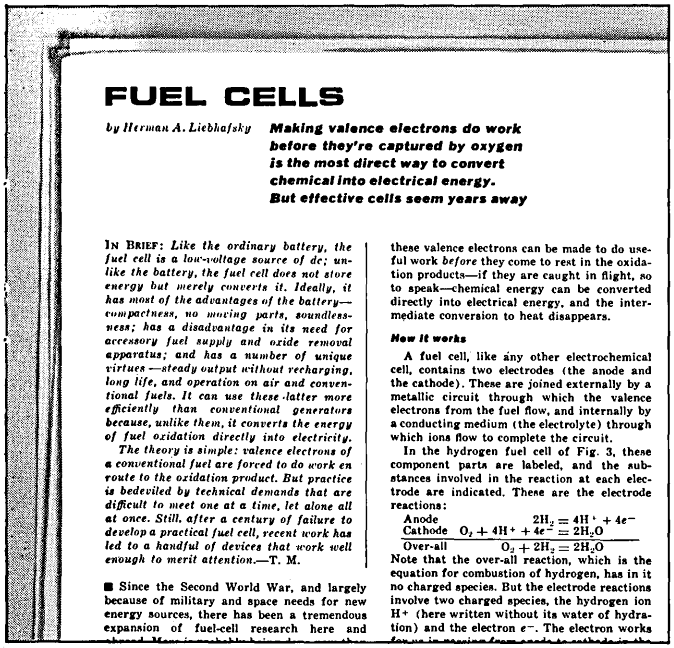


FUEL CELLS

by Herman A. Liebhafsky

Making valence electrons do work before they're captured by oxygen is the most direct way to convert chemical into electrical energy. But effective cells seem years away

IN BRIEF: *Like the ordinary battery, the fuel cell is a low-voltage source of dc; unlike the battery, the fuel cell does not store energy but merely converts it. Ideally, it has most of the advantages of the battery—compactness, no moving parts, soundlessness; has a disadvantage in its need for accessory fuel supply and oxide removal apparatus; and has a number of unique virtues—steady output without recharging, long life, and operation on air and conventional fuels. It can use these latter more efficiently than conventional generators because, unlike them, it converts the energy of fuel oxidation directly into electricity.*

The theory is simple: valence electrons of a conventional fuel are forced to do work en route to the oxidation product. But practice is bedeviled by technical demands that are difficult to meet one at a time, let alone all at once. Still, after a century of failure to develop a practical fuel cell, recent work has led to a handful of devices that work well enough to merit attention.—T. M.

■ Since the Second World War, and largely because of military and space needs for new energy sources, there has been a tremendous expansion of fuel-cell research here and

these valence electrons can be made to do useful work *before* they come to rest in the oxidation products—if they are caught in flight, so to speak—chemical energy can be converted directly into electrical energy, and the intermediate conversion to heat disappears.

How it works

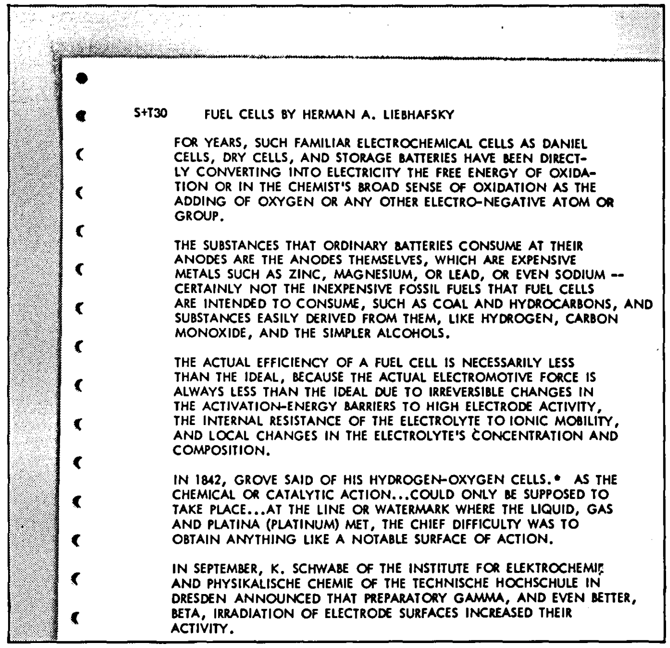
A fuel cell, like any other electrochemical cell, contains two electrodes (the anode and the cathode). These are joined externally by a metallic circuit through which the valence electrons from the fuel flow, and internally by a conducting medium (the electrolyte) through which ions flow to complete the circuit.

In the hydrogen fuel cell of Fig. 3, these component parts are labeled, and the substances involved in the reaction at each electrode are indicated. These are the electrode reactions:

Anode	$2H_2 = 4H^+ + 4e^-$
Cathode	$O_2 + 4H^+ + 4e^- = 2H_2O$
Over-all	$O_2 + 2H_2 = 2H_2O$

Note that the over-all reaction, which is the equation for combustion of hydrogen, has in it no charged species. But the electrode reactions involve two charged species, the hydrogen ion H^+ (here written without its water of hydration) and the electron e^-. The electron works

This 4000-word article appeared in the January, 1962, issue of International Science and Technology. *To abstract the article, a document analyst would read it, define its purpose, and summarize its essential points.*



S+T30 FUEL CELLS BY HERMAN A. LIEBHAFSKY

FOR YEARS, SUCH FAMILIAR ELECTROCHEMICAL CELLS AS DANIEL CELLS, DRY CELLS, AND STORAGE BATTERIES HAVE BEEN DIRECTLY CONVERTING INTO ELECTRICITY THE FREE ENERGY OF OXIDATION OR IN THE CHEMIST'S BROAD SENSE OF OXIDATION AS THE ADDING OF OXYGEN OR ANY OTHER ELECTRO-NEGATIVE ATOM OR GROUP.

