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Computerisation

ON LINE, REAL TIME INFORMATION AND CONTROL SYSTEMS ARE A REALITY OF THE PRESENT times, no longer the fantasia of Science Fiction. In fact, most of the explosive happenings of the post-war period—Nuclear Energy and Space Travel—would just not be possible without Computerisation.

The production of nuclear energy on which mankind will have to depend for Growth has to be computerised, not only on account of the inevitable necessities of remote control, but also because instructions to Process Control have to travel at speeds beyond human capacity; whereas a computer works by the measure of **nanoseconds,** which is a billionth of a second; and a nanosecond has the same relationship to our chronological time second that it has to 30 years!

Without computerisation, there can be no Space Travel, for all such flights, involving incalculable human costs and astronomical 'real' costs—as the economists call them — have to be simulated in a computer for all types of reactions and implications; and when the spacecraft takes off, a computer tracks it; and when its path diverts from the projected one, magnetic impulses are generated which send off programmed instructions, registered electrically on instruments within the spacecraft. No wonder, the United States National Aeronautics Space Administration (NASA) has 225 computers. As pointed out in this Issue of the Journal: "A large screen on the wall monitors the rocket's flight, and Godard (NASA's Spacelight Centre) can make corrections to keep it on course with the rapidity needed for a vehicle travelling at 20,000 miles per hour."

It has been **naively** said that it is only the Americans who can afford such enormous computerised systems: the truth is precisely the other way round. They can afford it, exactly because they have built up a Computerised Society. Not even 40 years ago, the United States touched the lowest level of poverty in the early thirties, when millions were jobless; and their Government was considered too poor to afford such Rooseveltian luxuries as the Tennessee Valley Authority, designed to provide jobs, electricity, fertilisers, irrigation for the mass of the people in the Tennessee Valley. That is the secret of Growth that has led the Americans and the Russians to Space Travel.

The story does not end there, for American Education is getting Computerised, in respect of which we have published a highly informative piece in this Journal. The University of Texas has an on-line computer, which can attend to 30,000 students. This year, the United States will be spending over $300 million on computerised education.

In the UK, there are to date 180 computers installed or on order for University and technical college use. At the moment of writing, the most powerful education computer is being installed at the new London University centre. There is an **Edinburgh Plan of computer familiarisation for all students!** And the productivity of the system can be imagined from the responsible statement of Principal Bill Broderick of the Royal Liberty School, whom we have quoted liberally in a subsequent paragraph : ". . . . the expense per head of student use" works out "to £6.5 a year and 2/3 shillings a lesson."

In our country, where we have to introduce mass education at the earliest, just to catch up with the world in the very elements of modern life, these real statistics are a pointer to what we need in the national interest.

In fact, Principal Broderick has said practically the same thing in an article recently published in the British Journal on Technical Education & Industrial Training:

> "Today, in this country, some schools have computers. My own Department here at the Royal Liberty School has a small computing system dedicated to teaching in computer science and research into the applications of the computer in secondary education. At Towyn School, under the direction of Maurice Meredith, there is a telex link between the school and a university computer. More and more schools are using technical college computers for giving students some experience in computing science. At least three centres are concerned with research into school timetabling, and computer-aided learning is being investigated both by industry and educational establishments. Many more students are being introduced to the elements of computer science without access to computing facilities.
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> "In industry and commerce the *mundane applications of the computer such as pay-roll invoicing, etc., are those which fail to give maximum benefit to the company in terms of money.* (It is usually accepted that the cost of producing an invoice or payslip by computer is very closely comparable with costs of doing this by reasonably efficient manual means). It is the application of management science techniques concerned with planning, stock control, siting of supply depots, etc., which achieve the most notable savings. So it will be in education; the routine data processing is unlikely to make any vast savings but the use of the computer in planning and allocating resources and optimising the use of these educational resources is likely to be the field in which the greatest benefits are going to accrue.
>
> "We are told today that the computer is too expensive a tool to be made available to secondary education. I do wonder if those who make this statement have done a deep study of the potential value such a tool could have, not based solely on today's values and systems, but based on the values and systems we will be encountering five to ten years hence. We should, after all, be planning now for this period..."(Italics ours)

And those who put forward the Employment argument would be well advised to read details of the tasks, listed by Professor Alan Kirk of the University of Sussex Computer Centre:

" 1. To organize a computing service to process as efficiently as possible the computing work of the researchers and administrators within the University...

" 2. To run, from time to time, courses for users specifically relating to the programming languages available...

" 3. To familiarize undergraduates of various disciplines, with the essential concepts of computing...

" 4. To pursue research, probably in the field of computing science, and to initiate projects for enabling the computing system to be used more efficiently and effectively...

" 5. To encourage interest in computing in local technical colleges, teacher training colleges, and possibly schools. Short extra-mural programming courses are probably what is required here ... "

All this, if we were to do it in our country—what we shall have to do, if we want to be a modern state—would create enormous employment and interest in our University campuses.

And what is happening all round in the world, will happen in this country, as it actually has in several areas :

> "*. . . . thousands of people work at programming. Newspapers are full of advertisements* offering high-paying jobs. Self-styled institutes display posts practically promising to double your salary if you take their short course in programming."—Prof. Julie Zell, University of London Computer Centre (Italics ours)

In this issue of the Journal, there is reference also to Computerisation of Hospitals; and the Canadian Case Study (Manitoba Victoria Hospital Project) printed here is a good one. Actually medical computerisation has gone a long way abroad and doctors are able to concentrate on their art—as they should be doing here—on curing their patients, for the Computer records all the instructions, has them carried out, including all the tests etc. In the United States, Government is supporting a project with $3,15,000 of public money, on a Computerised system linking Logan International Airport with the Massachusetts General Hospital; and the following case is actually recorded :

> "At the recent Boston demonstration a workman at the airport who had injured his hand was brought to the tele-surgery for a consultation with a surgeon, and the surgeon saw the patient. The patient was questioned, and was able to show the nature of his hurt, and to perform the various tests and movements dictated by the doctor. A diagnosis was quickly reached, and the nurse on the spot was told what to do." (*New Statesman,* 19 July 1968)

The picture of the outside world, as realistically painted by the distinguished contributors to this Journal, is an enchanting one: ". . . today tens of thousands of computers are operating day and night in every corner of the globe, in the depths of the sea and in outer space. . . . . And increasing number of merchant vessels are crossing the oceans, safely and efficiently, with computer nerve centres controlling everything on board from ship stores to boiler pressures. . . . ."

Taking for example, weather forecasting, it is a matter of life and death for the people of this country, for our food supply is stilll a 'function' of the monsoon! Yet accurate weather forecasting has to be computerised: even an elementary weather forecast for 24 hours requires a billion numerical operations. An article in this Special Issue gives an interesting view, how it is done abroad through computers.

In Germany, they are experimenting with computerised railway systems. By the time this is published, Hamburg may well be having in operation an automatic train control system. In fact, accidents in railway systems can be entirely eliminated through computerised control, in which as soon as an engine goes off the scheduled track, a warning signal flashes on the control system and, in a split second, brings the connected systems to a dead halt. It is in these areas of overwhelming public interest that we have to go forward in the field of computerisation.

Abroad, of course, they are, as recorded earlier, going forward at a faster pace, with computerised warehouses, power stations, chemical complexes etc. etc. :

> ". . . the uses to which process computers can already be put range from masterminding a city's traffic lights, operating foundries and rolling mills, running power stations and chemical factories—to high-speed typesetting with automatic justification and photosetting, using type that is scored electronically, not the usual lead . . .
>
> "A new continuous tube rolling mill, for instance, is operated automatically by two computers working together. One works out detailed instructions from customers' orders and allocates the various jobs so as to ensure maximum operating efficiency. The other supervises the actual rolling by means of measuring

equipment. The second computer can check up to a thousand work pieces simultaneously, a job mere humans could not manage . . .

"A special type of electronic tube even reaches out into space. Its function is to beam as much high frequency energy as possible, including electricity on the earth's surface, at a tele-communications satellite orbiting the earth in such a way as to appear stationary 20,000 miles overhead."

All this has a bearing on Productivity, as can be seen from the relevant statistics. A machine-making factory, entirely controlled by computers — to which a reference has been made in the Section on the UK in this Journal—produces components in one-twentieth of the time and at one-tenth of the cost of those currently being produced by the firm.

We have already referred to the enormous employment potential generated — and to be generated — in the field of computerised education alone. Of course, **computerisation would revolutionise the whole structure of employment,** but simultaneously, it would enormously increase the aggregate employment in the economy, for if we manufacture the computer indigenously — both the hardware and the software, with their billions of components and gadgets and accessories — and train the systems specialists and the programmers and the operators — we shall require them by the million, considering the size of the economy and its growth potential — **the aggregate volume of employment, with computerisation, should increase markedly: for whole new industries will come into being in the wake of computerisation.**

This judgment is based on experience, and recent experience of world trends. The Computer Industry, which hardly existed twenty years ago, has established nearly 100,000 computers throughout the world, including the Soviet Union, which leads in rocketry and must therefore be highly computerised. Only, recently, the Soviet State Planning Commission ordered the development of a three-level computer-grid (national, industrial sector and factory levels) for aiding the co-ordination of economic planning, about which we shall write in a later paragraph.

As it is, the Computer Industry has grown with great rapidity: and hard-headed business forecasts put the Growth Rate of the Industry at 20-25 per cent for the next five years. The following summary table gives the retrospect and the prospect :

Year		**Number of Computers (global)**
1959	—	20,000
1969	—	100,000
1972	—	200,000

This is not a vain forecast, because Mr. Robert McDonald, the President of Univac — supplier of large-scale computer systems to many American organisations, including NASA — estimates U.S. production alone to rise to 130,000 by 1972. It is well known that the Soviet Union is investing heavily in the line. The European Big Three—Germany, France, U.K. — will add $ 240 million to their already heavy investments in the next five years, as the market by the next year is likely to rise to $ 10 billion.

There is no reason why India should not have its share in this stupendous market. We are already having collaboration for computer production between Bharat Electronics and the ICT. We have a large number of electronics engineers: and other engineers can be re-trained, for they have the basic knowledge of the engineering sciences. Most of the Institutes of Technology have established training courses in Computer Science up to degree level. There is a regular Computer Centre at Roorkee: and there is the Tata Computer Centre at Bombay. The Joint Plant Committee of the Steel Industry has a modern computerised system, which processes orders. The HMT at Hyderabad turns out highly sophisticated transferline machines, including 16-station close loop system, doing automatic clamping, milling, drilling, fine boring, and washing operations on universal joint yokes: and it forks automatically. In all, we have nearly computer installations in this country. **There is no reason why we cannot multiply them ›everalfold, but in a manner that would create employment for our engineering per- nel, build a base for software manufacture in this country,** for it is in that field that the ket lies.

It is reasonable to presume that a substantial part of the nearly 7-billion-dollar annual output of computerware in the USA is software, for that is the real core of the computer system, not the bulk of the hardware, which is installed for reasons of prestige, as a symbol of Modern Management. **The essence of computerisation is in the software: and here our enormous gineering talent can come into play.** It is significant that in the French computer industry, 10 per cent of the total personnel employed are engineers.

This brings us to the vital question of Computerisation and the Volume of Employment. It is important here that we differentiate clearly between Automation and Computerisation, particularly in their very different impacts on the Volume of Employment. Computerisation is essentially an Information System: a system that brings instantaneously to "the eyes" of the management precisely the information required, neither more nor less. **At present, management has either too little or too much information, and always too late and after the event.** A Computerised system makes the precise information available on time, and conveys back the instructions in time, to keep the system going. In the first instance, therefore, Computerisation can only have a stabilising effect on the volume of employment. Secondly, and more importantly, it can become the basis of a highly expanding system, because it releases the energies of the management for a real exercise in enterprise.

The real crux of the matter is that computerisation will have a revolutionary effect on the whole character and set up of management. "In it," as one distinguished writer says in this Issue of the Journal, "are contained elements of mathematics, of information retrieval, of communications in all of its myriad forms, of publishing, of human and machine actions and interactions, and even of mind."

It is a point for very serious consideration what type of management this involves : not the order-shouting, decision-by-hunch, management by bluff type, but highly professionalised management, which understands what mathematical parameters are, and has the capacity to react intelligently, when, through the cathode ray, the young programmers put them on the television screen. There would be no middle managers to be shouted at, but reasoned responses to figures flashed by the computer. Really, under computerisation, teams of highly trained personnel, Ph.Ds in Mathematics, Econometricians, Programmers, Systems Engineers and the like, would be in control of management.

The real onslaught of a computerised system would be on the middle management cadres, for the intermediate communication channels would become redundant. Here also, it need not cause unemployment, at all. All that would be needed are massive retraining schemes, which are actually being organised by American Corporations.

ɔ. So far as labour is concerned, computerisation would mean, in the aggregate, a far larger volume of employment than a non-computerised society can ever offer. The very nature of ıterisation, and the extremely large number of elements that go into the system from manufacture to operation, would open out whole new fields of employment for our young boys and girls.

However, we must be cautious, particularly in areas and lines, in which the volume of employment is likely to be adversely affected. In fact, we need not — should not — have comprehensive computerisation, but **selective computerisation in areas of overwhelming public interest.**

Broadly, we are of the opinion that **nothing be done in this or in any other sphere against the interests or sentiments of labour**. In fact the broad approach of the NPC Productivity Journal throughout the last 10 years of its publication has been that **Productivity Techniques can only succeed against the background of a full employment-fair wage policy: and computerisation, being the most powerful Productivity Technique, as expanding beyond limit the capacities of the human mind, is a system that must be beneficially employed for the good of all.**

Often, in economic controversies of this type, Mahatma Gandhi, the Father of the Nation, has been brought in: and it has become difficult to differentiate the fundamental from the transient, in the Mahatma's pragmatic approach to the many problems that plagued the country in the inter-war period. But if one is determined to pick the grain from the chaff one comes across such fundamental propositions in the Mahatma's writings:

> **"I would favour the use of the most elaborate machinery if thereby India's pauperism and resulting idleness be avoided . . . .** I want to save time and labour not for a fraction of mankind but for all. . . ." (*Village Swaraj*, a collection of Gandhiji's writings compiled by H.M. Vyas, Navajivan Publishing House, Ahmedabad)

Apart from this, we were anxious to know the labour point of view, particularly from areas where computerisation has been resorted to extensively and in a high degree. Accordingly, we had requested the AFL-CIO of the USA for their official policy in this matter. For reasons of space, we have not been able to publish their analysis in this Issue of the Journal. But broadly, their spokesman refers to the computer, in true American style, as a wonderful machine, which should be employed, but simultaneously the Federal Government should push up the employment potential of the economy through massive investments in many fields, such as education, health, urban development etc. etc. We endorse this stand, because it is of paramount importance, particularly in a highly populated country such as ours, to concentrate primarily on maximising the employment potential, and simultaneously direct the volume of employment into the production of primary goods needed by the mass of the people. **A wisely planned computerisation programme will assist materially in boosting the employment potential, and in the massive output of primary goods.**

Computerisation has another significant contribution to make in the area of national policy making. A reference has already been made to the Soviet Planning Authority having ordered a three-grid national computer system, linking the macro level to the micro level: the supreme policy organ with the individual factory. At present, our decisions can hardly have a relation to reality, for the output and the employment statistics relate to some past period of record. By the time, our national decisions reach the ground (micro) level, the situation has materially changed: and we are always out of tune.

It is only a national computer system into which everybody feeds his individual information, and upon which Government can constantly draw, that can solve the problem of integrating policies with facts.

The reason why computerisation has been grandiloquently called the Information Revolution or Cybernetics (to use the prestige vocabulary of the operations researcher) lies in the capacity of the computer to bring operational reality to the working of policy organs at the macro as well as at the micro levels, and thus expand the possibility of the system to its logical conclusion.

There can, of course, be no substitute either for character or for intelligence; but with a given base in terms of these two imponderables of the human mind, the computer is a multiplier of infinite potential. ●●●

Utilisation of The Computer by Philosophers

John Morris*

PHILOSOPHERS GENERALLY SEEM TO SHARE with other humanists a sense of disdain or fear of the computer. References to the machines are rare in the philosophical journals, and I have not been able to find any articles published in these journals where the author actually **used** a computer in any way.

Again, of the 245 doctoral dissertations written in 1967 by American and Canadian students in philosophy, not one refers to the computer in its title, or gives any other evidence of interest in the machines. A closer check of the 52 dissertation abstracts in philosophy, published during July and August, 1967, does not reveal any use or mention of the computer. It is safe to say, I think, that **very few philosophers tend to use the computer as a tool.**

This, however, does not necessarily indicate that philosophy lags behind other humanistic disciplines in its use of machines. To provide some basis for comparison, I also checked 45 abstracts in music and 143 in history which were published during the same two months. None of **these** doctoral students used the computer, either.

What is more striking is that several of the dissertations in music and history dealt with data that **might** have been processed by machine. A half dozen students in music (all of them prospective teachers) conducted surveys, from which they extracted some non-statistical conclusions, with no evidence of help from computers. **One music student had made a detailed study of rhythms and chord progressions in a major opera, working with masses of data that fairly cried for computer-based methods.** But he did not use a computer.

Doctoral students in history, too, sometimes dealt with types of data that the computer could have processed. One abstract reported the use of statistical techniques for analysing warehouse receipts, and another compared lists of names in court records. Both of these studies might have used the computer to deal with their data, but neither did so.

In contrast with some of the work in music and history, not one of the dissertations in philosophy dealt with material which seemed at all amenable to computer-based analysis. **Philosophy simply does not appear to be the kind of discipline which is aided by the machine. Philosophers do not have masses of data to process,** like the warehouse receipts that the economic historian might study, the musical scores that the musicologist must identify, the

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potsherds of the archaeologist, or the multitude of scrolls of the Biblical scholar. The work of the philosopher, then, seems to be quite unlike the sorts of work that use the computer.

But there may be other motives at work. If contemporary philosophers ignore the machine out of a kind of supercilious disdain, they certainly have very honourable precedents for doing so. **Plato, Aristotle, and classical Greek intellectual society saw machines as children's toys, or the concern only of the artisan class.** Plato is not interested in machines. He mentions puppets, which were the simple predecessors of real automata, but these "wonders" (*thaumata*) are the source of deception, and the true philosopher must rise above this level. Indeed, in the *Sophist*, the word for "puppet maker" is the same as that for "wonder-worker" (*thaumatopoies*) and the deceiving sophists are compared with both of them.

Aristotle shows somewhat more interest in puppets which seem to have been developing rapidly in complexity at the time of Aristotle's early work. He calls them *automata*. In a famous passage in the *Metaphysics*, however, he sees the philosopher as one who can overcome his initial sense of wonder at an automaton: "Philosophy begins in wonder, but ends in understanding." Once we understand them, we no longer concern ourselves with the wheels and strings of children's toys.

It was only in the Hellenistic period that intellectuals would condescend to take machines seriously. Hero of Alexandria, perhaps the best-known automatist of all time, describes **whole theatres populated by automata, temples with automated sacrificial fires,** and the world's first steam engine. But for Hero, as for other Greeks, machines were good only for toys or thaumaturgy, or as gadgets to hold the interest of students with wandering minds. Even the steam engine was intended only as a device for teaching the principles of air pressure.

During the Medieval period in Europe, one philosopher deserves special mention for his development of a tremendously popular logic machine. He is Raymond Lull, the great Catalan philosopher of the fourteenth century, whose *Ars Magna* fascinated all Europe during the next three centuries. Essentially, the Art consisted in no more than the manipulation of a machine for combining words in various ways. As its wheels were turned, new combinations appeared. Followers of Lull, carrying the machines from town to town boasted that they could speak for hours, without repeating themselves, upon any given topic, simply by turning the dials of the machine one by one, and expounding upon the combinations that these formed.

The crudity of these computers should not be permitted to conceal their important attribute: They were able to exhibit in succession, all the possible combinations of the constituent terms of an expression. In doing so they were like truth-tables or circle diagrams in contemporary logic. By providing, in a mechanical way, a complete enumeration of all possible outcomes, they helped to insure the philosopher against omitting something. Like modern computers, Lull's machines helped to eliminate work that is tedious and repetitive.

Seventeenth century philosophers in Europe were completely unlike the early Greeks. Hero's automata, which had been rediscovered during the sixteenth century were the rage, with automated displays of classical scenes appearing in all the kings' gardens and grottoes. Rene Descartes, in particular, was fascinated by these automata, and planned a "house of wonders" of his own. More significantly, Descartes used the automaton as a model for a complete description of the human body. As such, it serves as the basis for Descartes' familiar 'mind-body dualism': **the body consists of everything that can be simulated by an automaton, and the mind is everything that can't.**

Descartes was familiar with Lull's logic machines, which were carried by itinerant Lullians throughout Europe. They seem to have suggested to Herbert of Cherbury, an English contemporary of Descartes, that all knowledge could be codified along Lullian lines. The machines may also have suggested to Leibniz the possibility of a "universal characteristic," or universal coding scheme, which would permit men to express all their disputes in symbolic form. Once the correct symbols were found, there would be no more reason to dispute over politics or theology than there is reason to dispute about geometry. **Whenever a dispute threatened, the rivals would only have to say to one another, "Let us calculate."**

Leibniz was also the inventor of one of the first calculating machines, an improvement upon the adding machine designed by Blaise Pascal, another seventeenth century philosopher. **It is worth noticing that the first two working calculating machines in the modern world were both designed by philosophers.**

Perhaps the most elaborate designs for a pre-electronic computer were those of Charles Babbage, in the nineteenth century. **Babbage's "difference engine" was to have had many of the functions of modern computers,** although Babbage's initial motivation was simply the desire to compute more accurate logarithms. Lack of finances, however, made it impossible ever to complete his machine. Significantly, he titles his autobiography *The Life of a Philosopher* (1864).

Philosophers have been involved in the design and construction of modern electronic computers from the very beginning. A.M. Turing, the mathematician whose work on abstract machines provides some of the theoretical base for modern computers, was as concerned with philosophical problems as with mathematics. **Of the three men who were responsible for the first working electronic digital computer, one of them, Arthur Burks, is a professional philosopher, and another, John von Neumann, made basic contributions to logic, decision theory, and the philosophy of mind.** And there are many other contemporary professional philosophers who are similarly working directly or indirectly on problems of computer design, and on the problems raised by the machine.

Today, while neither the dissertations written by students in philosophy nor the articles published in the philosophical journals show any noticeable interest in computer uses, **the computing journals are very deeply involved in philosophical problems.** Typically, the *Journal of the Association for Computing Machinery* devotes from a quarter to half its space to problems of logic and logical proof, questions of computability, theory of language, the logical design of abstract machines, and other topics which are clearly philosophical in character.

In addition to his work in machine theory, Turing also proposed one of the most interesting problems of contemporary philosophy of mind. He asked the question, "**Can a machine think**?" He then suggested that the answer might depend on whether we could tell the difference between messages sent by a human being over a teletypewriter, and those transmitted by a machine.

The problem to which Turing addressed himself forms the basis for an enormous number of studies — a thousand articles were counted by 1964, and the number has certainly increased since that time — in an area that might be called the "mind-machine problem." The question is generally one of comparing human thinking with the operation of a machine, to determine how they are similar or different. This is clearly a problem in the philosophy of mind.

The dichotomy that we have discovered, then, is this. **Since the seventeenth century, philosophers have been interested in the design of calculating and computing machines. During the past**

twenty years, the development of electronic digital computers has produced intensive work in areas generally regarded as philosophical often by professional philosophers. Yet very few philosophers use the computer as a tool. Does this mean that **there is something that makes the computer off-limits for the philosopher**?

To an extent, I think that there is something incompatible between them. Somehow, the act of "doing philosophy" is quite unlike anything that one can do with a machine. It is surely not counting or sorting. It is not likely to be comparing, classifying, or charting, as those acts are performed by a machine.

But there is no single definition of what a philosopher is, or does, or tries to do. As a field, philosophy is divided into schools that often seem totally unaware of one another's existence, and this division is reflected in a variety of styles and methodologies. Perhaps, if we characterised the philosopher's task as "critical reflection", without attempting to define it further, we might cover most of the ground. Negatively, we might say that philosophers are not often concerned with the collection and reduction of "data". We hardly know what would count as "data" for the philosopher. As one writer recently remarked, concerning British philosophers, their most respected source of data is *Alice Through the Looking-Glass*. American philosophers too, prefer to begin with such "data," the simple and obvious facts that we all know.

Nor is the philosopher much concerned about "output." He is not strictly concerned with the specific applications of his analysis. **Once a given problem has been specified clearly enough to make it suitable for computer applications, the philosophical task is over.** Actual building of the machine, or actual running of the programme, then, is almost superfluous, from the point of view of the philosopher. Of course, if he is human, he will want to see the results of his logical constructions, but as a pure philosopher he is no more interested in the actual computations than the pure mathematician is interested in doing sums.

Having stated (or overstated) the case this strongly, however, I have to backtrack somewhat. Although the philosopher's job is critical reflection, it is not necessarily also true that he is forbidden to use any tools that would make reflection easier or more effective. Pressed to its extreme, such a rule would forbid his using books and paper, and not even the early Greeks were **that** disdainful of tools. The computer is a tool which can ingest, manipulate, and count symbols, and these processes may aid the process of reflection. If they do so, then they should certainly be used.

Since a computer programme is a logical construction, it may be possible to represent a given philosophical structuring as a computer programme. By actually running the programme, it may be possible to find errors in the philosophical analysis. Such a use of the computer is seen most clearly in some recent techniques for the proof of logical theorems. By actually using the machine to perform the proofs, the need for new and more efficient methods has been shown.

Such uses of the machine require that the philosopher be able to state his analysis in such a way that it can be transformed into a computer programme. Very few philosophical systems have been stated in this way, and I am not at all sure that such systems are in any sense "better" than systems which are vaguer or less precise (in this meaning of "precise"). **If, nevertheless, a philosophical construction can be stated as a formally precise system, then a computer programme can be written which will represent it.**

On the other hand, for those students of philosophy (among whom I include myself) **who do not believe that rigorous formalism is the only way to truth,** the computer does, nevertheless, offer assistance of another sort.

Morton and Winspear, for example, using techniques borrowed from the literary historians, report an attempt to establish authoriship of Plato's *Seventh Letter*. By determining the frequency with which Plato typically uses certain syncategorematic words (such as *kai*, "and") and comparing this with the frequency of use of the same words in a disputed text, they have tried to show that there are (or are not) significant differences between them.[1] Unfortunately, their study seems to be inconclusive.

Techniques like this, when they are more fully validated, can be of major assistance in the study of historical authors whose works are disputed. Many of the Medieval and Renaissance philosophers — Duns Scotus is an outstanding example — could be better understood if there were effective ways of establishing their authorship of some disputed works.

But the methods here still must be validated, and there is not yet any simple way of feeding some texts into the computer and determining which were written by the same authors. One doctoral student with whom I have been consulting has spent more than a year of intensive effort to develop programmes that will validate authorship of a single disputed text, and we still have no guarantee that he will have any significant results. I mention his work as **a warning to those that look on computer methods as labour-saving devices.** For this student, they certainly are not.

At the same time, however, another philosopher, McKinnon is engaged in a number of studies that have had rather interesting results. Where many humanistic studies have concentrated on an author's use of connectives (like *kai* in the Plato study) which do not carry content or meaning in themselves, McKinnon's work emphasizes the study of the author's use of content-words ("categorematic" in the traditional sense). He has compared the styles used by Kierkegaard in his various writings. Some of these were written under Kierkegaard's own name, while others were written under a variety of pseudonyms. Distinguishing among these styles, content analysis identifies the pseudonymous works. McKinnon also reports studies of the works of Wittgenstein, and of Canadian frontier hymns.[2]

A number of scholars are preparing concordances of various works, of which the concordance to the works of St. Thomas Aquinas will be particularly widely used. Such concordances are not in themselves philosophical works, of course, but they will greatly assist in historical studies and analyses of their subjects.

My own study of the works of Descartes has relied heavily on the computer as a tool for philosophical research. I had been working with computer-based researchers in other areas for the preceding four years and wanted to avoid some of their mistakes. The results are therefore conservative, rather than daring, but I do feel that they are at least reliable.[3]

I concentrated on two major texts of Descartes, his *Discourse on Method* and the *Meditations*. A senior student in French began punching these two works on cards, to be used as input to the machine. Each card eventually got an identification number, indicating the volume number, page, and line number from which it came.

In an early experiment, I found how difficult it was to find content-free words that will actually identify an author's unique style. **Running chi-square tests on fifty such words in the *Meditations*, I proved**

1. A.Q. Morton & A.D. Winspear: "The Computer and Plato's Seventh Letter", *Computers and the Humanities*, 1, 3 Jan. 1967, pp. 71, 73

2. Alastair McKinnon: "*La Philosophie et les Ordinateurs*", Dialogue Sept. 1968; "Kierkegaard's Pseudonyms: A New Hierarchy", *American Philosophical Quarterly*, April or July 1969.

3. "Cartesian Certainty," *Australiasian Journal of Philosophy*, forthcoming "A Computer assisted Study of a Philosophical Text", Computers and the Humanities

beyond all doubt that six different people had written Descartes' six Meditations!

After a number of such failures, I came to rely heavily on a version of the Key Word In Context (KWIC) indexes. Such programmes are generally available at major computing centers. Our own Basic Indexing and Retrieval System is a particularly versatile and effective system, which includes a large number of other options.[4] The index prepared by such a programme consists of a list of each word used in the document under consideration (with frequently-used words omitted, if this is desirable), together with the line in which it appears.

In addition to indexing the *Discourse* and the *Meditations*, I also found the indexing programme useful for sorting out several thousand marginal notes that I had inserted in various texts. By simply punching each marginal note on a single card, together with the volume and page on which it appeared, I was able to sort out these notes according to subject.

Simple-minded as these techniques may seem, I could scarcely have completed the study of Descartes without them. The results that they make possible seem very exciting to me, and I think that they may be of value to Descartes Scholars.

I found, for example, that Descartes uses the term "natural light" in a very limited number of contexts, and that he never permits himself to doubt that it is a source of truth. By identifying these contexts, I may be able to resolve part of a long-standing problem in Descartes studies concerning the validity of his arguments for the existence of God. Similar studies show that Descartes has his own peculiar method of using terms like "common notions" and "eternal truths". I could also identify the precise contexts in which Descartes uses the pair of terms "cognition" and "conception", and show that these were regarded as two faculties of the human understanding. The word "reason" has also been a disputed term among Descartes scholars. By isolating every instance in which Descartes uses the term "reason" in the *Meditations*, I think that I have been able to show that he does not use it as a technical term at all.

One of my favourite hypotheses failed badly under this technique. I had thought that Descartes might use the French cognates of "arbitrary" and "voluntary" in quite different ways, and that an analysis of this difference might tell us something about the question of freedom of the will. As a matter of fact, when I had every use of "arbitrary" and "voluntary" listed, there was no indication whatever that Descartes intends them to have different meanings.

The methods that I used myself were self-consciously simple. I have written much more complicated programmes for numerical and verbal analysis myself, and have counseled dozens of researchers in their use. During that time, however, I have developed **an intolerable allergy to the person that uses the computer before he knows what he wants to do.** One undergraduate girl, in particular, collected a stack of replies to an ill-conceived questionnaire and wanted to "run them through the computer," without the slightest notion of what she wanted to find out, or what the method (which would probably have been factor analysis) would have told her.

I certainly hope that other student and professional philosophers will be less reluctant than I have been about using new or untested techniques. Perhaps the most obvious conclusion that can be drawn from this discussion of the philosophers and the computer is that there is a **very** great deal that has not yet been done ●●●

4. "Basic Indexing and Retrieval System" Learning Systems Institute, East Lansing, Michigan State University

The Computer Utility

Douglas F Parkhill*

Only nineteen years have passed since the first internal stored-programme electronic computer, the EDSAC, became operational at the Mathematical Laboratory of the University of Cambridge in England. Since that day in 1949, the descendants of EDSAC have proliferated, and *today tens of thousands of computers are operating day and night in every corner of the globe, in the depths of the sea and in outer space.* **In fact, without the availability of the information processing power represented by these computers, it would be impossible for a modern industrial society to operate at anything like its present level. Despite this, most people to date, have had very little direct contact with computers. For the most part, the machines have operated unobtrusively in the background of society, performing thousands of useful and important tasks, but shielded from our direct experience by layers of programmers, analysts, coders, incomprehensible languages and an insurmountable barrier of cost. Today, this anonymity is being rapidly destroyed by the emergence of what has been variously termed the "information utility", "the fireside computer", "the information utility", or as in this paper, simply "the computer utility." This is a development which promises to make the computer as much a part of our daily lives as is the telephone of today.** *In fact, before many years have passed, the telephone instrument itself will probably have merged with a television screen and keyboard to become the omnipresent and indispensable link between all of us and the total information processing power of earth.*

IT IS THE PURPOSE OF THIS PAPER TO PROVIDE a basic introduction to the subject of the computer utility by

1. Introducing the concept of **computer power as a sharable resource;**
2. Outlining the basic technology of time-sharing; and
3. Discussing some of the exciting possibilities of the **"direct access age"** that lies ahead.

SHARING OF COMPUTER POWER

A convenient way of looking at the many different types of computer utilities that are now evolving is to regard them as collectively comprising a new class of resource sharing systems in which a rather nebulous commodity called "computer power" is shared in a convenient and economical manner among many geographically distributed customers. These new systems differ fundamentally from the normal computer service bureau in that the services are supplied directly to the user in his home, office or factory without requiring the physical transport of data between the customer and the central processors. The data transportation, instead, is performed over communications links, and it is for this reason that the term tele-data processing system, i.e., combined communications and data processing system, is often used to describe the sorts of systems with which we are concerned here.

Computer utilities also differ significantly from other resource sharing systems in that computer power is a much more complex commodity than, for example, electric power or

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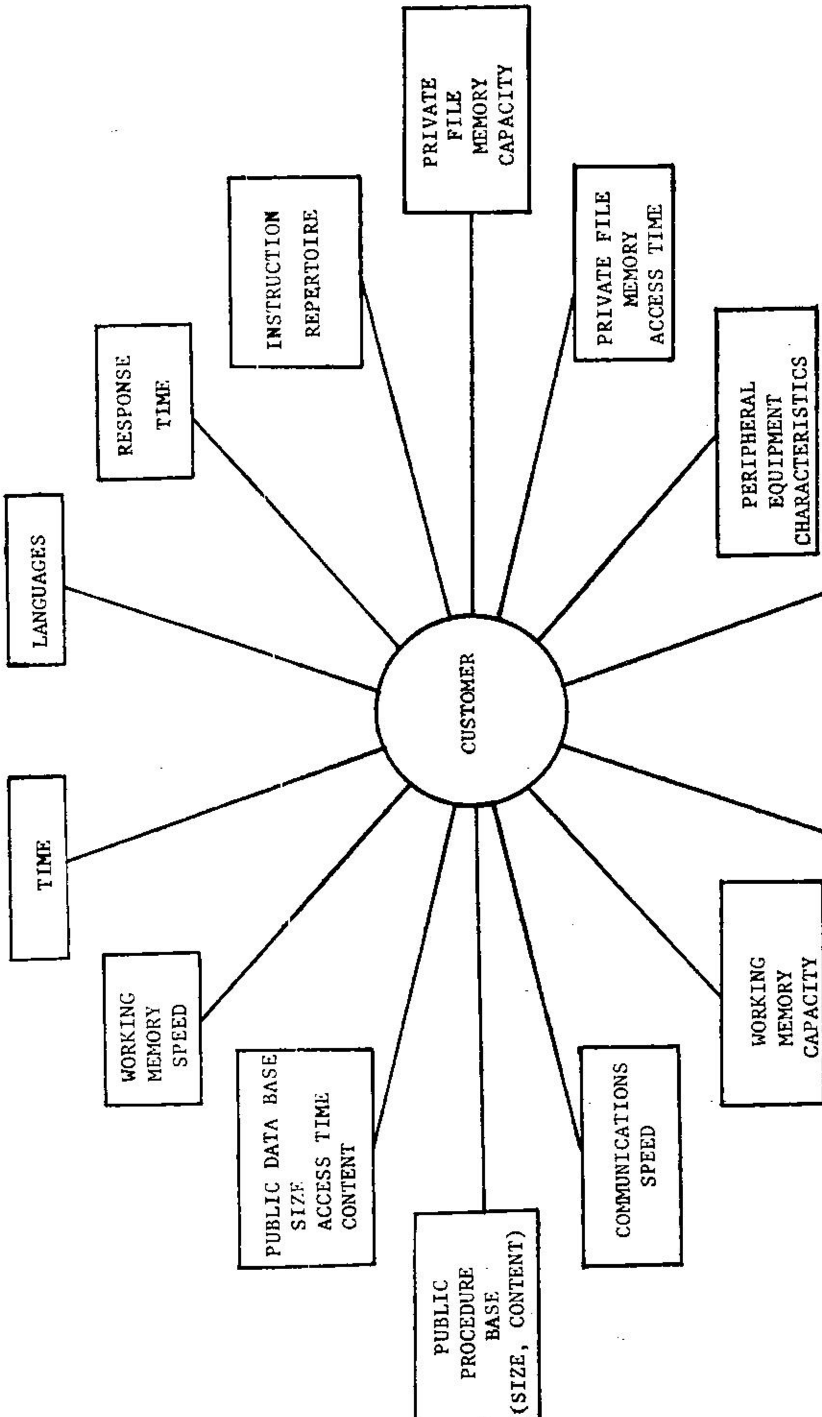

THE MANY DIMENSIONS OF COMPUTER POWER

FIGURE 1

telephone service. **In it are contained elements of mathematics, of information retrieval, of communications in all its myriad forms, of publishing, of human and machine actions and interactions, and even of mind.** Its definition involves complex combinations of time; computation rates; instruction repertoires; data and procedure bases; peripheral equipment characteristics and usages; communications speeds, capacities and access times, and so on. Figure 1 is an attempt to portray something of this complexity.

As might be expected with such a complex commodity, the systems employed in its distribution can take many different forms. Some of the basic categories are considered here.

Special Purpose: This is the oldest form and is exemplified by the familiar reservation and stock quotation systems. In it, the central processor is restricted to the performance of a single function or a group of related tasks specified in advance by the system designer.

General Purpose: These are systems which can handle an unlimited number of different kinds of tasks; i.e., in the limit, any task for which a digital computer programme can be written. In general, these tasks will not have been specified by or be known to the system designer.

Batch Oriented: In such systems, each customer's programmes are handled on a queuing or scheduled basis; i.e., completing customer A's work before going to customer B, etc. The operation here is similar to that in a normal service bureau batch processor operating under the control of an "Operating System", except, of course, for the fact that the data and programme are transmitted directly betwen the users and the computer over communication lines. The term, "Remote Batch Processing," is often used to describe this type of operation.

On-Line: The phrase, "on-line" carries the connotation here of "real time" operation or immediate access. Thus, the user is able to sit at his remote console and, in effect, carry on a dialogue with the computer in which the computer responds immediately to the remote users' queries and commands, and thus, creates the illusion on the part of each user th t he has the entire system under his sole control.

Mixed System: Many systems operate in a mixed on-line and batch mode, where on-line service for problems up to a certain size or of a critical priority is provided. but other problems are run on a batch basis in the "background."

Private: These are systems whose use is restricted to members of the owning organisation.

Public: It is these systems which have generated the greatest popular interest and led to the use of the term, "Computer Public Utility." As the term implies, they are operated as a public service, supplying computer power to many different customers outside of the owning organization.

Combinations of Forms: These different forms can be combined in many different ways. For example, we can have private general purpose systems like the pioneering MAC system of the Massachusetts Institute of Technology, private special purpose systems such as those used by individual airlines for reservation purposes, public special purpose systems, public and private multiple purpose systems, and a whole hierarchy of increasingly complex general purpose public systems which in the limit, could encompass the entire computing power of the golbe.

Time-Sharing

It is the technique of "time-sharing" that makes possible the efficient sharing of the many different elements that make up the commodity which we have termed computer power. This technique is currently evolving rapidly, and new time sharing computers or time-sharing modifications to existing machines are being announced in a continuous stream. Consequently, it would go far beyond the scope of this paper to attempt to provide a detailed analysis of current time sharing technology. Fortunately, however, the basic ideas are relatively simple and they are, therefore, reviewed here.

In a trivial sense, most computers that serve multiple customers are always "time shared" since, in general, a computer can provide service to only one customer at a time. Thus it becomes necessary to assign each user a particular interval of time during which the computer will be at his sole disposal. In fact, in many modern systems this assignment is made automatically by means of a special Executive or Control Programme called an "Operating System". When an Operating System is used, the various user programmes are stacked in some form of auxiliary storage and are automatically transferred into the working memory of the computer and run in a sequence determined by the Executive Programme. Thus, typically, the system would call up user A's programme, run it to completion, transfer the results to an auxiliary storage system for off line printing, call up user B's programme, run it, and so on all automatically with human intervention required only in case of trouble or occasionally for such tasks as the mounting and demounting of tape reels.

A true time-shared system, however, differs radically from even the most sophisticated of these automatic batch processing installations. Thus, instead of running one user's programme to completion before accepting the next one, a time-shared system switches from customer to customer at a rapid rate under the control of some sort of scheduling algorithm that in the simplest case is an ordinary round robin. Each user's programme is thus run in the form of short bursts or quanta of computation, so that all programmes are multiplexed together in a continuously repeating cycle. Ideally, the length of this cycle, and consequently the interval between successive bursts for any single customer, is less than a typical human response time so that a human operator at a remote console is unaware of the intermittent nature of his service and feels that he is the sole user of the system.

Many of the fundamental techniques and operating principles of time sharing can be identified by considering the operation of the hypothetical basic time-shared system shown in Figure 2.

The heart of the system is the "Control" or "Executive" programme which resides at all times in a special reserved section of the high speed core memory. It is the responsibility of this executive to supervise the operation of the overall system. Thus, it may contain routines for such tasks as scheduling user's programmes, assigning memory registers, interpreting users' commands, editing, monitoring and superivising input/output, providing tutorial assistance to users who request it, and error location. Normally, when not in use, customer programmes reside in the bulk storage facility (disc files, tapes, magnetic cards, etc.) and are automatically retrieved when called for and stored in an intermediate memory termed the "swapping store." This store is usually needed because with the current state of the art of memory technology it is not economically feasible to provide sufficient high speed working memory for the storage of all active programmes. The currently active programmes are thus stored temporarily in a less expensive memory, often a magnetic drum, and brought into the high speed memory in sequence when called for by the "scheduling routine" in the Executive. Very often the transfer of a programme from drum to high speed memory causes a conflict with another programme, and when this happens, the latter must be returned to the drum. This process of programme exchange is called "swapping"—thus, the term swapping drum in Figure 2.