THE SUBSTANCES THAT ORDINARY BATTERIES CONSUME AT THEIR ANODES ARE THE ANODES THEMSELVES, WHICH ARE EXPENSIVE METALS SUCH AS ZINC, MAGNESIUM, OR LEAD, OR EVEN SODIUM -- CERTAINLY NOT THE INEXPENSIVE FOSSIL FUELS THAT FUEL CELLS ARE INTENDED TO CONSUME, SUCH AS COAL AND HYDROCARBONS, AND SUBSTANCES EASILY DERIVED FROM THEM, LIKE HYDROGEN, CARBON MONOXIDE, AND THE SIMPLER ALCOHOLS.

THE ACTUAL EFFICIENCY OF A FUEL CELL IS NECESSARILY LESS THAN THE IDEAL, BECAUSE THE ACTUAL ELECTROMOTIVE FORCE IS ALWAYS LESS THAN THE IDEAL DUE TO IRREVERSIBLE CHANGES IN THE ACTIVATION-ENERGY BARRIERS TO HIGH ELECTRODE ACTIVITY, THE INTERNAL RESISTANCE OF THE ELECTROLYTE TO IONIC MOBILITY, AND LOCAL CHANGES IN THE ELECTROLYTE'S CONCENTRATION AND COMPOSITION.

IN 1842, GROVE SAID OF HIS HYDROGEN-OXYGEN CELLS.* AS THE CHEMICAL OR CATALYTIC ACTION...COULD ONLY BE SUPPOSED TO TAKE PLACE...AT THE LINE OR WATERMARK WHERE THE LIQUID, GAS AND PLATINA (PLATINUM) MET, THE CHIEF DIFFICULTY WAS TO OBTAIN ANYTHING LIKE A NOTABLE SURFACE OF ACTION.

IN SEPTEMBER, K. SCHWABE OF THE INSTITUTE FOR ELEKTROCHEMIE AND PHYSIKALISCHE CHEMIE OF THE TECHNISCHE HOCHSCHULE IN DRESDEN ANNOUNCED THAT PREPARATORY GAMMA, AND EVEN BETTER, BETA, IRRADIATION OF ELECTRODE SURFACES INCREASED THEIR ACTIVITY.

This abstract was prepared by an IBM computer. The text was first coded in machine language. The computer then counted key words, and printed out sentences having the greatest statistical significance.

Each year in the physical and life sciences, some 50,000 technical journals will be published throughout the world. 100,000 research reports and 60,000 technical books will also be written. Somewhere in this mass of knowledge may be information you need. To tell what is known—and where to find it—IBM is investigating systems for the dissemination, storage, and retrieval of information.

To create an advanced information retrieval system, labels must be found for *all* useful information in documents. With conventional library indexing, it is difficult to make allowance for new kinds of knowledge. However, computers let us use more versatile methods of indexing. In one of these, the KWIC INDEX (Key Word In Context), a computer selects significant terms in the titles of documents, then prints them out as index entries.

Once indexed, characteristics of documents' contents can be used to notify people of their existence. The Selective Dissemination of Information system at IBM stores profiles describing individuals' interests. A new document's key words are matched against key words in a person's profile. If there is sufficient correlation, he is informed of the document. Profile matching can also be used to retrieve information by storing documents and feeding key-word queries through the system.

At present it is relatively difficult to get text into machine-readable form. However, the development of high-speed optical character readers, automatic language translators, and improved methods of capturing linguistic information at the source may make it possible to introduce information directly into retrieval systems. Once harvested, vast quantities of information will present storage problems. IBM is investigating random-access photostorage systems capable of storing millions of documents and retrieving them in seconds. Out of systems like these may come total information centers which will acquaint scientists and businessmen with all the information needed in their work.

If you have been searching for an opportunity to make important contributions in information retrieval, component engineering, optics, space systems, or any of the other fields in which IBM scientists and engineers are finding answers to basic questions, please contact us. IBM is an Equal Opportunity Employer. Write to: Manager of Professional Employment, IBM Corporation, Department 539U, 590 Madison Avenue, New York 22, New York.

computer users had realized the savings anticipated in their original computer studies. He said that, in view of the large losses of computer builders to date, a paraphrase of a remark of Winston Churchill's might apply, "Never before have so few given so much to so many."

He said that it was clear to most people that this kind of distribution of profits and losses in the computer field between buyers and builders was unhealthy, and that it was not likely to continue. He estimated that the total cumulative loss of computer manufacturers already approaches the sum of the two biggest corporate losses in business history, i.e., Ford Motor Co.'s Edsel model, and General Dynamics' Convair Jet.