Once a programme has been moved into the high speed memory, control is transferred to it and it is permitted to operate until it indicates an input/output request, makes a detected error or reaches the end of its allocated quantum of time. Any of these events results in the interruption of the current programme and transfer of control to the next programme in the sequence. If the interruption is due to the exhaustion of quantum time, then the interrupted programme is returned to the drum or (if space permits) retained in the working memory until its next turn. In either event, of course, all intermediate results and machine

HYPOTHETICAL BASIC TIME-SHARED SYSTEM

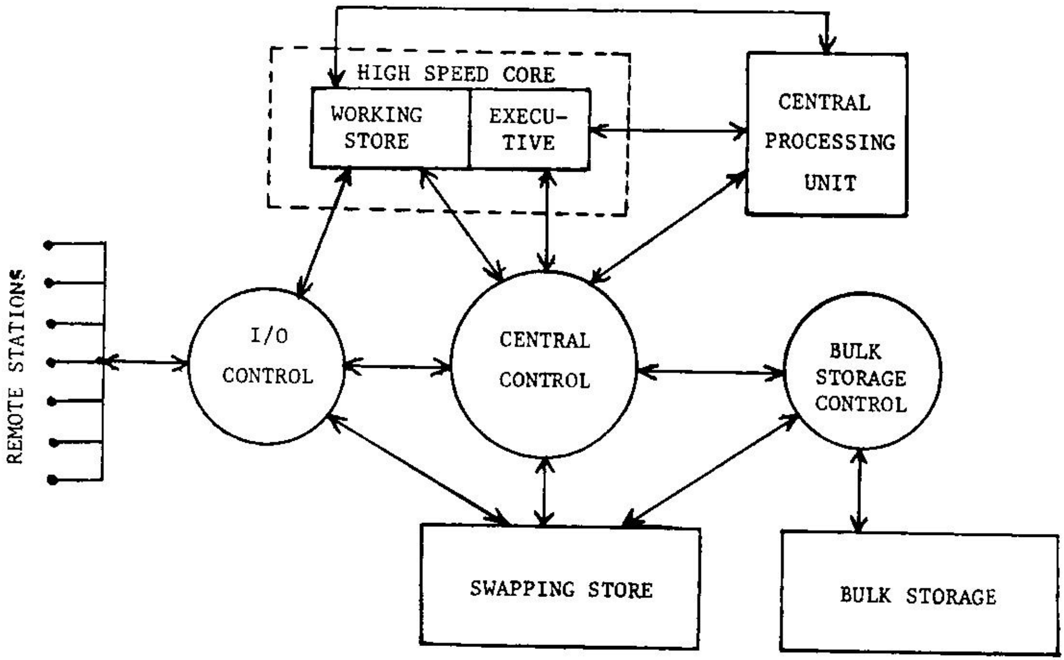

FIGURE 2

state details are retained so that when its turn again comes around, the programme can be processed with a machine environment that is identical to the one which existed at the time of interruption.

Interruptions that result from the initiation of input/output operations may be handled in many different ways depending upon the design of the system. In every case, however, such operations are carried on independently of and concurrently with normal processing. In fact, in many time-shared systems, a separate computer(s) is provided for input/output processing. In such systems, control is transferred to this machine(s) and processing proceeds independently of the central system until the specified input/output operations are completed. In general, this special processor(s) is also time-shared and operates under the control of a separate I/O executive.

Scheduling Algorithms

The length of a user's quantum together with the frequency with which this quantum is repeated is determined by a set of rules called a "Scheduling Algorithm" that is included in the Scheduling Routine of the Executive. Few parts of a time-shared system have a greater effect upon the characteristics as seen by the user than this algorithm. Consequently, its correct form is the subject of considerable debate among designers of time-shared systems. In some cases, the algorithm is trivially simple and permits each user's programme to run to completion. When this is the case, the system becomes in effect a remote batching system, and the job of the algorithm becomes simply one of assigning priorities.

At the other extreme, the algorithm may become very complicated and involves a multitude of considerations including the length of the user programme, the number and type of input/output operations, the current problem load on the system, the user priority number, the length of time the user has waited, the number and kinds of other waiting users, the system swap time, the maximum permissible response time, and so forth.

One of the most important considerations in the design of a scheduling algorithm is the Response Time. This is the interval between the issuance of a request by a user and the production of a reply by the computer. This time obviously will vary enormously with the type of processing involved. Thus, if it is a lengthy computation involving little or no human intervention, then a time measured in minutes or even hours may be quite satisfactory. On the other hand, where a display or keyboard is involved, the Response Time should not be longer than a comfortable human reaction time (about 10 seconds maximum and less than 5 seconds for trivial problems and queries).

In any truly general-purpose time-shared system, there is bound to be a problem mix that involves a very wide spectrum of programme types. Thus, programmes will vary enormously in size, running time, amount of input/output data, use of the subroutine library, auxiliary storage requirements, amount and frequency of human intervention and priority. Ideally, therefore, the scheduling algorithm would consider such factors in deciding the quality of service that is to be given to each user. Thus there is no reason why the quantum need be the same for every active programme. For that matter, it is not even essential that every user be serviced on every cycle. In fact, it might be permissible to serve some user, who did not require fast response on only every alternate cycle or perhaps even on every third or fourth cycle. This would, in effect, reduce the average number of users per cycle, and thus permit longer quanta for, say, 3 out of 4 cycles, and consequently, faster turn around times for the higher priority users.

The simplest form of user service discrimination merely separates the programmes into "on-line" and "background" groups. The background programmes by definition are those, like payroll jobs, that do not require operator intervention, and which, so long as they are completed by a certain scheduled cut off date, are not time-critical. Such programmes are usually run on a "time available basis" so as to fill up gaps in the on-line customers' demands, and thus, maintain a relatively constant load on the system. Many commercial systems provide this sort of service and during certain times of the day, say between midnight and eight o'clock in the morning, the chances are that most of the system's activities will be concerned with background programmes.

When it comes to on-line users, however, the provision of discriminatory service is a more complex problem. There are many different approaches. Probably the easiest to implement involves the arbitrary *a priori* separation of customers into different classes so that when the central processor receives an account number it automatically assigns the appropriate quantum value, response time, priority number and so forth. Other schemes require certain programme information from each customer before his programme is operated. This information typically may include such features as the programme size, the input/output requirements, and hopefully some indication of the user's own service preference. Ideally, the service assignments made before the start of a programme run are not fixed, but can be dynamically varied as the processing proceeds, so as to correct for errors in the initial estimate of programme parameters and also to compensate for changes in the total programme environment.

ADVANTAGES OF TIME-SHARING

The on-line querying, updating, and manipulation of large data bases as in a reservation system or an on-line stock control system is a good example of a natural time-sharing application. The debugging of computer programmes is another one. In fact, here the ability to interact directly with the computer and correct errors on-line can lead to order of magnitude improvements in programmer efficiency and enormously speed up the progamming process. In this connection it is worth remembering that **the largest portion of the total time required for producing a computer solution to a problem is the time spent in writing and debugging the programme.** Consequently, any technique that can reduce programming time is bound to have a major impact upon total problem solution time. Thus, in most cases, the savings in programming time with a time shared system more than compensate for any loss of effective computer speed.

Time-sharing can also make possible some entirely new ways of using computers, in which the distribution of work between the human problem-solver and computer undergoes drastic modification. Thus, **when one can have unscheduled access to a computer, can interrupt or modify the course of computation at will, and can at no cost sit and think at the console for as long as one likes between input/output operations, then it becomes economically feasible to employ even the largest of computers in an interactive mode. In such a mode, one can quickly try out promising ideas** and check their validity without having to go through the lengthy process of problem flowcharting, programming, coding, checkout, reprogramming, etc. In fact, problems can be solved piecemeal at the console without the user ever having to consciously write a computer programme in the usual sense of the term. On the other hand, all of the successful problem solution steps, if the customer desires, can be preserved and, thus, become available to other users in a public programme library.

The important point to note with respect to any sort of man/computer interactive operating mode is that even if the user had a private computer that computer would still operate in an intermittent fashion with long pauses between calculations, **while it waited for the human to react.** Consequently, with a powerful computer where **the discrepancy in speed between machine and human may be a million to one or greater,** the ratio of actual computing time to elapsed time may become extremely small. With a private computer, the "idle time" is paid for at the same rate as useful computing time so that **interactive operation is far too expensive for all except the most critical military applications.** With time-sharing it is a different story, however, for here the blanks in one user's processing are filled up with the processing of other customers, so that ideally, in a well designed system, the computer operates continuously, and idle time is reduced to zero. Thus, although the system simultaneously serves many users, each user is free to interact with the central computer as freely and effectively as if it were. in truth, his own private machine, but, of course, at a small fraction of the cost of a private system.

Applications of Time-Sharing Systems

The growth of direct access time sharing systems is now proceeding at a phenomenal pace with new systems and new commercial services being announced every week. In fact, the chorus of doubters who were so vociferous in their downgrading of time-sharing two or three years ago now seems to be silenced, and many observers are predicting that **by 1975 something between 75 and 90 percent of all computers will be operating on-line in a time-sharing mode.** The questions that are now being asked, consequently, no longer concern the merits of time sharing *per se*, but rather the relative difficulties and advantages of applying it to particular applications.

Any complete list of possible applications would resemble the index to the Encyclopaedia Britannica. In fact, even today the range covers all of those tasks for which conventional computers are normally employed, in addition to a host of others which only become feasible through the multiuser features. Consequently, any attempt to separately analyse each possible application would result in a document of encyclopaedia dimensions. On the other hand, a great deal can be learned by lumping the different applications together under suitable headings in a logical classification scheme. One such scheme that has been found useful employs six basic categories.

1. **Reference Services:** The first commercial applications of the on-line, real time and time-shared modes of operation were those which involved access to a common data base by many remotely located users. Early applications included airline and railway reservation services, order tallying and stock market quotation services. Today, the range of application is being further extended and specialized information networks are evolving for handling such diverse forms of information as police records, credit reports, medical and legal files, and scientific data of all kinds.

The evolution of such specialized networks is found to continue as more and more of the myriad social and occupational groups of the modern community come to appreciate the advantages of direct access. Some of the broad categories of services that might be provided include :

Professional—legal, medical, law enforcement, scientific, engineering, pharmacy, agriculture, etc.

Business—Credit, real estate, marketing reports, regulations, prices, trade data, etc.

Consumer—Consumer testing and satisfaction reports, product specifications and prices, product availability, advertising, etc.

General Information—Political and economic data, historical, travel, weather, etc.

It is obvious that **these categories could be expanded indefinitely until they included the totality of human knowledge,** and indeed, it is towards exactly this end that the evolution of the information utility is directed. In the words of Robert Fano, Director of Project MAC, it will become "the depository of the data base and information processing procedures of the community." **This depository will be in the long run drawn upon and integrate the resources of all the specialised utilities so that it becomes a gigantic electronic encyclopaedia, continuously distilling the essence from our society and making it available at any desired level of concentration to everyone.**

2. **Financial Services:** No aspect of direct access computer utilities has received more attention than their application to the world of finance. Applications concerned with ready access to financial data are, of course, partially covered by the reference services category, but there are many others, and just as in the reference services case they are likely to lead to specialised networks. These might include:

Investment Nets concerned with security transactions, market analysis services and stock quotation service.

Insurance Nets capable not only of providing routine services to insurance companies but even of generating tailor-made policies on-line for individual customers.

Banking and Credit Services. Both the banks and credit agencies have been particularly active in opening up the "Direct Access Age" and are currently heavily involved in such activities as the development of professional billing services; the provision of on-line teller terminals, sometimes integrated with management information services; and the establishment of banking and credit networks.

As a result of these and similar developments, it is likely that in the near future we will see the credit card idea merged with the concepts **of computerised banking** and credit bureaux to create a new type of universal financial utility whose **customers will identify themselves by means of a universal credit card or "money key". As time goes on, it is likely that this "money key" will replace both the cheque and most normal currency as a medium of exchange. In fact in both America and Europe key experiments aimed at exploring the possibilities of such automatic transactions are currently underway.** These experiments could eventually lead to an integrated worldwide financial network that will permit a customer to make money key transactions anywhere in the world. The range of services offered could also grow to eventually encompass every type of financial transaction no matter how complex or trivial it might be.

When this happens, the Financial Utility will have available within its files, a complete, immediately accessible electronic record of the current and past financial status of every customer from billion-dollar corporation to a school child. Bank balances, obligations, credit ratings, earnings (current, projected, and past), data on all of these and more will be contained in the records. As a result the flow of money between individuals, organisations, or even nations, will involve nothing more than an automatic transfer of information within the memory banks of the Utility. In effect, all of the world's myriad financial institutions will have been integrated and transformed into a single vast electronic information system.

3. **General Business Services:** Both the financial and reference services applications are, of course, deeply involved with business in all of its aspects. Nevertheless, there are many other areas of business life that could profitably use the services of a direct access computer utility. Some of these have been lumped together under the broad heading of General Business Services and are shown in Figure 3.

GENERAL BUSINESS SERVICES

Retail and wholesale Processing
- —Invoice Preparation
- —Merchandise Management
- —Credit Checking
- —Point of Sale Recording
- —Marketing

Production Control
- —Scheduling
- —Process Control
- —Production Reporting
- —Inventory Control
- —Materials Management
- —Resource Allocation
- —Project Status Reports

Purchasing
- —Shopping
- —Selling
- —Ordering
- —Payment
- —Consumer Satisfaction Survey

Planning
- —Sales Forecast
- —Policy Selection
- —System Evaluation
- —Market Analysis
- —Production Planning
- —Investment Analysis
- —Plant Layout
- —Resource Allocation

Management Information
- —Personnel
- —Financial Reports
- —Sales Reports
- —Production Reports
- —Inventory Status
- —Market Situation

FIG. 3

4. General Computation Services: Calculation in one form or another is, of course, interwoven with just about all of the applications that are discussed in this paper. Likewise, many of the functions included under the heading of General Computation Services in Figure 4 have already appeared elsewhere, either as functions within a larger application category, or as in the cases of reference data and planning, as major categories. Despite this, it was felt that the three major application categories shown—Design, Business Computation and Automated Laboratory Services, were sufficiently different from the applications that have been discussed hitherto to justify separate treatment.

5. Educational Services: In the long run, nowhere will the impact of Computer Utility be felt more strongly than in the area of education. Both the form of the school and the role of human teacher will undergo drastic changes as "fireside computer consoles", universal electronic encyclopaedias, teaching utilities and academic administrative utilities come into widespread use (See Fig. 4). For one thing, the concepts of grades and of classes based on calendar age may have to be abandoned. In their place will be a system of independent tracks for each student. Progress along these tracks will be continuous at a pace that will be separately controlled for each student according to his individual performance. **In fact, with the advent of domestic computer utility service there is no reason why much of a student's instruction and study could not take place at home. The time at school could then be devoted to laboratory work, group discussions and seminars,** and individual consultations with the human teachers.

6. Private Data Storage and Retrieval: Implicit in most of the discussions in this paper has been an assumption that in addition to providing computational and other services, the various systems would also make available private electronic storage files to which only the authorised user or his nominee would have access. And, indeed, many existing public systems in the U.S.A., with which the author is familiar, do provide such private storage facilities.

It is likely that as the cost of providing such storage decreases, and proven methods for assuring privacy are developed, computer files of this type will come to replace the majority of orthodox private data storage systems in the home as much as in business. One of the most significant features of this kind of file will be its dynamic nature. Thus, since the actual storage mechanism will be tied closely to powerful data processing facilities, much of the onerous task of file organisation will be delegated to these facilities. Complex data manipulation, editing, formatting, indexing and search routines will be available to the users and will introduce new dimensions to the usefulness of data storage systems.

Relation of Application to System Characteristics

Earlier in this paper, Figure 1 portrayed some of the many factors involved in a definition of "computer power." For any computer utility the relative importance of these factors and the ways in which they interact are to a large extent dependent upon the applications that the system is designed to support. For example, if the application of the system is to be restricted to the single job of storing and retrieving information, then there will be no requirement for either a customer programming capability or for extensive computational capabilities at the central processor. Thus, both the organization of the central machines and their programme structure can be optimised around the data manipulation and file searching problems. On the other hand, there may well be a need for the storage of voluminous amounts of narrative and pictorial information in a rapidly searchable form and for its transmission to and reproduction at the user's console.

Again, if the application is basically a routine business processing one—invoice production, credit checking or inventory control, for example—then the full facilities of a general-purpose business-oriented computer will be required at the central station, but once more there may be no need for user programming. Instead, an extensive library of packaged prewritten programming systems will be needed, each designed to handle a particular application for a whole industry, and hopefully capable of satisfying, with only minor modification, the needs of many different customers. Many of the Financial, Educational Support and General Business Services applications fall into this category.

At the other extreme are the systems where customer programming is a major element in meeting the user's needs. In fact, as was mentioned earlier, the interactive operating mode, which becomes economically feasible with time sharing, is in itself a major asset for

GENERAL COMPUTATION SERVICES

Design
—Calculation
—Reference Data
—Computer Graphics
—Simulation
—Engineering Notebook
—Cost Analysis

Business Computation
—General Financial
—Planning
—Calculation
—Cost-Effectiveness Analysis

Automated Laboratory Services
—Calculation
—Record Keeping
—Data Reduction
—Reference Data
—Control of Experiment

FIG. 4

EDUCATIONAL SERVICES

Administrative Services
—Record Storage
—Curriculum Generation
—Marking
—Financial
—Supply
—Progress Monitoring
—Testing
—Report Generation

General Encyclopaedia
—History
—Mathematics
—Language
—Current Affairs
—Art
—Social
—Sports
—Trade Data

Teaching
—Drill and Practice
—Tutorial
—Dialogue
—Generation of Teaching Programmes
—Game Playing
—Simulation

FIG. 5

the programmer. In such systems, most of the application programmes are written by the users, and the only software provided by the system, apart from the executive, is that which is concerned with providing assistance in the programming process.

Importance of Public Files

The system of files in most multiple user systems, whether general purpose, special purpose, private or public, in general constitutes one of the most basic and important features. These are of two types:

1. Private, where access is restricted to the authorised user or his nominees.
2. Public

In many systems these files represent the greatest single asset, for they contain an ever-increasing library of programmes and data generated by many different users, but accessible to every customer. Since the resources and information possessed by these files grows continuously as the system is used, they represent, at any instant in time, the integrated knowledge and intellectual resources of the users up to that time. Thus, they provide an unprecedented capacity for the rapid dissemination of knowledge. The effective utilisation of this capacity is one of the major challenges facing both the designers and users of computer utilities as we enter the direct access age.

Towards An International Information Utility

The advances in computer technology that have made possible the computer utility have recently been paralleled by a number of dramatic developments in the area of communications. Foremost among these is the realisation of the communications satellite—an event which ultimately could have as great an impact upon the future of the computer utility as the development of time-sharing has had in bringing it to its present state. With communications satellites, distance is no longer a significant factor in the cost of providing communications services. Further, since they eliminate the need for expensive ground relay networks, satellites are likely to be the least expensive means for providing mass communications in the less developed countries of the world. In fact **for areas like Northern Canada, India and Brazil it may soon be possible to provide communications services of the most advanced type at a fraction of the cost of conventional systems. These services could include not only high quality television, radio and telephone communications but also a wide range of data transmission capabilities.**

The latter are particularly exciting, for they open up the prospect of a world wide information utility which could act as a gigantic nervous system for the entire globe and make the complete store of human knowledge instantaneously available to every human being.

Operated by the United Nations, such a utility might take the form of a network of specialised information centres broadly distributed throughout the world and linked together by the point-to-point satellites of the INTELSAT and Intersputnik systems. Logically these centres would be operated by such specialised agencies of the UN as UNESCO, the World Health Organisation, the Food and Agricultural Organisation, the World Meteorological Organisation, and the World Bank. Backing them up, however, one can envisage a host of regional and national centres. In addition to handling the bulk of the routine local transactions, such centers would act as message concentrators and buffers and thus provide efficient gateways to the global net. High power, narrow-beam regional coverage satellites might be used in many parts of the globe for connecting the regional centres to local distribution centers which in turn would be connected to the individual customers via conventional communications circuits. Ultimately, however, the use of direct broadcast satellites should obviate the need for the local centres and provide a direct satellite path between the subscribers and the regional centres. ●●●

Pace of Computer Utilisation

Robert E McDonald*

COMPUTER UTILISATION THROUGHOUT THE world has increased prodigiously during the past decade and the pace of growth shows no signs of slowing down.

According to industry information, the number of computers in use worldwide, made by American manufacturers alone, has jumped from 1,700 units in 1957 to 57,600 at the end of 1967, and is predicted to grow to approximately 130,000 by 1972.

The total value of United States computer shipments during 1968 is estimated at approximately 6.5 billion dollars compared to about 5.5 billion dollars in 1967. This represents a gain of approximately 20 per cent.

Together with the fantastic growth in the number of computers in operation, there has been the equally amazing expansion in the applications to which they can be put. From such earlier routine tasks as payroll processing, accounting functions and inventory control, computers have progressed today to making seat reservations on the major airlines of the world in fractions of a second, preparing weather forecasts at rapid intervals, and switching thousands of messages for military and commercial networks every minute. Computers have also made considerable headway in manufacturing where numerical machine control is being increasingly refined together with production control and job scheduling.

Telephone companies are among a number of business concerns who wonder today where they would have found all of the personnel needed to deal with the tremendous explosion in their operations in the past decade, had not computers come of age.

We know that **in such scientific breakthroughs as space exploration, very few of the missions carried out to date could have been attempted without the guidance and control of computers.**

A number of distinct trends have become evident in the computer field today. One of these is the desire among many users for communications-oriented, real-time data processors. In such an application, a central site computer is linked to a number of field offices and plants by means of data communication devices able to rapidly transmit and receive information.

Another trend is for computers with time-sharing capabilities allowing several uses to have access to the same equipment virtually simultaneously. In actuality, a multiprocessor time-sharing system is continuously sharing its processing facilities with many users at such a phenomenal speed that each user has the feeling that the machine is completely dedicated to his own problem.

Yet another demand is for more complicated systems than heretofore and the desire for a

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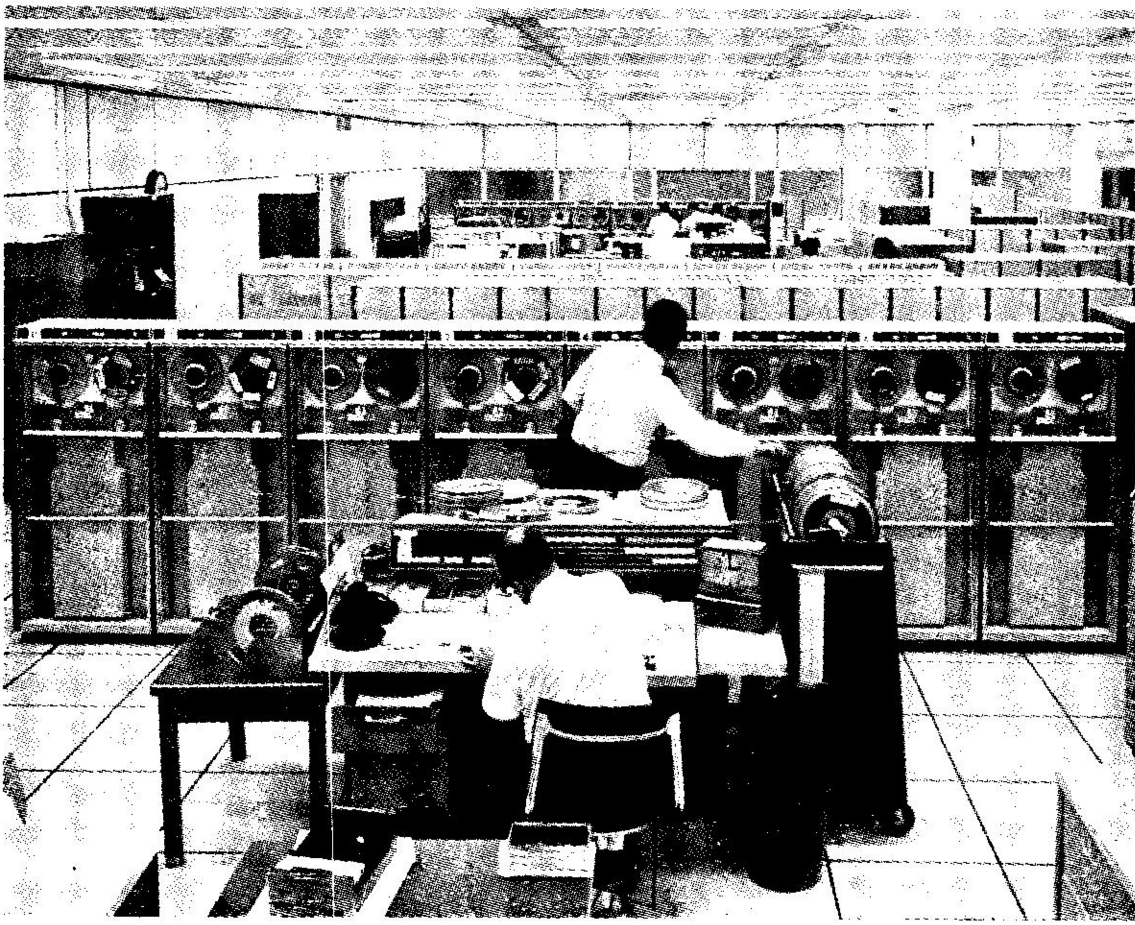
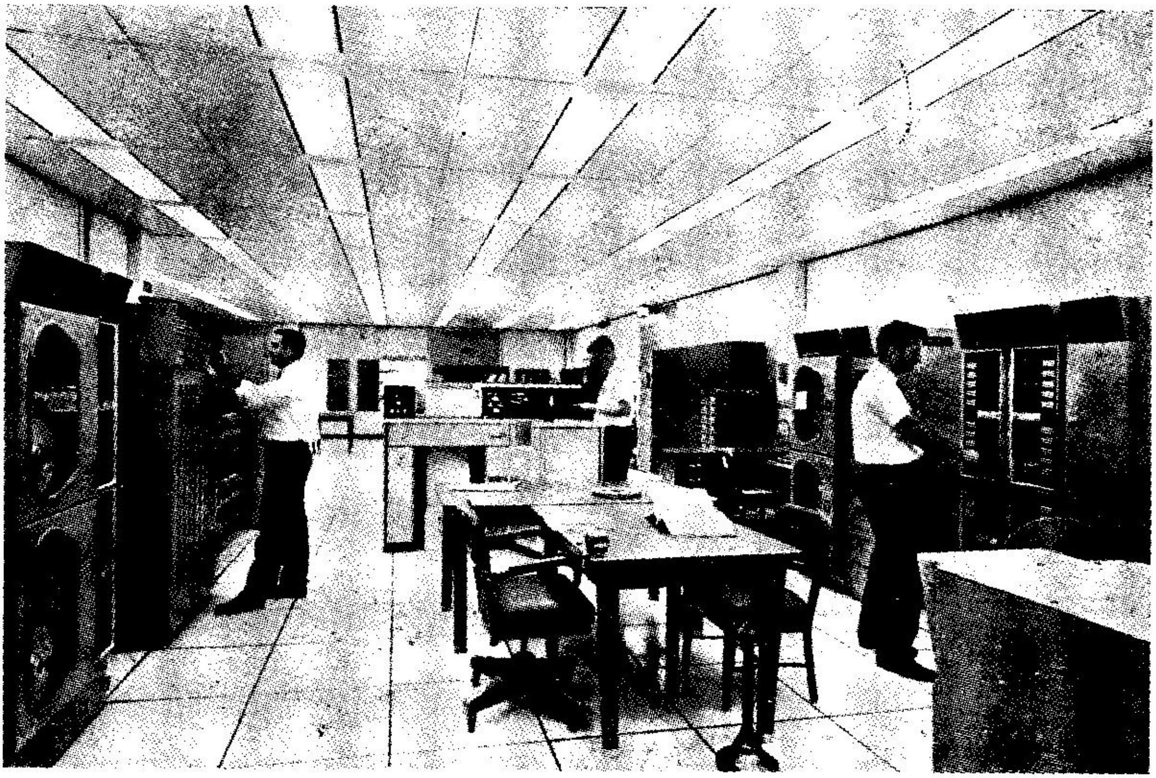
*President, UNIVAC Division, Sperry Rand Cor-oration, Philadelphia, U.S.A. This Corporation is e supplier of large scale computer systems to a ber of important concerns in the USA including Government's National Aeronautics and Space nistration Agency.



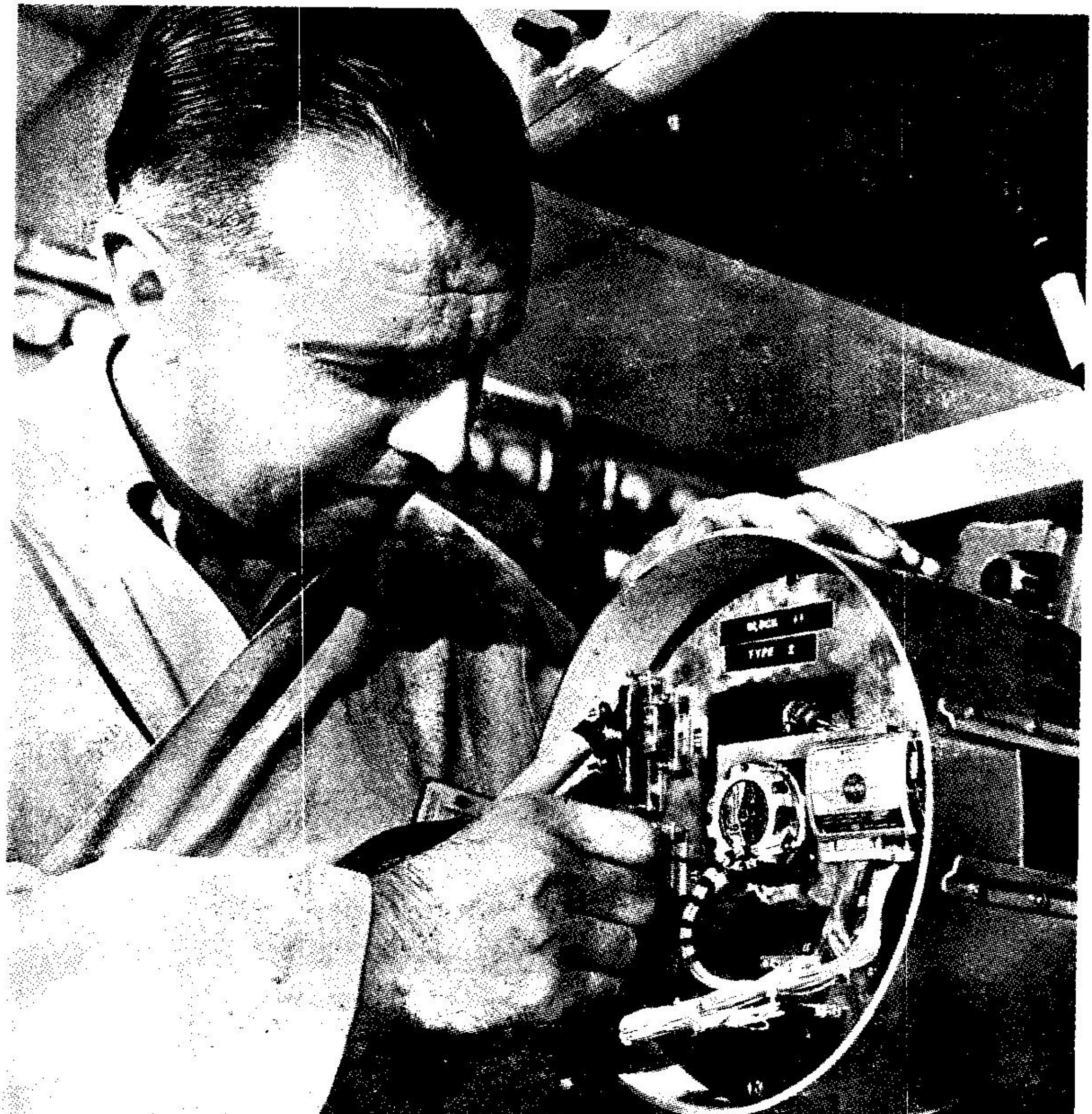
UNIVAC 1108 Computer System at NASA Space Centre, Houston, Texas, USA



Ruggedized Computing systems, products of Sperry Rand's UNIVAC Federal Systems Division, serve as the remote site data processing systems at tracking stations of NASA's worldwide Manned Space Flight Network supporting the Apollo programme. Advanced UNIVAC 1230 (NASA M 642-B) computing systems, such as the system shown above will process, accept, record, and transmit data originating from the spacecraft and compute and issue commands back up to the spacecraft. More than forty 1230 systems are installed and operating on the communication network.

Large-scale UNIVAC 494 Real-Time Computing Systems anchor NASA's worldwide Space Flight Network communications system. Serving as communications processors, provide the speed of computer control to handle, process and route the flood of communicat between Apollo spacecraft and Mission Control in Houston. These are over 15 times more than those used in the Gemini programmes.

The tiny device, called an accelerometer,—in a sense a "Space Speedometer",—a metal cylinder hardly larger than a spool of thread, is an important part of guiding both the Apollo Command and Lunar Module.



A small accelerometer, shown here mounted, in Inertial Measurement Unit senses the amount and direction of change in acceleration in space and electronically "passes along" deviation information to the guidance and navigation system's computer which generates corrective steering signals to the rocket engine system. The accuracy of the navigation and guidance system will be critical in assuring the proper altitude and angle of re-entry, to prevent the spacecraft from being burnt up.

computer to serve as the nucleus of a total management information system designed to supply the top executives of a company with timely information necessary to make important policy and planning decisions.

UNIVAC has placed great emphasis on the opportunities for computers to play a much larger role in such relatively untapped areas as medicine, education and local government, particularly in the field of law enforcement.

In education, computers can assist markedly not only through computer-assisted instruction but also by freeing teachers from many routine administrative tasks in order to spend more time in actual teaching.

In research and scientific exploration, UNIVAC has had the privilege of working with some of the oldest educational institutions in Europe, including the Ecole Polytechnique and University of Paris, France, the University of Rome, and the Milan Institute of Technology in Italy.

Medicine is another area where data processing can help by assisting in the provision of better services at lower costs. Computers are becoming the hub of medical information systems—designed to help physicians, nurses, and business administrators of hospitals perform their functions more efficiently.

To cite one aspect of work in the hospital environment, the computer can store in its files complete records of all patients admitted to the hospital. This data can be obtained either in printed form or visually on a television-type screen at a moment's notice by the attending physician.

In Stockholm, Sweden, an international medical centre is presently implementing what is considered to be the world's most advanced, totally integrated medical system at the Danderyd Hospital. Similar work in advanced medical systems is under way in France and Turkey.

In the local government sphere where authorities are constantly being asked to supply more and better services to the citizenry, the computer can play a major role. Presently UNIVAC computers are at work in such varied assignments as assisting the city of Toronto in regulating its traffic flow to processing social benefits for the National Institute of Social Security in Spain.

Law enforcement is particularly suitable for the use of real-time computers; the computer can store in its files information on "wanted" persons, lists of stolen cars and other property, and registration data on all automobiles owned in a particular state or province. With a real-time system, access to this information can be had within seconds to apprehend criminals. Such a system, now being operated by the State of Louisiana in the United States, perform these tasks as well as the automatic switching and routing of police messages of all types. This system is currently connected to all of Louisiana's state police stations and the United States Federal Bureau of Investigation in Washington. Plans are in progress to extend the network to all major city police departments in Louisiana.

One of the most advanced uses of computers today is in the field of city planning and regional development. An international firm, with headquarters in Greece, is engaged in such projects as planning the development of the area bordering the River Plate in South America, involving five nations and 80 million persons. By utilising high-speed UNIVAC computers to "map" or provide graphs of future characteristics of the population, this company is able to predict population movement, its composition and accompanying economic phenomena for years ahead.

We at UNIVAC look forward to participating on an ever-increasing scale in the **computer's impact as a great sociological force.** In many nations where computers have made only a small impact to date, the opportunity to effect far-reaching changes could bring untold benefits. ●●●

The Elements of A Computer

J G Krishnayya*

TO UNDERSTAND WHAT A COMPUTER IS, IT is best to look at it in terms that are parallel to those we use about ordinary language. The computer consists of a large number of elements, each of which is like a switch which can be either **on** or **off**. Three switches in a row can thus give us the values 000, 001, 010, 011, 100, etc. In the binary (powers of two) counting system, what we have just written down are the everyday decimal (powers of ten) numbers 0, 1, 2, 3, 4. Similarly, it is possible to represent alphabetic characters by means of longer combinations of binary switch elements. Thus, we could have—

A=000001, B=000010, C=000011, . . . Z=011010 and so on. It is therefore a very simple matter to represent any symbol or group of symbols in the binary system, or in a machine consisting of a large number of binary switches.

Let us now look at the way in which human beings communicate information to each other. We use language. Languages consist of a number of vocabulary elements or **words** and a number of rules which we follow in combining the elementary words. The procedure that my brain follows when I see something written on a paper is to read each word and try to match it up in my mind with my own vocabulary. The elements in my mental vocabulary have pictures or concepts associated with them and that is how I make a meaning out of what I have read. Actually it is more detailed than this. What one really does is first of all to match the individual letters which one sees with the alphabet which one knows, and then the grouped letters, i.e., the word, is matched in one's vocabulary.

What we have done now is **to make a model of all knowledge as a series of sentences which we construct out of words combined under logical rules.** Words themselves are logical combinations of individual letter symbols.

In a computer we go one step further and represent alphabetic characters, numbers etc., as logical combinations of binary digits. A computer is a logical machine, with the ability to represent anything which could be written out in words: this means that the computer could store a representation of any logical system which a human being can describe under the rules of language. This is what gives the computer its great power — its ability to simulate any logically describable process or thing. (In fact, even the working of a partially-designed new computer can be, and usually is, simulated on the previous generation of computers!)

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Instructing a Computer

When you want the computer to deal with numbers, you have to instruct it very much as you would a clerk to whom you give an adding machine to do some calculations. The basic operation inside the computer is really addition just like in an adding machine, and if you wanted your clerk to do some complicated calculations on a series of numbers, you would have to:

i. write out the data numbers in series,

ii. tell him which number to add to which and where to store the results,

iii. which number to take next and what to do with it, and

iv. when to stop.

In a sense you have "programmed" your clerk to perform certain operations with the adding machine, using a piece of paper combined with the adding machine's own output tape. By telling him to number the successive lines on the adding machine's output tape, you could probably simplify the work of writing the instructions or 'programme'. This is how it happens with the computer. The computer has a large memory of which each cell has an address. It has also an arithmetic element. In order to get the computer do anything, you have to write a programme which will tell it step by step which memory cells to take the data from, what to do with it in the arithmetic element and where to put the results.

In the early computers these instructions were given from outside the computer by means of holes in paper-tape or holes in punched cards, much as a textile loom's weaving patterns are directed by the holes in cards. In fact, the first digital computer was built in the 1830's by an English inventor who used punched cards for the instructions. Since reading instructions step by step drastically slows down the computer, the instructions themselves are usually stored inside the computer itself in advance in a special part of memory, and the computer can refer to this special part of its memory to find out what arithmetic step is to be taken next. This is much faster because reference to a computer's memory today can take as little as half a microsecond. Reading a punched card takes as much as 7 milliseconds.

Since we are now storing both the instruction programme and the data to be worked on inside the computer, we begin to see that the size of the computer's memory will be quite critical in determining what kind of programme it can handle. In the last 10 years various methods of extending the basic memory of a computer have been devised so that we can write very large, that is, complicated programmes or work on a large number of individual pieces of data. Memory extensions in common use today are magnetic tape, magnetic disc-packs (which look something like a record changer with many arms), magnetic drums etc.

Right Application

Computers can be used for all cases where logic applies. Thus, they are used now to control military radar systems, chemical plants, manufacturing time-tables for cars and trucks, etc. But the most common uses are in financial or accounting applications because that is where a large number of simple but repetitive calculations have to be done and it is in this department that most organisations begin to feel the pressure of work, and demand either more time or more men to do it. Very little of the computer's capabilities are used in such applications, and they do not always represent the most profitable use for the company. Such applications are beneficial only if

i. very little or no human verification of the work of the computer will be necessary,

ii. activities of the firm are not held up while the computer is digesting information and producing reports,

iii. there are genuine savings which provide rates of return better than other investments of the company (including other computer applications).

One danger in computerising clerical operations is that, in future, human interventions to speed up something or to treat certain documents as exceptions become very difficult. Under manual handling all the documents are available at all times, but once they are being processed by the computer you have no way of laying your hands on any single document until all the reports are ready.

A common fallacy in choosing computer applications is to consider that unless the computer is utilised 80 or 90 per cent of the time, something is wrong. This is a dangerous assumption because projects which may use a lot of computer time may not be at all worthwhile. The criterion should not be utilization, but "**Net Savings.**" **In a country like India where relatively skilled clerical manpower is freely available, substitution of a computer for some clerical operations does not seem a particularly imaginative use** unless some **time** is really **saved** and that time corresponds to large savings of money.

The computer as a logical machine can help in analysing and solving problems, many of which would be too complicated to try and do by hand. But it is **not a magic wand** and in order to accomplish a significant use of the computer's logical and calculating abilities it is necessary first to do a great deal of problem analysis and then much careful programming. It has now been accepted in America, where they have had 12 years experience with computers, that the investment in hardware or machinery must be matched on a 1 to 1 basis by an investment in **software** or Systems Analysis and Programming. It is this software investment which will point out those applications and a manner of executing them which would bring the greatest savings to an organization or which would provide the most useful information for decision-making.

What a Computer Can Do

The peculiar abilities of a computer make it particularly applicable to problems of forward planning and contingency planning. Since it can execute a large number of calculation steps in a very short time, it is well suited to answering questions of the "What if?" kind. What if the rainfall is 20 per cent less? What if the interest rate goes to 7 per cent? What if sales are lower or higher than expected? What if the British pound is devalued? These are the kinds of questions which the computer would allow the corporate or a Government planner to answer after it has been suitably programmed.

Some of the most profitable uses in business are in production and distribution management, inventory control, production planning, work scheduling, manpower analysis, cost accounting and cost accumulation, PERT analysis and up-dating, and the use of PERT models to allocate work, product and process modelling for value-engineering studies and, most important, forward planning to integrate capacity, sales and financial forecasts. Good systems analysis can ensure that information which is being collected in machine form for one application could be used for other applications later also if desired.

In public administration the relevant applications are budgeting, including programme budgeting and performance budgeting (performance budgeting would involve detailed cost accounting of a very large number of individual work-packets) and manpower planning, so that scarce manpower resources can be properly allocated both in space (to different projects already under way) and in time, taking into consideration such factors as leave, study periods etc. PERT models for sequencing of investments in inter-related fields is another application as are resource analyses of capital goods and raw-material inventories, and foreign exchange budgeting connected with licence utilisation and capacity utilisation. Simulation of large water resource systems so that scarce water can be fully utilised both for irrigation and power is yet another computer application which is possible provided we put in the required investments in skilled manpower devoted to Systems Analysis and Computer Programme Design. ●●●

India's Entry Into The Computer Age

Dan Sweeney*

MANKIND IS WITNESSING A NATION-BY-nation transformation as the tidal wave of automation continues to spread throughout the world. India appears to be the next to be hit.