Some of the reasons for this uncomfortable situation are well known, he said. One of the primary causes is the long lead time in picking up the full selling price for a computer because of leasing agreements extending over three to five years. However, one of the less known reasons is that nearly all manufacturers have been plagued with increasing demands for free services from potential computer customers. McCollister said that although computers are priced by their manufacturers at a reasonable profit margin, this demand for free services, when satisfied, makes severe cuts into the profit picture of any manufacturer. He said that the manufacturer's proposal itself was a heavy expense, and that when the customer allows an outside consultant to give specifications for the computer system, it results in substantial savings for the vendor.

All manufacturers are well aware, he said, that computers are today offered to a buyers' market, and they have all met up with the type of customer who wants to draw as much blood as possible. Today, he said, the vendor is not only asked, "What is the price of your computer?", but also

— How much of the pick-and-shovel detailed programming are you going to do for us?

— What special technical assistance will be provided before and after the computer installation?

— Will you guarantee repayment of any losses resulting from systems changeover?

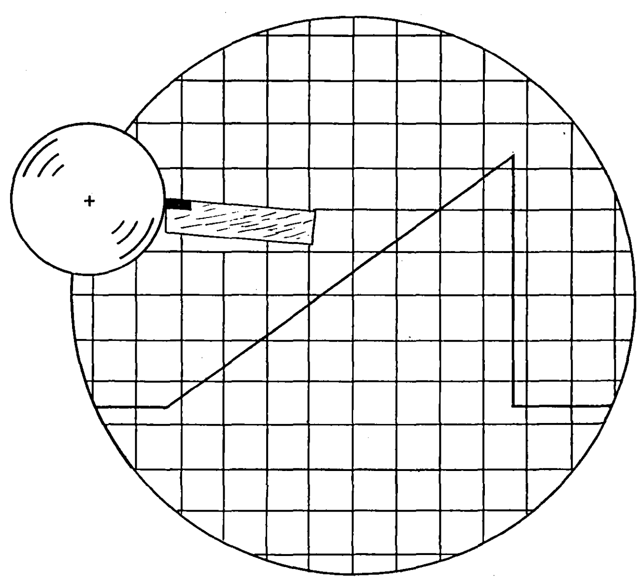
— Will your company undertake the programming for a complete inventory control problem?

McCollister said that he supports *general* price competition, but not *selective* price competition. He said that this results in customers being treated unequally, and this is a very undesirable situation for the computer field. He stated, "I think that we would all agree that this situation is a bad thing. The answer, then, is to eliminate this particular infection by putting everyone on an equal basis by pricing services separately from the product. Then the customer can make his choice, and everyone is treated alike. Moreover, this would provide a more open field for consultants, which in my view would be a real tonic."

Jay Schnakel, the Vice Pres. of Remington Rand UNIVAC, struck much the same theme when he remarked that technical support to the computer installation should be much more a customer function than at present, and that consulting firms should also have a bigger share of the technical assistance. He said that it is not natural that some computer vendors keep so close to the internal workings of the customer's company for long periods of time. He felt that this was a danger to the vendor's over-all competitive position. He said that the rate of introduction of the new computers in the years ahead will be strongly influenced by the rate at which the price of large-scale memories drop. However, he remarked, one still finds customers who think that they are not using their computer efficiently unless every memory register is occupied. They are still concerned about unused core memory.

Walter Finke, President of Honeywell EDP Division, drew a warm response to his telling of the story of a battered Yankee captain during the Revolutionary War whose boat was in the middle of a bad pounding from a huge British warship. When John Paul Jones waved the flag and shouted, "We have not yet begun to fight," he shouted with anguish, "There is always some SOB who hasn't gotten the word." He added that manufacturers were being asked to supply excessive amounts of technical assistance to computer customers, but that both parties shared a common problem—how does one obtain a sufficient number of good programmers?

The discussion that followed the talks brought out the fact that among others the manufacturers are watching with some trepidation the moves of the U. S. government toward establishing government computer service centers to handle the computing work of various governmental agencies, rather than maintaining bureau by bureau computer sections. The first move in this direction will be made in Philadelphia where the government will set up its first "computer service center" next year to test the merits of this approach. There is concern that this centralized set-up will take a big cut out of potential computer sales to the government.



CALENDAR OF COMING EVENTS

August 9-11, 1962: Northwest Computing Association Annual Conference, Seattle, Wash.; contact Robert Smith, Conference Director, Box 836, Seahurst, Wash.

Aug. 21-24, 1962: 1962 Western Electronic Show and Convention, California Memorial Sports Arena and Statler-Hilton Hotel, Los Angeles, Calif.; contact Wescon Business Office, c/o Technical Program Chairman, 1435 S. La Cienega Blvd., Los Angeles 35, Calif.

Aug. 27-Sept. 1, 1962: 2nd International Conference on Information Processing, Munich, Germany; contact Mr. Charles W. Adams, Charles W. Adams Associates, Inc., 142 the Great Road, Bedford, Mass.