The impact of computers on the economies of the western world has, in less than a decade, already made a significant penetration within large segments of business, education, hospitals and government. But most observers say the full impact of computers is yet to be felt.

The reason India may be next is basic. The country is showing an increasing awareness of computers. Right now, there are only about 50 installed — a figure far less than Western countries, however, enough to make India a pioneer in electronic data processing in Asia. Its biggest step thus far, was taken two years ago, when ambassador B. K. Nehru signed a contract for 10 computers with Honeywell, an international automation systems firm headquartered in the United States. The computers were to be used to establish a $ 7 million computer network throughout the country. Some of the applications then being considered were related to handling income taxes, providing labour statistics, controlling licensing of import-export merchandise and setting up statistics and production programmes for the Oil and Natural Gas Commission.

Until September, 1967, everything was on paper—programmes, flow charts and systems design — but then the multi-million dollar contract began to become reality. The first of four computers planned for installation in New Delhi arrived there. The remainder, due for shipment this year, are slated for the government's data centers in Bombay, Calcutta, Bangalore, Dehra Dun and Poona.

James H. Binger, Honeywell's board chairman and chief executive officer, visited India in November 1967 to review the progress of the project. He described the event as the first phase of a long-term programme that would give the Indian government "modern tools to match its modern administrative goals." He then directed Honeywell's Electronic Data Processing Division to form a computer team to work in India, assisting the government in selecting sites for the 10 Model H-400s and develop the necessary training courses and computer programmes to train the government personnel how to use the "tools".

Since then, the Group has conducted a series of surveys and selected prime computer sites. The first of several four-and-a-half month courses for systems analysis and programmers has been completed. Additional training programmes of six months duration

*Honeywell Electronic Data Processing, Wellesley Hills, Massachusetts, USA

have been set up for engineers to teach them how to install computers, do the trouble shooting and maintain and repair them.

When not occupied with instruction or surveys, the Group has been working on the programming requirements to handle adminsitrative tasks for the various levels of government. Though there is no real way to evaluate the effectiveness of the computer network after such a short period of operation, some measure of its potential value to India can be seen by reviewing the success the United States has had in controlling its massive income tax problems.

The US Internal Revenue Service has devoted 17 Honeywell computers full time to the task of keeping a check on more than 100 million taxpayers. In 1967, more than $130 billion was collected by the US Government. The computers detected that a large number of taxpayers had "short-changed" themselves in the amount of $7 million due to mathematical errors or incorrectly completing the form. The money was politely refunded, however the computers are not merely public servants. They are watchdogs as well, providing a comprehensive, uniform, nationwide check on a small number of individual tax delinquents and businesses neglecting to file returns. These strict controls have caused taxpayers to be more conscientious while at the same time bringing about a high degree of organization to the record-keeping functions of the Internal Revenue. These benefits and safeguards most certainly will be incorporated into the income tax applications scheduled to be handled on the Indian government's model 400s.

The insurance man who once sat for hours, mathematically calculating premium payments his policyholder had to pay each month, leaves all that to the computer. When an insurance payment is received, the agent pencil marks a card, puts the card into a computer-like device in his office that transmits the information to a central computer, thousands of miles away. The computer updates the policyholder's file, changes the cash value of his policy, prepares the agent's commission and remembers to prepare a bill in time for the next monthly payment.

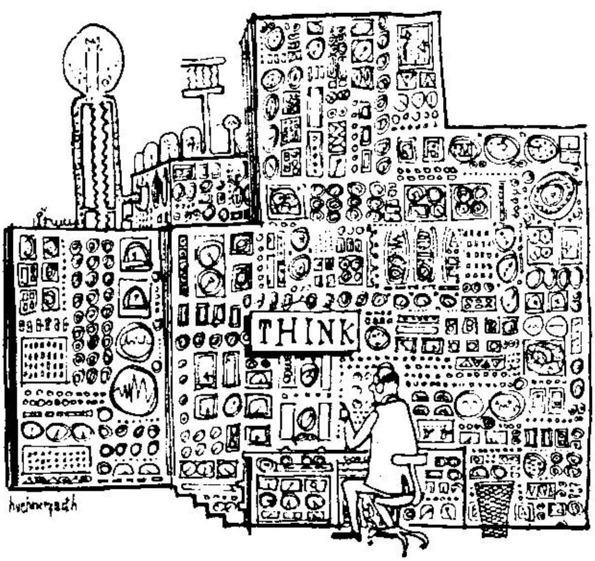
Teachers, too, have seen the advantage of computers. Using them, universities have been able to register and schedule thousands of students into classes. Audio-visual devices have gained popularity with their ability to display anything from academic records to instructional aids stored in the computer.

The day is not far off when a doctor will visit his patient in the hopsital, prescribe medicinal dosages and have a nurse code the information into a device at her station that instructs the computer to advise the pharmacy to fill the prescription and enter the fee on the patient's bill.

Scientists, as well, have effectively used the computer's resources for research. It has been said that *the computer can perform more calculations in one minute than a stadium of scientists could do in a lifetime.* Some computer uses have found more practical scientific applications. In agriculture, for example, computers are controlling crop rotation, and soil evaluation. A firm in Georgia, a state in the south-eastern US. has developed a computerized system for mixing chicken feed. Officials there boast of the statistics that prove a farmer can save as much as $1.00 per ton by having the computer calculate the proper mix of grain feeds. At least one company is pleased with these statistics. It manufactures over 40 million tons of feed in a year.

More and more, computers are being directed toward helping human beings with their day-to-day problems. Vehicular traffic, for example, in key cities has been a burdening problem. Computers now are determining peak traffic loads on the main roads in and out of the cities. City planners hope to control speeds and regulate traffic lights more precisely and thereby alleviate congestion. Banks are extending the ultimate in service to their customers by having the computer verbally quote the amount of money on deposit. Telephone companies have used a similar "talking" technique for determining charges on long-distance telephone calls.

India and its people are into this period. They have reaped the benefits of the technological pioneering done in the West, without having to go through the sometimes bitter consequences of trial and error. For India, this can be both good and bad. The period of maturation may be long or it may be short. In any event, the results will be reflected first, in the ability of India to accept computers as a very real and potent benefactor of man, and second, for government, education, science and industry — the most likely users of computers —to help educate the masses. Third, it is up to the manufacturers of EDP equipment to share their knowledge and experiences so that the nation, as a whole, can ride the crest of the computer wave, rather than be engulfed by it.



EDP In Pharmaceuticals

PR Dobson*

This is a highly interesting and informative account of computerisation at Glaxo Laboratories (India) where a Computer Centre is now fully equipped and working. Staffed by recruits from inside the Company, trained on the spot, it has successfully implemented several projects with ambitious plans for the future. The objective of the Glaxo (India) Management is to set up a management information system based on *the concept of a Data Bank.* This is a comprehensive set of data about the Company's activities, oriented towards the demands of the information system rather than the functional departments. The Company's EDP adviser recounts below the teething troubles of computer installation compensated by the successful emergence of a system, combining high efficiency, high accuracy, high speed . . . .

DURING THE LAST TWO YEARS WE HAVE been preparing for installing and starting a Computer Centre at Glaxo. As there are by now nearly 50,000 computers operating throughout the world, we certainly cannot claim to be pioneers, yet in India the installation of a computer for a wide sector of the commercial work of a large Company is still rare, so that some aspects of our progress and plans may be of general interest.

The decision to plunge into E.D.P. was not taken without heart searching. For many years the Company had been considering some form of mechanised data processing, and finally, early in 1966, it was decided to bypass the stage of using simple punched card machines, which is often considered a useful introduction to E.D.P., and to introduce a full-scale magnetic tape computer. This decision was based on experience gained by watching some other organisations progressing through as many as four levels of mechanised data processing, designing four sets of procedures, training staff through four levels and putting up with five years of constant change of methods. It accepted the fact that the equipment would run uneconomically for upto one year, but that subsequent returns would be higher.

It might appear at first sight that by having simple equipment, the procedures themselves could be kept simple, but in fact the opposite is the case. The simple equipment cannot cope with the complexities of the business, with the result that all the exceptional cases and unusual conditions are left as manual routines, and these can represent a very large volume of work. Moreover the equipment is not able to carry out many validity checks on the input data, so that more clerical work is devoted to locating errors.

A more powerful set of equipment can bring about a simplification of the running of the procedures although a great deal of meticulous investigation and systems design may be needed beforehand. An example of this is provided by the rules in use in our Company relating to Drug Licence requirements, calculation of Sales Tax and Octroi and of Milk Food quotas. After much study these rules have been completely incorporated into the computer programmes, and these calculations are performed automatically, including all the special cases. This is how it should be: the complications should be wrapped up in the machine,

*Group EDP Adviser, Glaxo Group Limited, London

because once a programme is running successfully, no matter how much blood, sweat and tears it costs, it will continue to perform its task regularly and without trouble. On the other hand, manual calculations of exceptions cause extra work, errors, and irritation permanently.

Choosing Equipment

After the decision to rent a magnetic tape computer, the next task was to choose the machine itself. The choice, however, was not difficult because it was so limited. In the U.K. and U.S.A. one is faced with an extensive range of computers, each with its own claims to consideration in terms of technology, service or price. Each machine is supplied in a range of models, with innumerable variations of specifications. By contrast, in India at that time there was but one machine available on rupee payment — the I.B.M. 1401. If the decision were being made now, it would be less straightforward : today the I.C.T. 1901 A and the I.B.M. 360/40 are available. Both these machines also offer disc storage as an alternative to, or as well as, magnetic tape. The 1401 also offers it now, but at that time disc storage was not available on rupee payment.

I have the greatest respect — even affection — for the I.B.M. 1401. As the model T Ford popularised cars, this machine, which is simple and reliable and was sold far and wide, brought E.D.P. to many Companies. Although in Europe and U.S.A. it has now been replaced by machines which are more modern in concept and offer greater capacity at a lower price, we expect it to meet our needs for some time to come.

Our machine was ordered in August 1966, for delivery in October 1967. Its specification was briefly, four magnetic tape decks operating at a speed of 20,000 characters per second, a line printer with a speed of 600 lines per minute, and 12,000 characters of memory; this, in my opinion, is the minimum core store size for proper use of magnetic tape files.

Staffing

No matter how powerful and modern your computer, it is only as good as the staff who design the systems and write the programmes. In the U.K. and U.S.A. the staff are by far the Computer Manager's biggest headache, particularly recruiting and retaining Programmers and Systems Analysts. His first problem is that they are scarce, requiring big, expensive display advertisements and inducements of every kind to woo them to consider a post in his installation. Then they are expensive: salary scales are very high and steadily rising. Moreover they are mobile: often just after they have learnt the business and become useful, they are tempted away by even higher pay. Even if he can keep them until the procedures are implemented, by the challenge and interest of development work, they become bored after things settle down and move off, leaving behind them a procedure which no one really understands in depth.

There are two reasons for this situation. The very rapid expansion in the field of E.D.P. is one obvious cause, but equally important is the fact that people with the intelligence quotient and logical ability to make good Programmers and Systems Analysts are also in demand in every field.

The situation here in India is quite different. Skilled, trained and experienced computer staff are so scarce that it is not worthwhile looking for them. On the other hand there is available a pool of very intelligent, ambitious young men who have no opportunity in their present job to use or develop their potential ability. The problem is to identify those with the right type of aptitude, and then train them intensively.

In order to identify suitable people we used a stringent set of aptitude tests, which were given to more than 130 applicants, all from inside the Company. Opinions differ as to the efficiency of aptitude tests but there seems no doubt that those who do very well in them have the ability to make good Programmers, although possibly some who would also make good Programmers may be rejected because they do not have the type of mind which is good at exams. Nor are the tests so successful at selecting Systems Analysts, who need qualities much harder to detect. They are, however, very much more reliable than merely interviewing candidates, which is not only too subjective but gives too much weight to verbal communication, which is a minor quality as far as programming is concerned; it may even be in inverse ratio to programming ability. We, therefore, relied on the tests completely and selected the top 13—nor have we any cause to regret our decision. The staff selected came from every department, and provided us, therefore, with a team with a wide knowledge of the Company's activities. The one thing they all had in common was youth, and as a result several were engaged in routine tasks which were well below their potential ability, as has been proved. But for the introduction of the computer, they would probably still be doing them, instead of the interesting and challenging tasks now facing them.

Staff Training

All were trained as Programmers and wrote and tested programmes. It is my firm belief that you cannot really understand computers unless and until you have written and tested programmes. In fact it is more than a belief—it is a conviction, or prejudice, depending on your point of view. Thus our Operations Supervisor and all our Systems Analysts have written programmes which are in current use. Of course, a Systems Analyst has still much to learn after he has become a skilled Programmer, but he is far more likely to design good systems if he understands the work of the programmers who will be interpreting his systems into machine operations.

Initial training in programming is given by the computer manufacturer; the rest is training on-the-job. Although one can learn by making mistakes, this is too slow a process, because designing and implementing a procedure takes at least a year and only then do the mistakes show up. It is advisable, therefore, for someone to supervise this training. For this reason I came out from the parent Company for two years to provide the leaven of experience.

Undoubtedly the hardest thing to teach Programmers and Systems Analysts is not the technical know-how, but the meticulous attention to detail that is so essential in all computer work. In a computer programme every possible condition must be foreseen and provided for: a programme which goes out of control when the unexpected happens can cause hours of delay in processing. An average Programmer will write programmes that work satisfactorily when everything goes right; when the input data contains no errors, the invoice contains no credit item bigger than the debits, or the customer does not exceed his credit limit by more than 500 per cent. It is only the exceptional Programmer who always looks ahead, who questions every restricton, and whose programme deals with the unlikely condition by printing out an error message which records the condition, quotes the document number concerned, deletes the item and then reads the next record and carries on without stopping.

Such refinements, however, use up large sections of the computer memory, so that when specifying a computer it is wise to ask for at least 25 per cent more memory than appears necessary in the initial stages.

Each programme must be backed up by complete, up-to-date documentation. It is almost always necessary to revise or amend a programme, perhaps long after it is written and in the absence of the original Programmer. It is then a frightening experience to find that the documentation consists of a flow chart on the back of an envelope and a pile of undated assembly listings. A programmer who works in this fashion, however brilliant the programmes he writes, will always be more of a liability than an asset.

Organisation

The organisation chart of our Computer Centre has a classic simplicity. Responsible to the Manager and his Deputy are two assistants, one in charge of operations, and one in charge of Development.

The Operations Supervisor has under him three sections, of which the most important is the Control Section. Here all batches of input documents are received and recorded and the totals entered in a control book. The work of the other sections is also scheduled by this section, and all reports prepared by the computer are scanned, checked to control figures, and recorded. The other two sections are the Computer Room and the Punch Room.

The staff in the Control Room and the Computer Operators were also selected by aptitude tests, (though less stringent ones, backed up by an electric device, developed by ourselves,) for testing reaction speeds. It is interesting that the results of this test correlate quite well with operating ability but not with programming skill.

On the development side are the Systems Analysts and the Programmers. These are organised into project teams, as opposed to the more common principle of having a group of Systems Analysts with a Chief Systems Analyst and a pool of Programmers with a Chief Programmer in charge. A Project Team normally consists of one Systems Analyst and two to four Programmers, but the make up of a team is to some extent fluid. As projects are completed and new ones started, staff are transferred between them. Although some Programmers may assist the Systems Analyst in the collection and preparation of data, generally Programmers need not join the team until at least some of the programme specifications have been completed. Similarly, a Systems Analyst may start up a new project before programming is completed on his previous one.

One of the main advantages of the project team system is that the members of the team identify themselves with the project and co-operate more effectively. The Programmers can understand the purpose of their programmes more easily if they have a clear understanding of the whole project, overall and in detail. This does not, however, absolve the Systems Analyst from the need to prepare a complete, clear and detailed specification for each programme before it is started. Preferably all programme specifications for a project should be complete before any programme is started, otherwise modifications to half-completed programmes are inevitable. This, however, is a counsel of perfection, and is rarely achieved.

As our plans were ambitious and even our earliest programmes were complex, we allowed three clear months for programme testing and for pilot runs between the delivery of the machine and starting up the procedures; even this was barely enough.

Computer Procedures

Although Glaxo is a big organisation, its operations are not complicated by diversification, and the activities can be summed up in the conventional cycle :

Buy — Store — Produce — Pack — Distribute — Store — Sell.

These seven activities are all interdependent, being linked by forecasts and by feedbacks, and one of the most important tasks of the computer is to help management control more efficiently these links.

In any company the overall efficiency can be gauged by examining the efficiency of the links between the main activities. There are many organisations with efficient production and buying departments but holding vast stocks because the links between these departments are disorganised. In the same way, delivery periods may be excessively long because of poor communication between production and sales.

The relationship between these activities is one of arithmetic and logic — fields in which the computer is pre-eminent — but in order to guide this relationship, the computer system must contain within its data store full details of the operations at each of the seven stages — in other words it must establish a data bank.

A data bank (also called a data base) is a store containing complete and up-to-date records of the activities of the Company. Examples of the different types are shown in Table 1. These records are contained in files (stored on magnetic tapes or discs),

TABLE I

TYPES OF RECORDS HELD IN DATA BANK

Name	*Examples*
Master Records	—Codes, Names and Addresses of Customers
	—Codes and Names of Products
	Packs
	Depots
	Towns
	Raw Materials
	—Standard Pack Specifications
	—Product Formulae
	—Optimum Stock Levels
	—Standard Costs
	—Selling Prices
Forecasts	—Sales Forecasts
	—Budgets for Raw Material Requirements
	—Production Schedules
Historic Data	—Sales for Past Months and Years
	—Material Usage Statistics
Current Data	—Daily Sales
	—Current Stocks
	—Outstanding Requisitions and Orders

oriented towards the information requirements of the Company, not in conformity with its functional departments. Each item is entered into the data bank at one point and once only, and one record is maintained for the history of a transaction. For example, the history of a purchase is held in one record, updated through the successive stages of requisition, purchase, bill, payment. Similarly, for a sale there could be built up one record to cover order, delivery note, invoice and payment.

It will be realised at once from these two simple examples that this system cuts completely through inter-departmental barriers, and, therefore, calls for total management involvement. It also demands very strict discipline and very high standard of accuracy in the preparation of input data. A further requirement is for one common coding system throughout the organisation, with unique code numbers for raw materials, bulk products, pack, etc.

Every item from the data bank is available for any purpose: for example, preparation of a production schedule will require drawing from the files information relating to each of the seven activities.

Uses of Data Bank

To illustrate how each of the seven main activities of the Company feed information into the data bank and how each is controlled by drawing out data relating also to other activities, the various computer procedures which will use the data bank are described. Because the procedures are so closely interdependent it is not possible to explain one without referring forward to others not yet described, but perhaps the best place to start is sales forecasting.

A forecast of the sales of a pharmaceutical product is a blend of four main factors:

(a) A steep or gradual upward slope for the increase of sales of that type of product in the country;

(b) a curve repeated each year showing the seasonal pattern of sales;

(c) a long-term parabola representing the life of the product;

(d) rises and falls reflecting the effect of sales promotional activities during the period.

Of these, items (a) and (b) can be calculated by the computer from historical data ; items

(c) and (d) must be provided by the expertise of the marketing division.

Initial sales forecasts, therefore, are calculated by the computer by reference to current sales data and historic sales record; they are then modified in the light of sales promotional policies, and fed into the data bank.

Sales Data

Information about current sales is fed into the data bank promptly. For sales in the Bombay selling area, the details are taken from customers' orders (invoices for these customers are prepared as a by-product); copies of invoices covering sales throughout the rest of the country are the starting point of processing of other sales.

Customers' orders from Bombay, and copies of invoices from other points, are sent to the Computer Centre daily, and these are transcribed on to punched cards. An input editing programme transfers all valid items to magnetic tape and rejects all queried items. From this point the data is processed through seven stages of calculation and checking. At each stage all suspected items are rejected for resubmission on the following day, so that only correct data is fed into the data bank. Items checked include:

—product coding

—pricing

—extensions

—sales tax rate

—octroi rate

—inclusion of debit and credit adjustment.

The programmes include routines to deal automatically with every type of error that can be foreseen, so that nothing disturbs the complete processing routines, which take about four hours per day. If any new type of error arises, causing a halt in the proceedings, the situation is analysed and the programmes are amended to deal with it if it arises again.

The preparation of prompt statistics for all levels of the selling and marketing divisions of the Company is a first priority. The reports prepared are designed for the specific needs of the recipient. The Managing Director will be interested in sales values and profitability of products; the Sales Director is anxious to know the progress and performance of sales in relation to targets. Branch Managers are most interested in value of sales in their selling area compared with other Branches, while Branch Sales Managers compare the performance of the sales areas, and Area Sales Executives study the sales to their big customers. Marketing Division need prompt figures about the effects of sales promotion, as well as the long-term trends.

Each person should receive the statistics he needs, in a clear form, without being flooded with sheaves of paper. To present the complete picture eleven types of reports are prepared, many of them at three different levels:

(a) All-India and Branch — for Head Office ;

(b) Branch and State—for Branch Management ;

(c) State and Sales Area — for Area Sales Executives.

For these purposes we draw from the data bank cumulative and comparative sales figures accumulated by town, representative, product pack, product group, and type of customer. We draw also names of products, towns, etc., rates of profit, and sales targets.

Material Control

The second priority is the control of raw materials, as the cost of materials is the biggest cost of element in our industry.