Sept. 3-7, 1962: International Symp. on Information Theory, Free Univ. of Brussels, Brussels, Belgium; contact Bruce B. Barrow, Postbus 174, Den Haag, Netherlands

Sept. 3-8, 1962: First International Congress on Chemical Machinery, Chemical Engineering and Automation, Brno, Czechoslovakia; contact Organizing Committee for the First International Congress on Chemical Machinery, Engineering and Automation, Vystaviste 1, Brno, Czechoslovakia.

Sept. 4-7, 1962: British Computer Society Annual Conference, Cardiff, South Wales (immediately after I.F.I.P. Congress in Munich); contact G. J. Morris, International Computers & Tabulators Ltd., Putney Bridge House, London, S.W. 6, England

Sept. 19-20, 1962: 11th Annual Industrial Electronics Symposium, Hotel Sheraton, Chicago, Ill.; contact Ed. A. Roberts, Comptometer Corp., 5600 Jarvis Ave., Chicago 48, Ill.

Sept. 19-21, 1962: 7th National Conference of the Bendix G-15 Users Exchange Organization, Sheraton Hotel, Philadelphia, Pa.; contact Dr. Arthur L. Squyres, Chairman, Bendix G-15 Users Exchange Organization, E. I. du Pont de Nemours & Co., Inc., Eastern Laboratory, Gibbstown, N. J.

Sept. 19-22, 1962: Institute on Information Retrieval, Univ. of Minn., Minneapolis 14, Minn.; contact Director, Center for Continuation Study, Univ. of Minn., Minneapolis 14, Minn.

Sept. 20-21, 1962: JUG-CODASYL Decision Tables Symposium, Barbizon Plaza Hotel, New York, N. Y.; contact L. V. Parent, Trunkline Gas Co., P. O. Box 1642, Houston 1, Tex.

Oct. 2-4, 1962: National Symposium on Space Elec. & Telemetry, Fountainbleu Hotel, Miami Beach, Fla.; contact Dr. Arthur Rudolph, Army Ballistic Missile Agency, R & D Op. Bldg. 4488, Redstone Arsenal, Ala.

Oct. 8-10, 1962: National Electronics Conference, Exposition Hall, Chicago, Ill.; contact National Elec. Conf., 228 N. LaSalle, Chicago, Ill.

Oct. 8-26, 1962: Seminar in Search Strategy, Drexel Inst. of Technology, Philadelphia, Pa.; contact Mrs. M. H. Davis, Seminar in Search Strategy, Graduate School of Library Science, Drexel Inst. of Technology, Philadelphia 4, Pa.

Oct. 15-18, 1962: Conference on Signal Recording on Moving Magnetic Media, The Hungarian Society for Optics, Acoustics and Cinetechnics, Budapest, Hungary; contact Optikai, Akusztikai, es Filmtechnikai Egyesulet, Szabadsag ter 17, Budapest V, Hungary

Oct. 15-18, 1962: Instrument Society of America's 17th Annual Instrument-Automation Conference and Exhibit, New York Coliseum and Hotel New Yorker, New York, N. Y.; contact D. R. Stern, Publicity Mgr., Instrument Society of America, Penn Sheraton Hotel, 530 Wm. Penn Pl., Pittsburgh 19, Pa.

Oct. 24-25, 1962: 1962 Computer Applications Symposium, sponsored by Armour Research Foundation of the Ill. Inst. of Technology, Morrison Hotel, Chicago, Ill.; contact Ed Hansen, Ill. Inst. of Technology, 35 W. 33 St., Chicago 16, Ill.

Oct. 24-26, 1962: Cooperating Users' Exchange Meeting, Los Angeles, Calif.; contact A. P. Jensen, Vice Pres., CUE, Georgia Inst. of Technology, Rich Electronic Computer Center, Atlanta 13, Ga.

Oct. 29-Nov. 2, 1962: 9th Institute on Electronics in Management, The American University, Washington, D. C.; contact Dr. Lowell H. Hattery, Director, 9th Inst. on Electronics in Management, The American University, 1901 F St., N.W., Washington 6, D. C.

Oct. 30-31, 1962: Conference on Eng. Tech. in Missile & Spaceborne Computers, Disneyland Hotel, Anaheim, Calif.; contact William Gunning, EPSCO-West, 240 E. Palais Rd., Anaheim, Calif.

Nov. 4-7, 1962: 15th Annual Conf. on Elec. Tech. in Medicine and Biology, Conrad Hilton Hotel, Chicago, Ill.; contact Dr. J. E. Jacobs, 624 Lincoln Ave., Evanston, Ill.

Nov. 5-7, 1962: NEREM (Northeast Res. & Engineering Meeting), Commonwealth Armory, Somerset Hotel, Boston, Mass.; contact NEREM-IRE Boston Office, 313 Washington St., Newton, Mass.

Dec. 4-5, 1962: Eastern Joint Computer Conference, Bellevue-Stratford Hotel, Philadelphia, Pa.

NEW PATENTS

RAYMOND R. SKOLNICK
Reg. Patent Agent
Ford Inst. Co., Div. of Sperry Rand Corp., Long Island City 1, New York

The following is a compilation of patents pertaining to computer and associated equipment from the "Official Gazette of the U. S. Patent Office," dates of issue as indicated. Each entry consists of patent number / inventor(s) / assignee / invention. Printed copies of patents may be obtained from the U. S. Commissioner of Patents, Washington 25, D. C., at a cost of 25 cents each.

March 6, 1962 (cont'd)

3,024,445 / Arnold M. Spielberg, Haddonfield, and John F. Page, Barrington, N. J. / R.C.A., a corp. of Del. / An information transferring system.

3,024,446 / Nathaniel R. Kornfield, Camden, N. J. / Burroughs Corp., Detroit, Mich. / One core per bit shift register.

March 13, 1962

3,025,409 / Richard L. White, Skokie, Ill. / Hoffman Electronics Corp., a corp. of Calif. / Logic Circuits or the like.

3,025,411 / William G. Rumble, Van Nuys, Calif. / R.C.A., a corp. of Del. / A drive circuit for a computer memory.

3,025,497 / Erik G. Westerberg, Stockholm, Sweden / Aktiebolaget Atvidabergs Industrier, Atvidaberg, Sweden. / A magnetic memory shift register.

3,025,498 / Edwin O. Blodgett, Rochester, N. Y. / Commercial Controls Corp., Rochester, N. Y. / A data collecting system.

3,025,500 / George R. Hoffman, Sale, and Michael A. Maclean, Manchester, Eng. / I.B.M. Corp., New York, N. Y. / An electromagentic storage and switching arrangement.

3,025,501 / Lyle G. Thompson, Broomall, Pa. / Burroughs Corp., Detroit, Mich. / A magnetic core logical system.

3,025,503 / Kenneth E. Perry, Newton, Mass. / Minneapolis-Honeywell Reg. Co., a corp. of Del. / An information storage record and apparatus.

March 20, 1962

3,026,033 / David L. Spooner, Columbus, Ohio / Industrial Nucleonics Corp., a corp. of Ohio / Means for digitally indicating fractions of an analog signal.

3,026,034 / John F. Couleur, Fayetteville, N. Y. / G.E. Co., a corp. of N. Y. / A binary to decimal conversion system.

3,026,035 / John F. Couleur, Fayetteville, N. Y. / G.E. Co., a corp. of N. Y. / A decimal to binary conversion system.

3,026,036 / John W. Haanstra and Roy L. Huag, San Jose, Murray L. Lesser, Palo Alto, and Louis D. Stevens and William W. Woodbury, San Jose, Calif. / I.B.M. Corp., New York, N. Y. / A data transfer mechanism.

3,026,420 / Richard L. Whitely, Haddonfield, N. J. / R.C.A., a corp. of Del. / A magnetic switching and storing device.

3,026,421 / Hewitt D. Crane, Palo Alto, and David R. Bennion, Lomar Mar, Calif. / Burroughs Corporation, Detroit, Mich. / A core device for performing logical functions.

WHO'S WHO IN THE COMPUTER FIELD — CUMULATIVE EDITION, 1962

Computers and Automation will publish this summer a cumulative edition of "Who's Who in the Computer Field."

If you are interested in computers, please fill in the following Who's Who entry form (which may be copied on any piece of paper) and send it to us for your free listing. If you have friends in the computer field, please call their attention to sending us their Who's Who entries. The cumulative edition will include only the entries of persons who send us their Who's Who information.

Name? (please print) ....

Your Address? ....

Your Organization? ....

Its Address? ....

Your Title? ....

Your Main Computer Interests?

( ) Applications
( ) Business
( ) Construction
( ) Design
( ) Electronics
( ) Logic
( ) Mathematics
( ) Programming
( ) Sales
( ) Other (specify):

....

Year of birth? ....

College or last school? ....

Year entered the computer field? ....

Occupation? ....

Anything else? (publications, distinctions, etc.) ....

....

When you have filled in this entry form please send it to: Who's Who Editor, **Computers and Automation,** 815 Washington Street, Newtonville 60, Mass.

3,026,422 / Gwilym Phylip-Jones, Harrow, London, Eng. / G.E. Co. Lim., London, Eng. / A transistor shift register with blocking oscilator stages.

3,026,499 / Adam Chaimowicz, Stevenage, Eng. / International Computers and Tabulators Lim., London, England / An information storage apparatus.

3,026,500 / Michael May, Santa Monica, and Daniel L. Curtis, Manhattan Beach, Calif. / Hughes Aircraft Co., Culver City, Calif. / An electronic circuit for selectivity shifting the time position of digital data.

March 27, 1962

3,027,079 / Taylor C. Fletcher and Lawrence M. Silva, Fullerton, Calif. / Beckman Instruments Inc., Fullerton, Calif. / A data handling system.

3,027,082 / Shih Chieh Chao, San Jose, Calif. / I.B.M. Corp., New York, N. Y. / A digital apparatus for adding and multiplying.

3,027,465 / Bernard A. DiLorenzo, Waltham, and Walter R. Anderson, West Newbury, Mass. / Sylvania Electric Products, Inc., Wilmington, Del. / A logic "nor" circuit with speed-up capacitors having added series current limiting resistor to prevent false outputs.

3,027,547 / Fritz E. Froehlich, Morristown, N. J. / Bell Telephone Lab., Inc., New York, N. Y. / A magnetic core circuit.

3,027,549 / James D. Allen, Jr., Santa Clara County, Calif. / I.B.M. Corp., New York, N. Y. / A magnetic transducer.