Recording current stock levels is, of course, a common-place application for mechanised data processing at all levels, but the procedure planned and in course of implementation goes far beyond this.

As soon as a requisition for an item of raw material is raised, a record is opened in the data bank. This record is updated and expanded as the requisition is progressed through the stages of.

- —purchase order
- —delivery
- —quality test
- —acceptance or rejection
- —incorporation into stock
- —bill
- —payment (or, alternatively, removal if rejected).

An undue delay at any stage is signalled by preparing an exception list of requisitions overdue for purchase order, overdue deliveries (or early deliveries, which could lead to goods being paid for long before they are needed) and rejected items not taken back by the supplier. Various analyses of the usage and stocks held of raw and packing materials are also prepared, for example :

- —stocks in excess of budget
- —ratio of inventory to usage
- —ranking of stocks in order of value
- —slow moving stocks.

Most of these are exception reports, including only items requiring action.

For all expensive items, the quantity needed is calculated directly from the production schedule by the following method. The schedule (the preparation of which is described later) is drawn from the data bank, and by reference to a master file of the make up of each item, it is broken down to material requirements for each product and pack. Common items are aggregated, and the resulting summary is compared with the raw material file which contains records of items available in stock and on order, so as to determine where additional orders should be placed and for what quantity. The necessary requisitions are then prepared and printed out by the computer.

Production Scheduling

It is in the preparation of the production schedule that the widest use is made of the data bank, because in deciding how much of each product to make, it is necessary to consider sales forecasts, stock position of packed stock, and availability of raw materials. The production schedule, covering three months at a time, is prepared three weeks in advance. The stock position at the start of the quarter is, therefore, a calculation from the last known stocks, plus expected production, less expected sales.

To make the procedure easier to follow, assume that we are preparing in early March a production schedule for the quarter April to June. The following data, relating to each product pack, will be drawn from the data bank for use in the calculations:

MASTER DATA

- — economic batch sizes of preparation of bulk
- — quantity of bulk needed for each pack
- — total quantity of packed stock which should be available at the start of each month
- — raw materials required to make the bulk stock
- — expected and budgetted contract (i.e. non-standard) sales for April to June.

FORECASTS

- — sales forecast for January-March, April-June and July-September.

CURRENT DATA

- — All-India stock position on 1st March
- — expected production in March

This information is collated together and from it is prepared a tentative manufacturing schedule of the number of batches of each bulk product. The first stage in this programme is to calculate for each product pack the expected all-India stocks at the start of the quarter, which is equal to the stocks on 1st March, plus expected production in March, less expected sales in March. This figure is compared with the desired level, in order to determine the shortage or excess stock at that point of time. The average sales estimate for the next six months is then calculated, and from this is determined the amount which should be produced in each quarter in order to bring stocks to the desired level at the end of six months. The total requirement for the quarter is split into a monthly requirement, to which is added known and expected contract sales (i.e. large volume sales to special customers) in each month. Requirements of the various pack sizes of each product are aggregated, and finally the total requirement is converted into the number of economic size batches.

Cases where priority should be given to an item and where stocks are dangerously high or low are indicated.

When all the data are available in the data bank (the last items to arrive are the stock reports from the depots throughout India), the calculation and printing of the schedule takes less than 15 minutes. The report is called the tentative manufacturing schedule, because it still requires two further checks before being finalised. It is broken down to raw material requirements, in the way already described, and compared with material availability. It is also broken down to production departments and compared with manufacturing capacity. This highlights problems which could be caused by shortage of raw material or of production capacity, and management then decide how these can be overcome, or how the schedules should be amended. From these decisions a final schedule is prepared and is in turn fed back into the data bank, to be itself used as a link back to raw material purchase (already described) and to distribution of packed stock, which is our next topic.

Distribution Control

One of the uses of the computer will be to control the distribution of stock to the Company's depots throughout the country. Here our objective is naturally to keep stocks to the minimum without running the risk of going out of stock. No central buffer stock is kept: stocks are distributed to the depots as soon as packing is complete.

The production schedule itself is based on stock requirements so that if the estimates of sales were correct and no difficulties in production arose, then the amount produced would exactly meet the stock required and distribution would need only simple calculations. Such ideal circumstances, however, cannot be relied on, but reference to data available in the data bank enables the best allocation of the stock to be determined.

The calculation is made in the last few days of the month for the following month, and the following facts relating to each product packs are required :

- stock at each depot on the first day of current month
- sales for the month to date
- estimated sales for the remaining days of the month
- despatches in the current month
- sales estimates for the following month
- desired stock factor, represented as a number of month's stock at estimated sales rate
- stock available for distribution in the current month.

From these facts a schedule is prepared showing the quantities of each product pack to be distributed to each depot. Urgent items are indicated, and the quantities are automatically divided into optimum size loads.

Essential Features of the System

This description of the procedures has been very much simplified: many complications and exceptional conditions have been omitted in order to clarify the explanation, which is especially designed to show the essential features of a data bank system which are that :

- each item is fed into the system at one point only
- all information is available for any purpose.

In addition to the procedures described above, the computer will also be used for others; for example, the preparation and maintenance of the share register for the forthcoming public share issue.

We still have a long way to go before the total system described above is fully implemented. So far, only the sales procedures and the production scheduling are running; the remainder together with some unrelated applications) are in various stages of planning. However, the total framework has been clearly defined, and we expect to make steady progress towards completion of the project, in line with the plans which have been made and announced for a considerable expansion of the Company, following its change of status from a Private to a Public Company. ●●●

The Computerised Jumbo Jet

Most dramatic of all the innovations is the extensive use of computers to aid flight crews. At the New York airport, for example, the captain will be given a computerised flight plan for the entire 3,546 mile journey to London, telling him what to expect: everything from wings, weather and alternative routes to fuel consumption and arrival time.

In flight, other computers aboard the plane will correlate and monitor from the autopilot and the three inertial navigation systems such data as air speed, power settings, fuel flow, engine temperature, latitude and longitude.

Arriving at London, the pilot may elect to land automatically. His computers will lock to the aerodrome's instrument landing system, line up the huge 747 with the runway and bring it safely to earth.

"The whole integrated system will relieve us of a lot of duties and distractions, greately simplifying flying and improving safety. "The Project's Chief test pilot, 44-year-old Jack Waddell, explained to me. "I expect to flying the 747 with one hand—like power steering."

With similar advanced technology, Boeing engineers have built reassuring safety features into every system of the infinitely complicated aircraft. For example, four independent hydraulic sub-systems supply power for flight controls, steering, brakes and wing flaps. If one fails, another takes over.

The jet also has dual autopilots, and backing-up systems for rudder, elevators, ailerons, cabin pressurisation and navigational aids. And, with the aid of automatically inflated airslides accomodating passengers side by side, the huge 747 can, in an emergency landing, be emptied in 90 seconds.

Simulating actual flight in the testing laboratory, engineers stall the great jet, dive and pull it to a breaking load, fly it through severe turbulence.

Training in EDP

James F Donohue*

The author has described how, as he puts it, "Americans Helped People of India Master Computers". It is actually the Training Programme, run by Honeywell experts, in connection with their installation of computers for the Government of India.

THE PEOPLE OF INDIA ARE QUICKLY TAKING over their own computer age, with help from an American computer manufacturer.

The Government of India announced in 1966 that it was constructing a $ 7-million-dollar computer network with 10 Honeywell Model 400 computer systems.

Early in 1967, a team of Americans from Honeywell's Electronic Data Processing Division moved into the Department of Statistics in New Delhi and began a series of classes aimed at training the programmers and engineers to run that network.

The course already has produced approximately 200 programmers and 40 engineers. And it is continuing, producing graduates at the rate of about 100 a year.

Honeywell's part gradually is being phased out and will end completely in October 1969, when the last American will return home.

Right now the Americans act solely as consultants to a course otherwise run by Indians.

High-Pressure Course

The Government of India will use the computers in several agencies including Army Research and Development, the Department of Statistics and the Reserve Bank.

Four of the computers are slated for the Department of Statistics at New Delhi. Three are installed currently.

The seven Americans from Honeywell EDP used high-pressure teaching methods: two quizzes and one examination a week plus a final examination at the end of each segment of the course.

"Many of the students told us they had never worked so hard in all their lives," recalled Terry Gallagher, one of the American teachers.

The course lasted 20 weeks, six days a week. Instruction was in English.

Students came from all parts of India, some as far as 1,500 miles. Others commuted from their homes in New Delhi. One man bicycled 22 miles round-trip a day.

The Indians quickly adopted the American teaching techniques. When the second course began—this time with Indians as instructors—the pattern of hard work and pressure was established. It was not changed.

"If anything, the Indian instructors were much more strict than we had been", Gallagher said.

*Chief, Honeywell Electronic Data Processing, Mass. USA

Gallagher recently returned to Honeywell EDP in Wellesley Hills. Only three Americans remain in New Delhi.

"We returned with the very highest regard for the people of India," Gallagher said. "They applied themselves to a very difficult task and acquitted themselves very well. Many of these men spent 11 or 12 hours a day at their books."

The graduates will man the 10 computers once the installation of the network is complete.

Besides the four computers in New Delhi, the Government of India will have one at the Reserve Bank and one at the Atomic Energy Commission, both in Bombay.

Other computers will be at the Indian Statistical Institute in Calcutta, Hindustan Aeronautics Ltd. in Bangalore, Army Research and Development in Poona and at the Oil and Natural Gas Commission in Dehra Dun. ●●●

From Unit Record Machines to the Computer

Sarwottam S Thakur*

It is nearly seven years now since the first computer was installed in India for processing Commercial Applications. A considerable amount of experience, knowledge, and insight have been gained during this period, but not sufficient for commercial organisations to go in for an Electronic Computer directly, without first experimenting with what are commonly called Unit Record Machines. Thus most commercial computers used in India today are the outcome of a growth from the Unit Record Machines. This change-over is always coupled with its own inherent difficulties, far more complicated than a layman can think of. The following is, therefore, presented as a case-study of such a change-over from Unit Record Machines to a Computer. It is hoped that this study may prove to be of some help to other organisations contemplating such changes.

OUR ORGANISATION, THE BOMBAY SUBURBAN Electric Supply Ltd., is an electricity distribution Company. We purchase electricity in bulk from the Tata-Koyna grid and distribute it throughout the area of the suburbs of Greater Bombay to about 210,000 consumers. There is no generation of Electricity involved, but over 450 sub-stations are maintained, spread over the area of supply. The Company has about 1500 persons on its payroll.

With the rapid development of the suburbs of Bombay during the last few years, the number of consumers started multiplying so fast that a decision was taken to install mechanised accounting machines (Unit Record Machines), and these were installed in February 1962. The set finally consisted of the following IBM make machines. Seven type 24 punches, three type 56 verifiers, two type 77 collators, three type 82 sorters, one type 548 interpreter, three type 513 and 514 reproducers, two type 602 calculating punches, and six type 402 accounting machines. The applications mechanised were preparation of energy bills to non-industrial consumers, which accounted for more than 90% of the machine utilisation, and some Stores Accounting. The 'Adrema' section embossed the addresses on about 75% of the bills prepared on these machines, while addresses of the remaining 25% were printed by the type 402 accounting machines. Bills pertaining to Industrial Consumers were still prepared manually and staff was also employed for checking and control of the machine-prepared output. This was very necessary, as wrong billing was quite common due to what the manufacturers called "Type Bar Failure". (They could diagnose the fault easily—it was chronic and incurable).

The machines were on a monthly rental amounting to about Rs 35,000 a month. The department employed about 30 persons for

*Bombay Suburban Electric Co., Bombay. The Author is grateful to the Management of Bombay Suburban Electric Supply Ltd. for permission to reproduce official statistics.

machine operation. The expenses on punch cards amounted to Rs 10,000 per month.

We had over a dozen payment collection centres where the consumers made payment towards their energy bills. Any consumer is allowed to pay at any centre. We also have provision for accepting advance payments against future bills. In some cases, part payment is also accepted. With the installation of the accounting machines as detailed above, we were able to prepare a consumer's energy bill in about a fortnight's time from the date his electricity consumption meter was read. There used to be a gap of about one week between the day the bills were prepared and the day when payments made against earlier bills were incorporated in these bills. This invariably resulted in the bills showing arrears and the consequent angry letters from consumers on some occasions.

After the Unit Record System worked, or, rather, attempted to work for about a couple of years, it was felt that an improvement in the quality and speed of mechanised billing was necessary. Mistakes like "Type Bar Failure" and "Punching Failure" (but remember, never a "machine failure") necessitated extensive manual checking and also a considerable amount of correspondence resulting from consumer complaints. Hence a decision was taken to install an electronic computer, and as a result a Type IBM 1401 computer was ordered.

Whatever anyone may say, I know for certain that a computer is a rather inexpensive machine. Unfortunately it does not work properly and usefully unless you couple it with other machines which are quite expensive. Then there are certain things called "special features". We use the IBM 1401 computer, which was considered the world's largest selling computer. Believe me, on a monthly rental basis you have to pay about Rs 2500 extra every month to have the "multiply-divide special feature" on this computer. Personally I do feel it should be embarrassing for the manufacturers to consider multiply-divide as a Special Feature on a computer, but then how could they supply a cheap computer unless all essential things are considered as extra? Our projected main job of billing involved a multiplication (units of electricity consumed multiplied by rate per unit) at every stage. So naturally, the multiply-divide feature looked like a **must**. But we calculated that at Rs 2500/- a month, this feature would multiply our expenses and thought that it would positively be cheaper to carry out the multiplications by successive additions. We have had no occasion to regret our decision. (We are now contemplating adding this feature, from some other consideration.)

Planning for the computer installation started over a year in advance. Programmers were selected and deputed for training in programming in February 1966. They started working from April 1966 after their initial training was over. The billing system followed on the Unit Record Machines was quite thorough and had very rigorous controls. However, the unit record machines have limitations of their own (even the computer has), and these were naturally reflected in the billing system. Hence the first task assigned to the programmers after their training, was to evolve a billing system that would fully utilise the capabilities of the computer and thus would be more comprehensive. The programmers, with the help and guidance of the manufacturer's representative, spent the first two months in evolving this new billing system. Two of the three programmers were internal promotions from the existing Unit Record department and were quite familiar with the working and intricacies of the billing department. Regular programming work started from the end of May 1966.

The staff working now was only a nucleus of the full-fledged computer department that was shaping up, but no attempt was made to employ more personnel. It was felt that, if, due to the multi-directional working necessary in the initial stages of the setting up of a new department, a feeling of over-employment crept in, then it would be extremely difficult to do away with the resulting Parkinsonian inefficiency at a later date. This explains why it was the programmers who were made to spend the first couple of months on Systems Designs.

The first few programmes were ready by the end of June 1966 and the programmers had gained enough confidence to work without help from the manufacturers. This was considered an ideal time to start working independently of any help or assistance from the manufacturers, for, after all, such help, irrespective of all promises, is unreliable.

Mechanised accounting like billing, always involves what is commonly termed as a "parallel-run". This means that the existing manual work is continued as it is, and the first outputs from the mechanised systems are checked against these regular outputs for some time, before the manual working is discontinued. This is the most troublesome aspect from the personnel-relations point of view. Usually the norms of working get adjusted and the existing staff is just enough to look to the manual work. Staff is required to collect data for mechanisation, and then also to check the two parallel outputs. This is coupled with the natural human resistance to any changes from the existing procedures. It was, therefore, decided to take up Industrial Consumer's billing as the first application on the computer. This application was not yet mechanised on the unit record machines. It was a small-volume large-turnover job, and data collection was, therefore, no major problem. The programmers themselves helped in collection and checking of some data. The computer was still a long way off. So, the pre-installation free-testing time allowed by the manufacturers on another similar computer was partly utilised for parallel-run-test of this application. When the parallel runs were found to be successful, three of the six clerks were freed from the rigours of involved and complicated calculations. It served as a base for confidence that was needed in the computer department, as well as made some manpower available for help in computerising the next applications. No attempt whatsoever was made at this stage to change the existing procedures; for, it is comparatively easy to check parallel-run-outputs when both the procedures are more or less the same. It also solves a lot of staff problem considered above. This approach was evolved by us and was very extensively followed for many other applications. It paved the way to the successful working of the department and also helped in a better utilisation of the expensive computer, rather than keeping it idle till new procedures were found workable.

The computer was by now ready to arrive and was installed in early February 1967. We had kept our promises ready for the arrival of the computer. A room was reserved for the use of the maintenance engineer as suggested by the manufacturers. (I must admit one thing here. When the suggestion of a room for their exclusive use came up, I did look to the proposal with suspicion. Why all this fuss for "maintaining" a computer? Now, looking back to all the time the maintenance engineer spent on our machine during the last year, I can say that the demand for a room was not high-handedness on the part of the manufacturers. It showed their modesty. They should have asked for living quarters for their engineer.)

The installation of a computer is a rather complex matter. Many diverse factors are involved (and get involved) in it. Our computer was delivered to our premises right on the promised date, and cable laying and testing started immediately. The Central Air Conditioning was already in operation, and we had all plans ready for the inauguration a week later. The day before the first scheduled inauguration, I wanted to take a final check on the computer working, and the machine felt so shy that it refused to work properly. To our great embarrassment, the computer went into a loop, (well, is that not the present national trend?), and repeated this performance for our postponed inauguration and even for the re-postponed inauguration. It was clear that the machine had developed a stage fright.

We started wondering whether, to meet the delivery schedule, the manufacturers had sent out the computer without the usual checks and tests. Finally, the engineer installing the computer showed us some rags and announced that some rats (he could not use the computer yet to calculate their exact number) had eaten up some cables inside the machine. This "special feature" was very definitely not ordered by us. The manufacturers were equally emphatic that the computer was imported in a knocked down status, and as per their bill of lading, no rats were imported. There was no question of smuggling, either. Then we heard that at another installation in Bombay, rats were involved in an identical incident. The matter ended there and the mouse that roared quietened down.

The computer rental starts as soon as it is supposed to be installed. Eeven without many really special features, our computer has a minimum monthly rent of over Rs. 41,000 (excluding the rental for punches and verifiers). Hence now our major problem was proper utilisation of the expensive computer. By the way, besides the monthly rental, there is also a "small" one-time installation charge. God alone (perhaps) knows what this installation charge is about. For our computer, this "small" charge amounted to over Rs. 134,000.

We could not discontinue with our existing billing, which accounted for most of the time on our Unit Record Machines, till we were sure of the success of the parallel runs of the new billing system we had evolved for working on the computer. This meant that we would be forced to continue to use all our Unit Record Machines for at least a couple of months after we get the computer. But we had a large number of these machines, and keeping them would have meant extra expenses running into at least a lakh of rupees. Hence a month before the computer arrived, we concentrated on writing simple programmes which would do some simple jobs like printing, sorting, reproducing, collating, etc., exactly as they were being carried out on our Unit Record Machines. In short, we decided to use the computer as a faster Unit Record Machine in the beginning and to have both outputs for the parallel runs from the computer. This helped us to accomplish two things which, we feel, we were the only organisation in India to accomplish at that time.

The first is that the day the computer was installed, we returned more than half the unit record machines, thus cutting down the machine rental considerably. We returned all the remaining collating, reproducing, accounting and calculating machines in a couple of weeks from then; and the only unit record machines we now have are the punches and verifiers, one Type 82 Sorter and one Type 548 interpreter. (It is our experience that, however expensive computer time may be, keeping the unit record machines for odd one-time jobs is likely to be much more expensive. Unless one has practically full-time work on the accounting machines, it is not worth the money to keep these machines once you have a computer. The computer could be scheduled and gainfully employed to do the relevant one-time jobs).

The second thing we accomplished is regarding free testing time. Ours is a computer taken on monthly rental. There is a minimum monthly rental we have to pay to the manufacturers for usage of the computer up to a certain number of hours. There is extra rental for excess usage. However if the computer is used for programme-testing during the first 30 days of its installation, then this testing time is not chargeable even if the machine utilisation exceeds the obligatory usage specified. We exceeded the stipulated usage right in the first 30 days and availed of the free testing time.

With parallel runs reasonably satisfactory, we switched over to the computerised billing procedures from 1st April 1967. The procedures were all right, but we wanted a very thorough checking on the programmes and output. The switchover immediately released nine clerks who were posting customers' payments, since this was now taken over by the computer. We now had people for checking as well as for any other related work that had cropped up. It is a fact that introduction of computers releases staff, but not to the extent a layman fears. Computerisation does bring in its own checks and counter-checks for input and output, which have to be manned.

It is over a year since our computer was installed, but we still prefer taking up a new job on an 'as-is' basis and only then look to its systems and procedures aspect. The method has worked very successfully so far, has allowed us to take care of a number of big and small jobs, and has also let us use the computer extensively, besides eliminating the staff problem or the parallel runs.

Now to the economic front: On the direct costs aspect, the computer costs us about Rs. 9000/- more per month on rental (we have all along been using it much more than the stipulated minimum time) compared to the earlier unit record machines. But then, our expenses on the usage of the punch cards alone have come down by about Rs. 7000 a month (and this amount includes the cost of all cards used for all the different jobs that we are processing now). The saving was achieved by re-using the cards as well as by multiple-record designing of the cards instead of the unit-record design which was necessary on the Unit Record Machines. We are printing bills of two customers simultaneously, thus reducing the number of bill forms to half the number required before, thougn the bill form size has correspondingly increased. Staff overtime has considerably reduced, and some credit for this goes to the installation of the computer. We have not resorted to any retrenchment whatsoever, but on the contrary have opened up avenues of promotion to our staff in the fields of programming, computer operating, etc. A company which is dynamic enough to go in for a computer (I am speaking of Indian conditions) can always diversify its activities and expand to absorb whatever staff is rendered surplus by the introduction of the computer. In all probability such a diversification might not have been possible but for the introduction of the computer.