3,027,550 / Robert C. Lee, Madison, and John J. Yostpille, Livingston, N. J. / Bell Telephone Lab., Inc., New York, N. Y. / A signal pulse detector and register.

April 3, 1962

3,028,081 / John R. Knight, Poughkeepsie, N. Y. / I.B.M. Corp., New York, N. Y. / A remote reader system.

3,028,085 / John F. Donan, Reseda, Ralph R. Powell, Los Angeles, and Chris A. Christoff, San Gabriel, Calif. / Clary Corp., San Gabriel, Calif. / An electronic calculating apparatus.

3,028,086 / Huberto M. Sierra, Santa Clara, Calif. / I.B.M. Corp., New York, N. Y. / A division system apparatus.

3,028,087 / Charles A. Walton, Owego, N. Y. / I.B.M. Corp., New York, N. Y. / A numeric multiplier system.

3,028,088 / Bradford Dunham, Poughkeepsie, N. Y. / I.B.M. Corp., New York, N. Y. / A multipurpose bias logical device.

3,028,509 / Erwin S. Teltscher, Forest Hills and Constantine G. Valavanis, Brooklyn, N. Y. / Sperry Rand Corp., Ford Instrument Co. Div., New York, N. Y. / A transistorized wave shape converter.

3,028,551 / Frank Secretan, West Los Angeles, Calif. / Collins Radio Co., Cedar Rapids, Iowa / A digital phase storage circuit.

3,028,583 / James E. Fernekees, Wappingers Falls, and Leonard Roy Harper, Poughkeepsie, N. Y. / I.B.M. Corp., New York, N. Y. / An information storage calculation system.

April 10, 1962

3,028,659 / Wen Tsing Chow, Syosset, and William H. Henrich, Woodbury, N. Y. / American Bosch Arma Corp., a corp. of N. Y. / A storage matrix board for digital computers.

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3,029,412 / Carl D. Southard, Endicott, N. Y. / I.B.M. Corp., New York, N. Y. / A data input-output control mechanis.

3,029,414 / Henry W. Schrimpf, Waltham, Mass. / Minneapolis-Honeywell Reg. Co., Minneapolis, Minn. / An information handling apparatus.

3,029,415 / John A. Baldwin, Jr., Murray Hill, N. J. / Bell Telephone Lab., Inc., New York, N. Y. / A nondestructive memory circuit.

3,029,416 / Edward A. Quade, San Jose, Calif. / I.B.M. Corp., New York, N. Y. / A high speed magnetic drum.

April 17, 1962

3,030,019 / Kenneth L. Smith, Southampton, Eng. / International Computers and Tabulators Lim., London, England / An electronic computing machine.

3,030,519 / Hewitt D. Crane, Palo Alto, Calif. / Burroughs Corp., Detroit, Mich. / A logical "and" circuit.

3,030,520 / Hewitt D. Crane, Palo Alto, Calif. / Burroughs Corp., Detroit, Mich. / A logical "or" circuit.

3,030,521 / William H. Lucke, Moores Lane, R.R. 3, Box 170, Clinton, Md. / ——— / A magnetic core binary counter.

3,030,522 / Benjamin Fennick, River Edge, N. J. / The Bendix Corp., a corp. of Del. / A phase selective diode gate circuit.

3,030,609 / John C. Albrecht, Chatham, N. J. / Bell Telephone Lab., Inc., New York, N. Y. / A data storage and retrieval system.

3,030,610 / Robert K. Phillips, Philadelphia, Pa., and Edward E. Clarke, New York, N. Y. / I.B.M. Corp., New York, N. Y. / A magnetic core circuit arrangement.

3,030,613 / Philip A. Trout, Washington, D. C. / U.S.A. as represented by the Secretary of the Navy / A transistor-core flip-flop memory circuit.

April 24, 1962

3,031,140 / Roderick A. Coopper, Hyde Park, N. Y. / I.B.M. Corp., New York, N. Y. / Parallel adder.

3,031,141 / Kikuo Oki and Shigenobu Sato, Tokyo, Japan / Nippon Electric Company, Ltd., Tokyo, Japan / Electronic root-locus computing device.

3,031,584 / Robert A. Henle, Hyde Park, N. Y. / I.B.M. Corp., New York, N. Y. / Logical circuits using junction transistors.

3,031,585 / William Ensign Frady, Palos Verdes Estates, Calif. / Thompson Ramo Wooldridge Inc., Cleveland, Ohio / Gating circuits for electronic computers.

3,015,586 / John L. Anderson, Poughkeepsie, N. Y. / I.B.M. Corp., New York, N. Y. / Multipurpose superconductor computer circuits.

3,031,587 / Geoffrey Ord, Malvern Wells, and Peter Lawley Lewis, Great Malvern, England / National Research Development Corp., London, England / Two-state electronic circuits.

3,031,588 / Manfred Hilsenrath, Los Gatos, Calif. / Lockheed Aircraft Corp., Burbank, Calif. / Low drift transistorized gating circuit.

3,031,648 / Harold E. Haber and Richard M. Clinehens, Dayton, Ohio / The National Cash Register Co., Dayton, Ohio, a corp. of Maryland / Magnetic data storage device.

3,031,649 / Chirstopher L. Snyder, Plainfield and Robert S. Straley, Franklin Park, N. J. / Indiana General Corp., a a corp. of Indiana / Matrix for computers.

3,031,650 / Ralph J. Doerner, Redondo Beach, Calif. / Thompson Ramo Wooldridge Inc., Los Angeles, Calif., a corp. of Ohio / Memory array searching system.

ADVERTISING INDEX

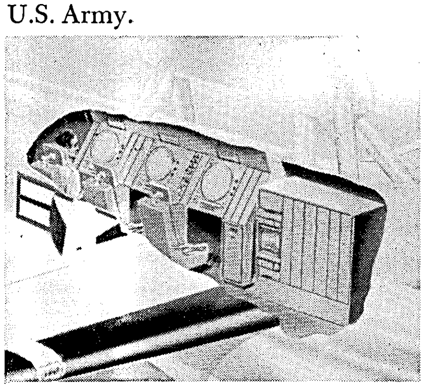
Following is the index of advertisements. Each item contains: Name and address of the advertiser / page number where the advertisement appears / name of agency if any.

ADVANCED AIR DEFENSE SYSTEMS WITH FIRST-DAY CAPABILITY

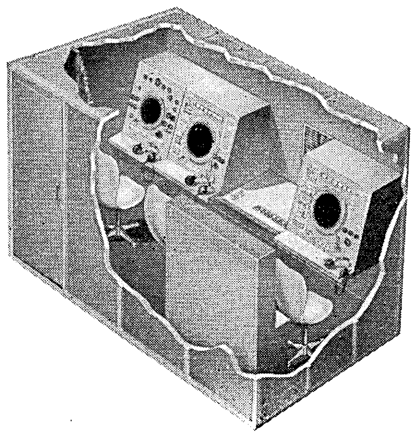
The needs of today's air defense systems pose a problem that would have seemed insoluble ten short years ago. The problem of furnishing mixed-weapons command and control, with first-day capability, in a system that is portable to any place in the world.

Here is how that problem has been solved through creative engineering utilizing a decade of industry progress in tactical data systems.

Systems already delivered by Litton to the military, or in the advanced state of development and production, include: Airborne Tactical Data Systems (AN/ASQ-54, AN/ASA-27) for the U.S. Navy, the Marine Corps Tactical Data System (AN/TYQ-1, AN/TYQ-2) for the U.S. Marine Corps, and the AN/FSG-1 Retrofit Improvement System (OA-3063/FSG-1 (V)) for the U.S. Army.



The first of these, the Airborne Tactical Data Systems, provides a capability for the mission of Airborne Early Warning and Control (AEW & C) in defense of large land masses, attack carrier task groups and other naval units. Both the AN/ASQ-54, installed in a land-based AEW & C aircraft, and the AN/ASA-27, installed in a carrier-based AEW & C aircraft, furnish early warning data on enemy raids to surface elements of an air defense network and provide airborne control of interceptors.



The second of these systems, the Marine Corps Tactical Data System (MTDS), features capabilities for continuous and effective control of Combat Air Operations during an amphibious assault. Facilities are available for control of aircraft on missions such as close air support, reconnaissance, and interdiction and for air defense with mixed weapons, both ship-based and shore-based surface-to-air missiles and interceptors. An integral air traffic control system assists in initial and continuous identification of friendly aircraft.

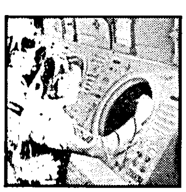
The third, the AN/FSG-1 Retrofit Improvement System, significantly increases the counter-countermeasures capability of the AN/FSG-1 Missile Master System deployed within the Continental United

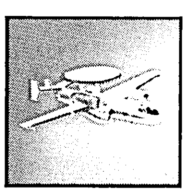
States to furnish surface-to-air missile battery coordination in the defense of large cities and industrial areas.

Through the successful design, development and manufacture of systems for air defense missions, Litton has demonstrated its capability to proceed with even further advanced data systems. Such systems are now under conception and development at Litton.

Air defense systems that not only fulfill today's defense requirements but also defy obsolescence for years to come require engineering that is versatile, inventive, aggressive, and adaptable. This is the kind of engineering Litton expects from its people. If you are qualified to perform engineering at this level, you are invited to write: H. E. Laur, Litton Systems, Inc., Data Systems Division, 6700 Eton Avenue, Canoga Park, California; or telephone DIamond 6-4040.