Yes, how could we escape? We did have some anti-automation staff problems in the beginning. In fact, during our initial pre-installation programme testing, one of the programmers had to use the computer from 1-00 A.M. to 3-00 A.M. To relieve the strain, he let the computer print the message "Emergency Computer Run *Zindabad*". Next day our staff union raised a serious objection to our using the word *Zindabad* for a computer, stating that it was their official policy to be against the computer and usage of some complimentary phrases for the computer may cause friction. Fortunately, such frictions are all over and we are now a united family again.

We have completely computerised during the first year, all electricity consumption billing which is our major application with over 10,000 bills a day. We can now print the bills two days after the electricity meters are read, as compared to more than a fortnight before; and the payment gap has also been reduced to the minimum of one day from the one week before. Applications of Stores Accounting and Inventory, Payroll Accounts, Interest Calculations, etc. are also computerised and with two shifts working, we still have time to rent the computer to outside users for their production jobs and even for the time-consuming programme testing jobs. ●●●

WHY QUESTION ANYTHING?

No one wants to fight, including those in command—one assumes somebody is in command—who transmit their orders from an area outside reality . . . A computer error promotes Private Major to Major Major Major, who then cares about nothing except the retention of his rank. Naturally, any of a thousand ridiculous orders also could be a computer error—but why question anything?

—SPAN, Nov. 1968

Evolution of Britain's Computer Industry

Sir Leon Bagrit*

One exciting aspect of computers is the rapid pace at which the industry, in Britain and elsewhere, has grown in its comparatively short history.

This growth has left in its train a host of misconceptions about automation. Lay discussion of computers most often revolves around office automation, such as payroll, accounting, and stock control.

Although this popular conception is understandable in view of the publicity attracted by this initial and early field of computer automation activity, it suggests that we had better look at the evolution of the British computer industry from the point of view of the less prominent but far more significant applications of computers in the ever-widening area of human activity.

COMPUTER PEOPLE ARE FREQUENTLY ASKED to define activities in which computers could be employed. The short, but admittedly unhelpful answer is "practically anything", including cases where computers lose their identities when incorporated into automatic systems.

Examples of this are traffic control schemes, such as that in Munich and those planned for Barcelona and Madrid, in which a computer anonymously controls signal lights to suit traffic conditions, and in flight simulators where the complex responses to the actions of trainee aircrew at the controls are a precise reproduction by the computer of the actual flight situation. An increasing number of merchant vessels are crossing the oceans, safely and efficiently, with computer nerve centres controlling everything on board from ships' stores to boiler pressures.

Computer-aided typesetting in Britain has progressed to the point where the compositor's keyboard operation is automatically converted by a computer into a coded, punched-paper tape image of the final printed page for feeding direct to a typecasting machine.

In medicine, computers are automatically analysing blood samples; and in one Scottish hospital, neurological patients may soon be "plugged-in" to a computer which, by analysing the electrical signals in the brain, can assist diagnosis of neurological diseases.

Control of Processes

Moving across industry we find computers controlling manufacturing processes such as chemical plants and paper mills and assisting in design offices of every type and size of engineering company. The gas, water, electricity and transport utilities of Britain have been quick to adopt computer techniques to solve complex conservation, forecasting and distribution problems inherent in maintaining high standards of amenity for a concentrated community.

Much of the research carried on by universities, industry and government establishments is frequently entirely dependent upon the

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ability of computers to perform vast numbers of complex mathematical calculations at lightning speed in order to analyse masses of research data and to monitor or control experiments.

In defence, it is fair to say that if the right computers had not been available at the right time in the right quantities the logistical, communication and technical requirements of our modern western defence systems could not have been met.

This summary, covering only a fraction of current automation activity in Britain, will serve to illustrate that the expanding employment of computers in the service of man is limited only by the horizon of man's own ingenuity and vision.

First Models

The history of Britain's computer industry goes back to 1946 when the University of Manchester designed a laboratory model shortly after the development of ENIAC in the United States of America. Also about then, Elliott Brothers (later called Elliott-Automation), started work on the Elliott 150 Series which were the first "on-line" computers designed to control events while they were actually happening. The Manchester machine and its progeny EDSAC (University of Cambridge) and ACE (National Physical Laboratory) were designed by scientists for scientists to use as calculating machines in research work.

The emergence of an embryo computer industry became apparent in the early 1950's when the first commercially built machines were marketted by the manufacturers. Computers of this vintage decade include the Ferranti Mark I, English Electric Deuce, Leo Mark I and the Elliott 400 Series.

During the 1950s, the Age of Automation really dawned, adding impetus to the development, manufacture, marketing and applications of digital computers. It was in the early years of this decade that business management realised the tremendous potential of computers for dealing with administrative tasks, which in later years led to the acceptance of the computer as a working tool in management techniques.

The size and prestige value of the business market was to be quickly exploited by an increasing number of manufacturers and electronic data processing (EDP) became the fastest growth sector of the British computer industry.

Birth of "Leo"

The pioneering spirit of the early British computer manufacturers is admirably demonstrated by the circumstances of the founding of Leo computers. In the early 1950s, J Lyons and Company Ltd., the well known firm of caterers, decided to employ computer techniques to relieve their growing administrative burden. In the absence of suitable EDP equipment available from existing manufacturers at that time, Lyons teamed up with scientists from Cambridge University to build their own computer.

This was christened "LEO", Lyons Electronic Office, and on the basis of its success Leo computers was formed to market the system. Several marks of Leo computers were subsequently supplied in considerable numbers throughout the world.

It is characteristic of the pace of computer technology that now, only twelve years later, the first Leo computer, with other first generation machines, is a curiosity in the Science Museum in London.

However, most computer developments at this time stemmed from the new computer divisions of established companies. These included Elliott-Automation, English Electric, Ferranti, Associated Electrical Industries (AEI) and Electric and Musical Industries (EMI). An important new company called International Computers and Tabulators (ICT) was formed by a merger of two competing punched-card system manufacturers – Power-Samas and Hollerith.

Specialist Approaches

As each of these participating computer manufacturers pursued developments appropriate to its resources and expertise, three distinct types of computer application emerged, each requiring a specialist approach.

Firstly, the scientist required a computer capable of handling complex calculations but few input and output devices. Because of his education and training he could very quickly be taught how to programme and operate his computer.

In contrast, the business-data processing user required a wide variety of input and output devices in order to manipulate large quantities of business information but because of his ignorance of computer theory he required comprehensive training facilities and ready-made programming routines.

The third trend of development was "on-line" computer control of industrial processes which was stimulated by the desire of the large industrial organisations to press forward with plant automation. Because of the very complex problems involved in, say, the automatic control of a blast furance and the specialist knowledge of the industry which was necessary, process control systems were nearly always designed by a joint computer-manufacturer/customer team.

Since the 1950s the British computer industry has undergone considerable rationalisation to the point where today two major groups, English Electric and ICT, dominate the field. The computer interests of EMI and the electronic data processing activities of Ferranti were absorbed into ICT and those of Marconi and Leo into English Electric. More recently, Elliott-Automation also became part of the English Electric Company.

Capital Outlay

This process is basically similar to that of any progressive industry reacting to changes in its operating climate. Very large sums of money are now required to support the rapid rate of technical innovation and the burden is aggravated by the long-term return on capital invested.

Unlike most capital-goods industries, the "hardware" is only part of the product. In the computer business, the programming systems, or "software", and training facilities can spell success or failure for a new installation, and may account for 50 per cent of the development costs.

The benefits of operating in large units are obvious -- especially in countering the fierce competition from powerful USA corporations backed by immense government orders.

Another compelling reason for the regrouping of the British industry was to bring together complementary skills and experience under common direction. The strength of the present structures lies in their capability to handle the largest and most complex systems backed by adequate financial and technical resources.

In technological development, the British and USA computer industries ha e followed the same pattern – the first generation equipment (thermionic valve), second generation (transistor) and third generation (micro-electronics) designs. In these developments, Britain has secured a high reputation for technical innovation and specific expertise in many applications. Radar surveillance systems, head-up navigational displays and flight simulators are typical examples.

Far-Sighted Policy

When in 1964 English Electric, one of the leading British groups, boldly decided that its new system 4 range of computers would "leapfrog" existing technology and would be constructed entirely of microcircuits, there was international speculation about the commercial wisdom of such an advanced technical venture. Events have shown this to have been a far-sighted policy and a large order book shows the confidence the market has in this advanced technology.

The British Government is considering prosposals for designs of very large computers. These could be many times more powerful than the large Atlas systems currently installed in the Universities of London, Cambridge and Manchester. If installed in key applications, they would considerably boost the country's research and development effectiveness. They might be used also for large data processing activities, and as the basis for multi-access systems.

There are two schools of thought about multi-access work. One body of opinion favours the concept of a central computer, or group of smaller computers, linked to a large number of subscribing users via data links and local data terminals. This would give users direct access to the central complex only, with no local computing facilities.

The alternative proposal is for a satellite system comprising a large central computer, or group of computers, linked to small, low-cost computers on the user's premises. The system would be so designed that when the local computer reaches the limit of its capability, it automatically calls upon the central computer to satisfy the demands made upon it.

"Slide Rule" Service

The advantage claimed for this concept is that the limited occasions, when additional computing capacity is needed, do not invalidate the obvious advantage of having your own computer to hand. This is especially true for the scientist and designer who want a "slide rule" type of service to assist a train of thought. A reinforcement for this argument is the constant improvement in capability, size, and cost of small computers. The probable final outcome may be a hybrid of the two concepts.

It is generally recognised that the rate of computer installations in the USA is flattening off and that the immediate growth market lies in Europe, including the eastern bloc.

The British home market shows an overall 30 per cent compound rate of growth annually between 1960 and 1966. The tabulated figures below which include exports, are quoted from the British Central Statistical Office's Monthly Digest of Statistics.

DELIVERIES OF BRITISH COMPUTERS

(Value: £ Millions)

Year	1959	1960	1961	1962	1963	1964	1965	1966
Home	5.6	5.9	9.6	10.9	21.3	39.2	28.2	40.2
Export	2.1	2.3	1.3	2.5	3.5	5.0	6.4	20.7
Total	7.7	8.2	10.9	13.4	24.8	44.2	34.6	60.9

The table reveals that Britain's computer industry, already the largest national computer industry outside the U.S.A., is rapidly developing into an international one. Inevitably, this trend will continue and will accelerate as Britain's economic ties with Europe become closer. Many British companies already have some kind of association with European organisations as recently advocated by the British Prime Minister, Mr. Harold Wilson, and closer cooperation between the British and European automation industries is desirable and practicable.

A Computer can be fed with the symbols it is equipped to digest and its output is in terms of them: the machine that can in an instant calculate the speed and distance of the remotest nebula, can it in its answer, convey the immensity and the awe?

—*Ronimund Von Bissing*

Computers That Pick Out Their Own Programmes

Norman Jenkins*

A COMPUTER STANDING ALONE IS A BRAIN without eyes or ears to provide information and instructions and without a voice to speak conclusions.

The software that goes with computers stands between the simple machine and the human brain with eyes and ears that determine what calculations shall be made and what use shall be made of the answers to the sums done. Because **the computer is a seeming paradox,** a clumsy machine that goes a long way round to work far faster — and for longer — than the human brain, there has to be a programme to spell out what shall be done and in what sequence.

Like Encyclopaedia

Figures rather than words — **figures that mean words** — once the basic programme has been written, can be used as would any encyclopaedia, building up messages and instructions for computers, first in one sequence and then in any other.

Such is the store of programme material now existing in Britain's computer industry, gained from automating a large number of diverse industries, engineering production lines and accountancy, clerical and commercial systems, that almost every word, every type of calculation and engineering process requirements, exists somewhere.

Programme compilation has now entered the field of automatic production. The making of a programme to suit one or a number of overall functions of an industrial or commercial enterprise has progressed to the stage where it is no longer essential — although in many cases desirable — for either special staff to be recruited or members of the management to take time off to attend complex instruction in computer operation.

It can be assumed that any of the leading British computer manufacturers now knows enough about the production of iron and steel to produce a programme for plant integration and the output of billets, rolled and drawn sections, coiled strip or merchant sizes. More simply, there can be full automation of soaking pits, rolling mill, arc furnaces or cut-up line as separate functions.

Customer Handling

The integration of process runs from customer orders to routing deliveries. The same applies to oil refinery operation, to the production of complex chemical products, conventional and nuclear power stations, motor car and domestic equipment parts manufacture—

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as problems in automated production, online and real-time computer control. Equally, every aspect of accountancy, customer handling and management data provision can be coped with.

In fact, it was not until the use of computer became really widespread that industry realised, probably for the first time, that so many and diverse commercial undertakings shared such a large number of individual operations. Once these operations could be separated from the context of their overall endeavours they could be tackled in their essential individual simplicity.

This is precisely the position in which the British computer industry finds itself. So much has been done that what now remains to be done is automatic, following the many examples that have been worked out, developed and proved to function thoroughly well over years of ultra-high speed working.

Automatic System

In the engineering and process fields, Elliott Automation, now part of the English Electric group, have developed an effective automatic programming system known as APEX. Simplifying the work of any plant engineer, APEX entails no more than filling in answers to a questionnaire. This specifies in plain language what the plant, rather than the control computer, has to do. Automatic programme compilation does the rest in conjunction with, say an ARCH computer and the CUDOS (Continuously Updated Dynamic Optimising Systems).

The first use of CUDOS was at the Warren Spring Laboratory of the Ministry of Technology with an ARCH 1000 computer on a pilot-scale water gas shift reactor. Results have shown that the feedback of operational data, revising overall systems instruction as production cycles succeeded one another, produced **a plant performan e closer than 0.1 per cent of that desired.** This also showed that there had been continuous compensation for unpredictable process variables.

A.E.I. Electronics have programme preparation aids in the form of Process Assembler Language, a series of code statements which in turn select the required functions of FORTRAN mathematics and compilers. Compilers for the A.E.I. CON/PAL 4000 computer go a step beyond the PAL programme since they enable the use of plain language statements and symbols, FORTRAN converting these to machine instructions.

The FERRANTI equivalent has organiser or executive programmes, using other programmes in the right sequence in exactly the same way but this company has taken the control of computers and communication much further.

Shown on Tube

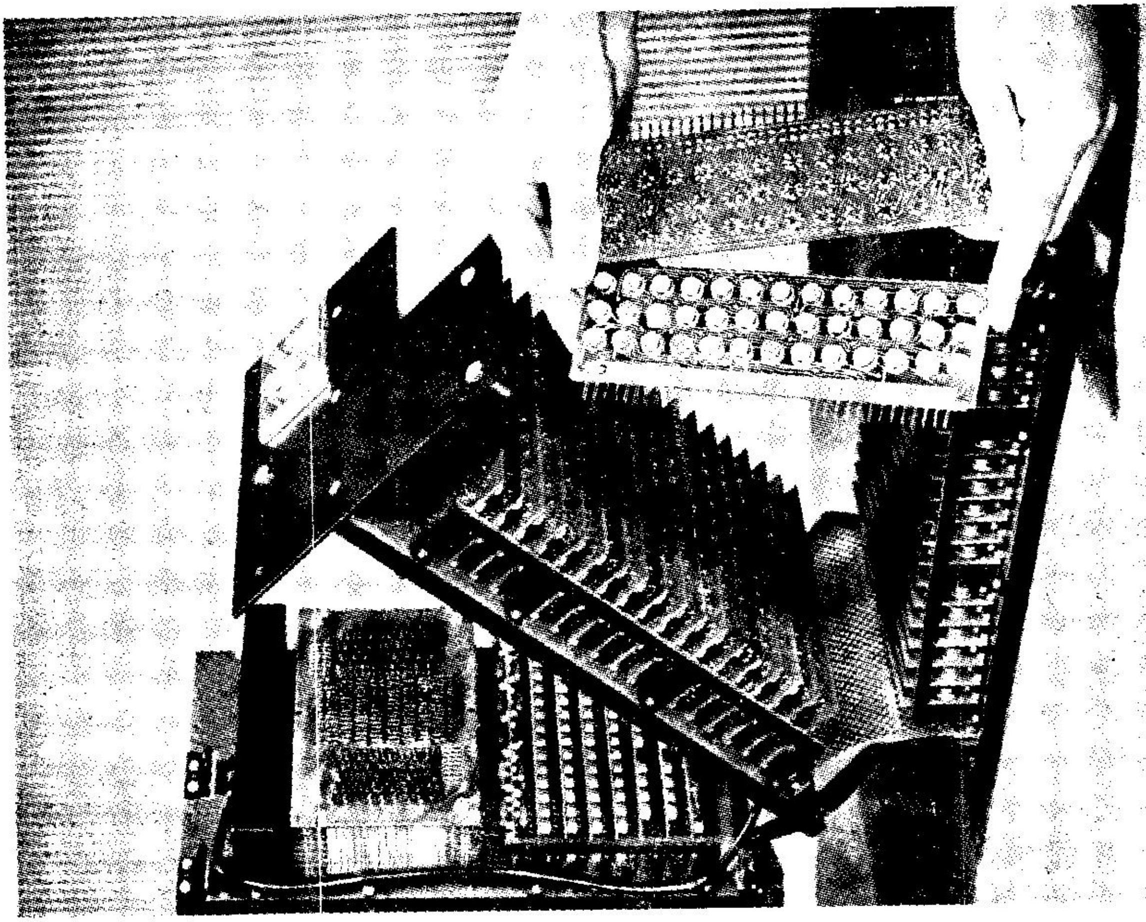
The ARGUS system is essentially a display one, showing comupter-generated information in the form of normal characters, figures and built-up words presented on cathode ray tubes. The same method of shape generation is used for diagrams, symbols and sketches.

Data insertion is carried out by using any or all of five units — an alpha/numeric keyboard with 58 keys; a tracker ball; joystick, sketch units; and normal software packages giving programme routines.

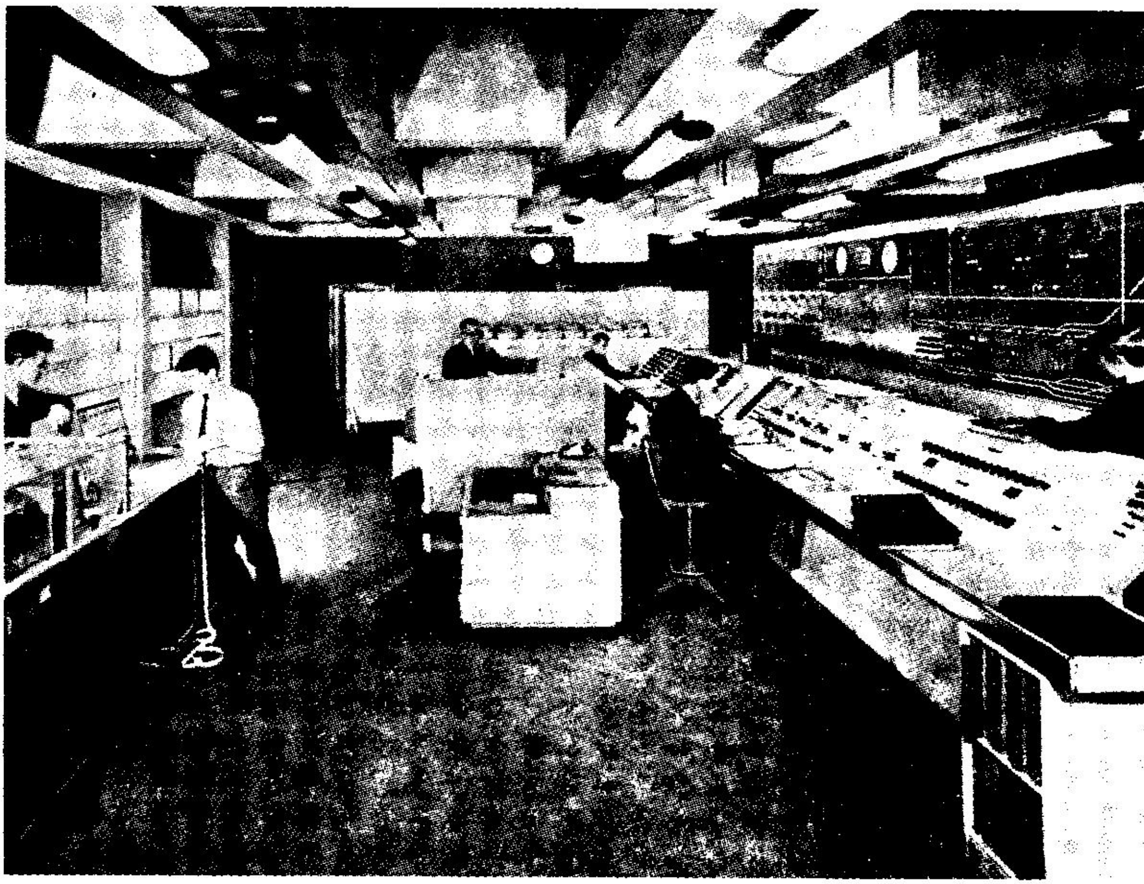
Automatic programming — "Conversational Graphics" as this method of computer communication is known — requires a different attitude to the use of computers. It is one thing to provide a computer with means of displaying information in directly readable text on a television screen complete with symbols and drawings ; it is entirely another to use this facility for evaluating information and obtaining structural design data direct from diagramatic loadings.