An Equal Opportunity Employer



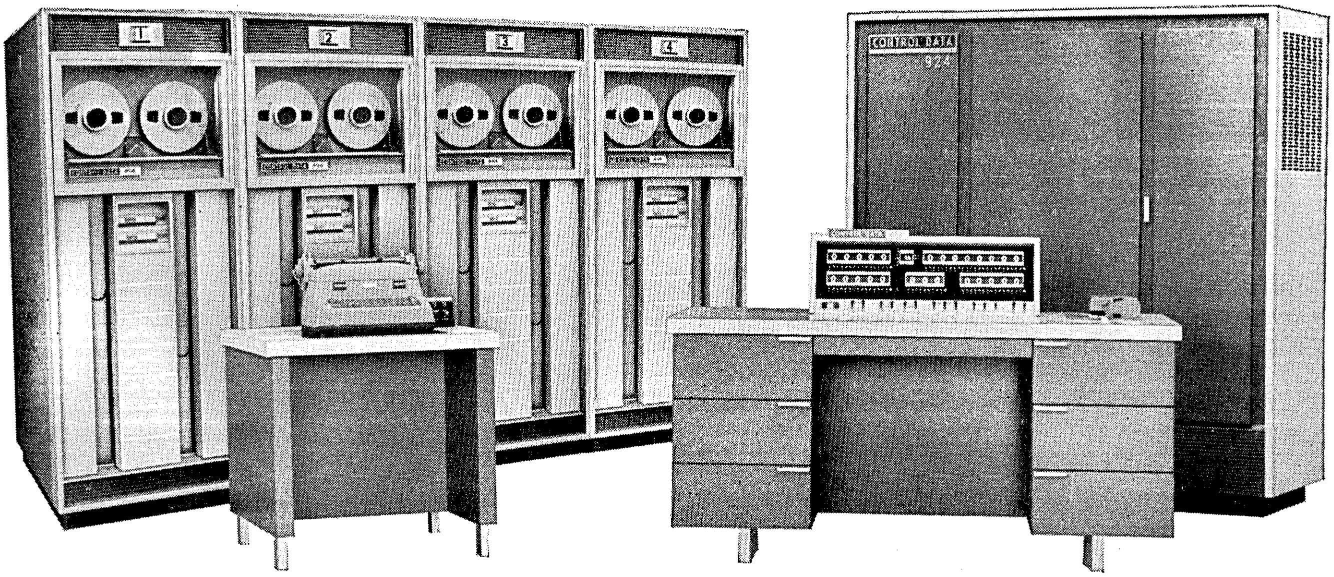


DATA SYSTEMS DIVISION

LITTON SYSTEMS, INC.

A DIVISION OF LITTON INDUSTRIES

DATA HANDLING & DISPLAY SYSTEMS • COMPUTER SYSTEMS • MODULAR DISPERSED CONTROL SYSTEMS



NEW CONTROL DATA 924 COMPUTER

Built for speed...priced for economy

The Control Data 924 is a medium-scale computer classed between the desk-size 160-A and large-scale 1604-A computers. Field-proven reliability, performance, and design techniques of these two computers are incorporated in the 924.

The Control Data 924 is exceptionally adaptable to applications carried out in control and data reduction systems. For example, the 924 has an input-output rate of 2,400,000 bits/second. Where A-to-D and D-to-A equipments are used in these systems, the 24-bit word length of the 924 is ideally suited. Internal speeds of the 924 are extremely fast, and include both built-in multiply and divide. Average multiply time is 23.5 μs; average divide time is 32.9 μs; average add time is 9.2 μs. The many other outstanding features of the 924 are included below:

SUMMARY OF FEATURES

- Stored program, general purpose digital computer.
- Parallel mode of operation.
- 24-bit word length.
- Single address logic, one instruction per word:
  6-bit operation code
  3-bit index designator
  15-bit execution address
- Six index registers.
- Program interrupt.
- Indirect addressing.
- 8192 words of magnetic core storage (expandible to 16,384 or 32,768 words):
  Independent 4096 word banks, alternately phased
  5.3 microseconds average effective cycle time
  1.8 microsecond access time
- Versatile input/output facilities: capable of receiving or transmitting up to 2,400,000 bits per second:
  Three 48-bit buffer input channels
  Three 48-bit buffer output channels
  Both channels are completely buffered, compatible with all 160-A and 1604-A computers and peripheral equipment such as card readers and punches, line printers, magnetic tape systems, and, when properly interfaced, A/D and D/A converters, telephone, microwave, telemetry, and special displays.
- Binary arithmetic—Modulus 2^{24-1} (one's complement, parallel addition in 1.2 microseconds without access).
- Real-time clock.
- Completely solid state, diode logic, transistor amplifiers, magnetic core storage.
- Small size (basic system requires less than 100 square feet).

924 INPUT/OUTPUT EQUIPMENT

Provided as standard equipment on the 924 console are the Control Data 350 Paper Tape Reader and the Model 110 Teletype Paper Tape Punch. Optional Control Data input/output equipment available for the 924 includes: the 161 Typewriter; the 165 Plotter; the 166 Buffered Line Printer (medium speed); the 167 Card Reader; the 1610-A Control Unit for a Card Read/Punch System; the 1612 Line Printer (high speed); and the 606 Magnetic Tape Transport which operates in conjunction with the 1615 Tape Synchronizer.

PROGRAMMING FEATURES

Sixty-four flexible instructions are available for programming the 924 Computer . . . including instructions for performing arithmetic, shift, transfer, logical search, indexing, jump, stop, and execute operations. There are, however, features which provide even greater programming flexibility, as follows:

Jump Instructions	Fault Condition
Search Instructions	Real-Time Clock
Masking Instructions	Program Interrupt
Shift Instructions	Buffer Operation
Scaling	External Function

For additional information, write for publication No. BR-1

8100 34th Avenue South,
Minneapolis 20,
Minnesota

CONTROL DATA
CORPORATION