These are **time-saving aids for the expert, not interpretation of language for the ignorant.**

Plessey Automation, well established in British component manufacture for the industry and in the development of both computer and usage techniques for the armed services and civil aviation and navigational control, have



Micro-miniature components and circuit board assembly for the Ferranti Argus 400 computer. This system shows computer-generated information in the form of normal characters, figures and built-up words presented on Cathode Ray tubes



This is the arc furnace control room in the great steel works of Steel, Peech & Tozer at Sheffield, N. England, with Argus 100 computer installation.

recently taken new steps to make this exprience available to industry.

Eliminating Failures

The new generation of Plessey computers known as the XL12 went into production in March 1968. Aiming at a section of industry and commerce which has not previously contemplated such aids, Plessey have determined to eliminate failure in the electro-mechanical peripherals, using knowledge gained, in particular, in the field of air traffic control.

This, like the Ferranti development, is concentrated on cathode ray tube data display and a type of interface which, by a technique known as "**touchwire", enables a comparatively inexperienced operator to communicate directly with the computer**. For intimate knowledge of high and low level programmes, a discipline involving a basically simple set of phrases is the only requirement.

Plessey Automation see the development of XL12 essentially as a management decision-making tool, capable of being installed as an overall package of varying complexity with a basic price of around £15,000 but an installed system price nearer £25,000, complete with all ancillaries. The basis is a micro-miniature, 4,000-word, one microsecond, 16 bits store computer; the peripheral equipment being virtually unlimited within the scope of that now available.

Design by Computer

Direct design by computer, the ultimate development of both these Ferranti and Plessey innovations, although rapidly becoming a practical operation tool, is still at the research stage. Conventional computer use for design is again another conception but one that is rapidly becoming accepted procedure.

In Britain, facilities and basic programmes are available, either through bureaux or association channels, accessible to any organisation with routine design problems.

Immediate development of computer-aided design facilities is in the hands of the Ministry of Technology, supervising work in hand at the National Engineering Laboratory, East Kilbride, Glasgow; a unit at Aldermaston developing computer applications in engineering—APACE—which has access to two of the largest computers in Britain—STRETCH and ATLAS II; and another specialist automation/computer unit within Imperial College, London.

In addition, the Ministry of Technology is setting up a multi-access unit for research and development on computer aided design which, it is expected, will co-ordinate all information and design ideas. This will store and make instantly available the kind of data estimated now to take 30 per cent of drawing office time to retrieve.

The eventual aim is to make such facilities, when perfected, available to industry and as easily accessible as a telephone call.

Easier Operation

Throughout both the expressed intentions of individual companies developing British advances in computer operations and what can be disclosed of research in this field, there is a clear pattern of resolve. **Computers must be reduced in bulk, weight and price — in spite of peripherals remaining at virtually irreducible proportions — and be much easier to operate, as easy as a typewriter.**

"Under Computerisation, Management becomes topless"

Unloading Meat At The Port of London

J Sharpe*

THE MEAT HANDLING SCHEME AT THE Royal Victoria Docks, Port of London Authority, is here described. The scheme involves the construction of a new sorting house, the installation of a complex system of conveyors, and the control of the sorting by means of digital computers. At present the meat is lifted from the hold of the ship in slings and lowered to the quayside. Here the meat is sorted and taken by hand barrows to waiting lorries.

New System

The Blue Star Line, with the collaboration of the Port of London Authority, is installing a new automatic meat handling system at 'B' berth, Royal Victoria Docks. This facility will also be shared with the Shaw Saville and Albion lines for their ships carrying cargoes of carcass and cartoned meat from Australia and New Zealand, but can also be used to unload fruit and other cartoned cargoes.

Among the advantages of the new system are :

(a) Reduction of overall handling costs,

(b) Reduction of turn round time for both ships and consignees' vehicles,

(c) Reduction of the amount of handling and exposure time of frozen carcasses, thereby keeping damage and deterioration to a minimum,

(d) Availability of printed records of all unloaded cargoes and improvement in security.

The chief cargo to be handled is frozen meat from Australia and New Zealand. The meat is in two forms: carcass meat, and carton meat. A number of significant features have to be recognised in order to identify the meat correctly .

i. Type of Animal, ii. Type of Offal, and iii. Grade and/or cut. In addition certain codes are employed to identify the packer, the quality, the farmer, or the order number. Besides meat, the handling system can also be employed to distribute other products such as crates of fruit.

All the cargo is sold to specific importers who wish to collect their part of it as soon as the ship has docked, and remove it to their own refrigerated warehouses. The meat is not stored on the quayside at all. From the details of the ships' manifest, it is possible to arrange for the different importers to send their insulated lorries to the quayside at the correct time to collect their part of the cargo.

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Conveyor System

The Conveyor system permits the unloading and sorting of cargo by means of three separate channels. Each channel has its own completely isolated electrical and electronic control system. The division of the system into three parts permits flexibility in the rate of handling cargo, permits routine maintenance to be carried out at periods of low activity and ensures that in the event of any failure, mechanical, electrical or electronic, only a part of the total handling capacity will be incapacitated.

As each channel is identical only one of the three channels is here described. A gantry system carries a pocket belt conveyor. This conveyor is positioned over the ship's hatch by traversing the gantry. The lift is lowered into the hold and the cargo is manually placed in the pockets of the conveyor which lifts it out and across the quayside to drop it onto a transverse conveyor. The direction of the transverse conveyor can be reversed if necessary so that whatever the position of the pocket belt gantry the carcasses are fed to the conveyor transporting them to the sorting house. In the sorting house, the carcasse, cartonss, etc., are transferred to the sorting conveyor. The sorting conveyor is a drop bottom slat type and conveys the carcasses to road, or rail loading bays where they drop onto transverse conveyors leading to the road or rail vehicles. Some of these conveyors can also be reversed to feed vehicles on either side of the conveyor.

The pocket belt and sorting conveyors are fitted with variable speed drives so that the throughput can be adjusted to meet operating requirements. Each of the three conveyors can handle a maximum throughput of 3,000 carcasses per hour. The complete system is capable of distributing 9000 carcasses per hour to 43 load out points.

Sorting House

At the beginning of each sorting conveyor is a small office where the items of cargo are identified. As the rate of sorting is very high, it is necessary to have four operators, whose task it is to identify the contents of particular trays of the conveyors. To help them identify their own trays, the conveyor trays are cyclically painted in four colours. Hence one operator's task is to identify the contents of one colour tray of the conveyor only. He ignores the rest which are dealt with by the other operators in the sorting office.

Each of the four operators has a key-board with 7 columns of 10 keys. One button in each column is depressed to encode the parameters which identify each item of cargo. Each button remains depressed when pushed and releases any other button which had previously been depressed in the same column. When all the details of the carcasses, etc., have been encoded on the key-board, the operator presses a Register button. Pressing the button transmits all the encoded information to the electronic control computer. The computer is synchronised with the sorting conveyor. Pulses are generated by means of windmill-like cams driven by the conveyor. As the blades of these cam plates pass magnetic transducers, electrical synchronising impulses are generated and fed to the control computer.

As each item of cargo is registered by the key-board operator, the details of the cargo and position of the tray of the conveyor are recorded in the memory store of the computer. Approximately a second later the tray has moved one section through the sorting house and its location is, therefore, changed. The synchronising pulses generated by the windmill cams are used to "update" or change the recorded location for each tray of the conveyor in the memory store of the computer. The computer memory, therefore, knows the contents and location of each tray of the sorting conveyor. As the conveyor moves, the synchronising pulses continuously change the recorded details of the locations of each item to keep the records accurate. It follows that if the keyboard operator is slow in encoding the information, he could get out of step with the synchronising of the conveyor and computer. The item of cargo would then be recorded in an incorrect location in the computer store. To prevent this happening, if the operator is too slow, a

Operators, each provided with a key-board with seven columns of 10 keys, pressing keys to identify trays of meat

"TOO LATE" lamp is illuminated and the encoded information is not recorded in the control computer.

Control Room

The control room contains a mimic diagram showing the running condition of all the conveyors and three control consoles from which the operation of the three sorting channels is controlled. Associated with each console is a card reader and a teleprinter.

The cargo of each ship is known in detail before the ship docks and arrangements are made with the importers to have their vehicles at the quayside when their portion of the cargo is due to be unloaded. Each lorry driver has an order for cargo which is converted into a punched card. When a loading bay is available the lorry is summoned from the lorry park and directed to the appropriate loading bay. There are a total of 43 lorry loading bays and 15 rail car bays. The punched card for the selected lorry is placed in the card reader and the number of the bay to which the lorry is directed registered by means of a selector switch. The punched card is then read into the computer and the information stored and related with the address of the selected loading bay.

For each punched card or address location in the computer it is possible to record the details of up to 10 different items and a quantity of up to 999 of each of these items. A print out can be obtained on the teleprinter of the details of each order stored in the computer.

Loading Bay

When the lorry reaches the loading bay and is ready to receive cargo, a key switch on the local control panel is turned indicating to the control room operator that the bay is "Ready to Load."

The control room operator then presses the "LOAD" button for the appropirate loading bay and cargo is allocated to this bay in accordance with the order requirements.

Allocation

The details and location of each item of cargo on the sorter conveyor is recorded in the computer and continuously updated in synchronism with the movement of the conveyor. The details of the order requirements for each of the load off points are also recorded in the computer. When an item is recorded in the computer by the keyboard operator, it is compared with the requirements of each of the load of f points by means of a priority and cyclic distribution technique, incorporating a priority system. If the cargo item can satisfy an order requirement, it is immediately allocated against that requirement.

The existence of coincidence between the details of an item on the conveyor and the requirement of a loading bay is used to generate a signal which reduces the outstanding quantity of that item for the selected discharge point by one. When the item approaches the selected load out point, a signal is sent by the computer to a solenoid-operated latch which results in the bottom of slat conveyor dropping as the conveyor travels onwards. The item of cargo drops down a guide chute onto a transverse conveyor and is delivered to the waiting lorry. In falling down the chute, a mechanism operates an inductive detector confirming that the item has been delivered. When this signal is received by the control computer it confirms the instructions to reduce the outstanding order requirements by one and operates a counter on the loading bay control panel and on the operator's control console. The counters enable a check to be made on the number of items delivered to each lorry. If, for any reason, the item of cargo fails to be delivered, the inductive detector does not operate and the quantity of outstanding items is increased by one, back to the value before the item was allocated. This failure to deliver is also reflected in the counters which do not operate.

In order to prevent excessive discharge at the points near the beginning of the sorting conveyor, a cyclic distribution pattern is arranged. The discharge points at the loading bays are divided into two groups:

(a) Priority allocation

(b) Non-Priority allocation

A discharge point can be included in the Priority Allocation by switching on a switch for the desired point on the operators control console. Each item of cargo is first offered to the priority group starting with the discharge point next to that which was allocated delivery of one item. If all the priority points refuse, the item is offered similarly to the non-priority group. The cargo is therefore distributed roughly evenly between the loading bays in each group. If necessary the loading staff at a particular bay can be increased to handle the high rate of delivery which occurs if that bay is given priority over all the others. This cyclic distribution and priority system is also used when all the cargo is of one type, e.g., crates of fruit. In this case, the sorting keyboards are not manned, and the items are allocated to each discharge point in turn within each of the two groups. Discharge points which are not actually being used for loading are automatically excluded from priority allocation.

Unwanted Items

If for an item loaded onto the sorting conveyor no requirement is found at any discharge point, it travels to the end of the conveyor where it drops onto a manual handling point and temporarily stored in insulated containers. This is also the fate of carcasses which are not encoded in time by the keyboard operator, or which cannot be accurately identified because certain coding marks are illegible or obscured as a result of the way the item is lying on the slat conveyor.

Interruption of Sorting

Sorting can be interrupted for a number of reasons, e.g. power failure, equipment failure, end of shift, strike, etc.

The computer is powered from storage batteries which are continuously charged from the mains power supply. The computer will, therefore, carry on working in the event of a power failure, so that the whole system remains in synchronism as the conveyor comes to a halt. No information is lost and start up can be carried out without mis-sorting of any of the items on the conveyor when it stopped. The use of storage batteries also overcomes the problems of mains-borne interference and short duration power drop outs. At any time it is possible to obtain from the teleprinter a print out of the state of the orders for each discharge point.

COMPUTER CONTROL

Computer

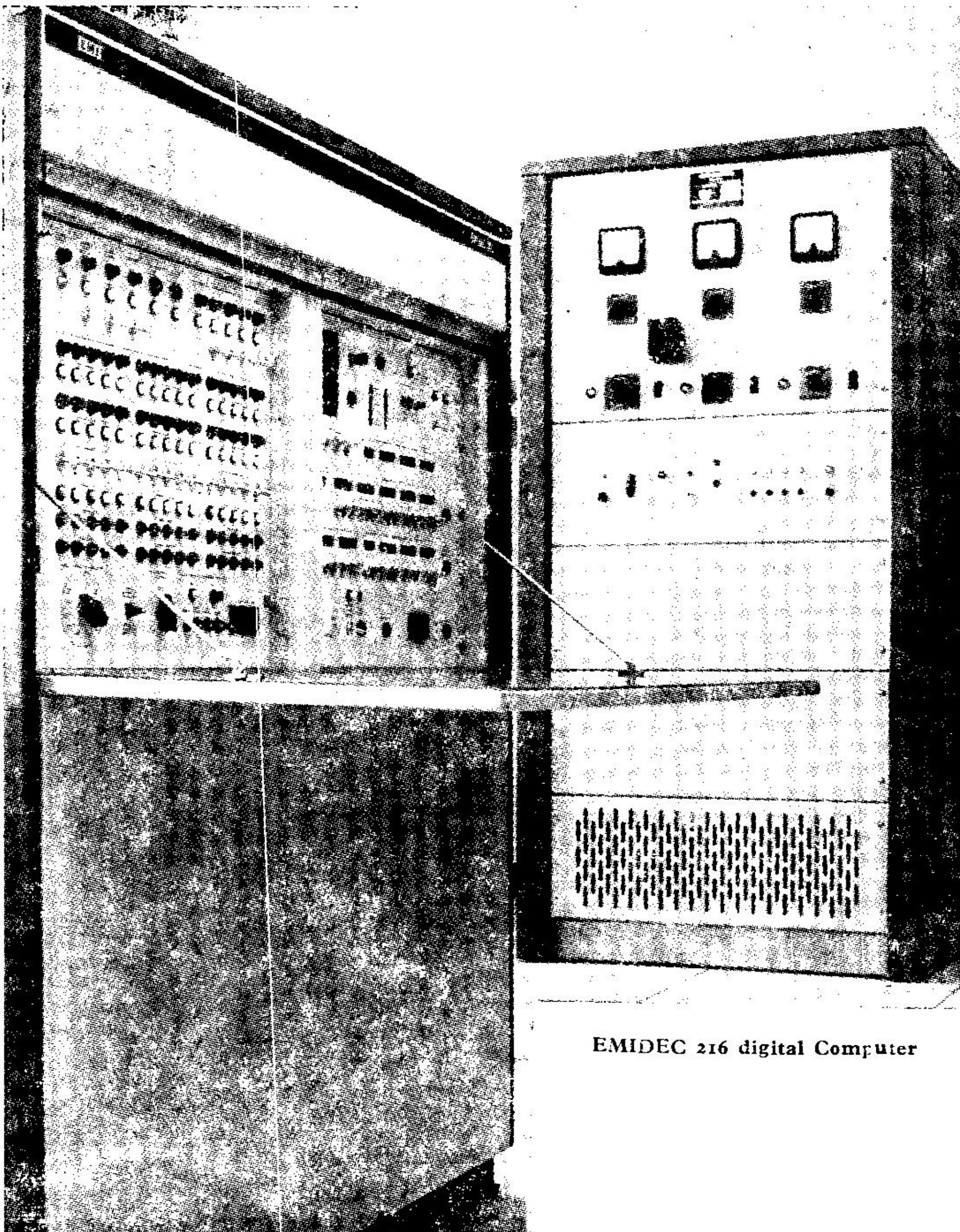
The control computer is an EMIDEC 216—a small stored programme digital machine designed specifically for on-line control applications. This machine operates in parallel on a 16 bit binary word, and simple arithmetic functions are set up and executed in 15 microseconds. The comparatively small amount of storage needed in this application is provided by a 2048 word core store with a cycle time of 6 microseconds. Some 200 single bit input and output registers are built into the computer These are used to interrogate switches and relay contacts, and to drive display lamps and solenoid actuators.

Control of the peripheral units is intimately connected with the built-in programme interrupt facility. In particular, the synchronising pulses derived from the sorting conveyor are fed in as programme interrupts which start various control programmes. The programme interrupt system is also used to control the more conventional peripherals, that is the card reader, the teleprinter, and a paper tape reader. A programme-controlled priority routine ensures that these control functions do not delay the vital on-line programmes. The computing centre and peripheral controls use integrated circuits in To5 packages, mounted on small printed circuit cards, and the cards are wrap-connected to form a complete assembly.

As with all process control computers, it is vital to eliminate the transmission of impulsive interference from the external units to the computing centre. This is achieved by solid state input and output buffers which are contained within the computer cabinet, but are separated from the computing centre by a double skinned screen.

Control System

The various parts of the system and their method of use have already been described, and the block diagram shows their interrelation with the computer. All the units forming the system act under the control of various programmes which are fed in initially through the paper tape reader. Two synchronising pulses are produced by the transducers attached to the conveyors, and each is used to start a sequence of programmes. The first set of programmes has to match the load description set into the keyboard with a requirement in one of the orders stored in the computer, and the



EMIDEC 216 digital Computer

second set must energise a solenoid to drop the load at the required discharge point.

The computer has to compare the description listed in the orders for load out points with data fed in from the keyboards. When an operator presses the Register button on his keyboard, a programme interrupt is sent to the computer, and the computer reads the keyboard setting onto a temporary location in the store.

The computer is synchronised with the conveyor. It follows that at a certain point during the time in which a conveyor tray moves past a keyboard, the computer must compare the description of the load in the the tray with the outstanding orders. At this point, a synchronising pulse is generated which starts the first sequence of programmes. The computer then reads the load description from the temporary location in the store. If, by this time, the operator has not pressed the Register button on the keyboard, the computer assumes that the tray is empty and the load is not assigned to an order. When a matching description is found, the order data is updated to increase the quantity dispensed by one, and the load description and discharge point number are loaded into a part of the store which is used as the conveyor simulator.

As a conveyor tray moves past a discharge point, a position is reached where a solenoid-operated latch must be energised if the load is to be dropped. Just before this time, a further synchronising pulse is generated, and this starts the second sequence of programmes. The computer de-energises all solenoids which have been turned on at the previous synchronising pulse. It then interrogates an associated relay which is set by the mechanially actuated proximity switch whenever a load drops from the sorting conveyor. In this way, the computer determines whether a load has failed to drop, even though the solenoid was energised. If this is so, the quantity dispensed, which is held in the computer store, is reduced by one.

Once the correct state of each order has been confirmed in this way, the computer checks all orders for completion. If any completions are found, these are noted in another area of the store, so that a printout can be produced later. The computer also determines whether any completed orders exist whose printouts have also been completed. In such a case, it lights Order Completed lamps on the console and on the appropriate loading bay control panel. The computer then checks the conveyor simulator to determine whether there are any loads which have to be dropped in the current cycle. If so, it energises the appropriate solenoids. At this stage, the computer simulator is shifted along one cycle to correspond with the movement of the conveyor trays. Data is then assembled in the store for any automatic printouts of completed orders, and the first character is sent to the teleprinter. Finally, all relays which have been set by the mechanically actuated proximity switches are de-energised, ready for the next cycle.

These sequences of programmes occupy the computer for less than one third of the available time. In the remaining time, the computer actions any programme interrupts produced by the peripheral units. For instance, when the teleprinter has printed a character, it sends a programme interrupt to the computer, and the computer sends back the next character from the printout data assembled in its store.

In the absence of a programme interrupt from a peripheral unit or from the conveyor transducers, the computer reverts to its one remaining programme. This is a test sequence which checks the stored programmes and the basic computer instructions. If any of the tests fail, the computer prints out the type of fault, and in extreme cases, it halts and sounds an alarm.

Ergonomics

Ergonomics is the study of the problem of the interface between man and machine. The meat sorting system described offers a very complex ergonomic problem with many features requiring detailed study before the design could be conceived.

Our Ergonomic laboratory undertook a special study on this project to ensure that the system operated with the highest efficiency and minimum fatigue to the operators and minimum risk of maloperation. This study is so fascinating and has proved so valuable that a separate paper will have to be written about it. Space here only permits a brief indication of the type of problems encountered:

*Investigation of codes employed on cartons and carcasses,

*Recommendations for codes with particular reference to type of code, size and dimensions of character and location of the code on the carton,

*Sorting office environment, with particular reference to noise levels, colour schemes, illumination both natural and artificial, temperature, ventilation, reflectivity and glare, etc.

*The design of the keyboards, their location and operator siting with respect to the conveyor.

Similar problems were encountered in the control room and at the loading bays. The whole concept of the system was considered to ensure satisfactory relationship between the various functions that had to be carried out both by the machines and the operators.

A number of mechanical handling and ergonomic problems were encountered on the meat handling project which could only be solved by experiment.

A prototype conveyor and experimental control system was constructed and many modifications tried out to obtain satisfactory and reliable operation.

To ensure hygiene, the meat handling equipment has to be hosed down for washing at regular intervals. All control equipment in the vicinity should, therefore, be waterproof. ●●●

Computer-Controlled Factory

A machine-making factory, by now completed at Deptford, London, is entirely controlled by computers. Claimed to be the first of its kind in the world, the factory has been built by a British firm which specialises in the manufacture of cigarette-making, packing and processing machinery.

It is only one-sixth the size of a conventional factory having a similar output, and it is being equipped with the company's system 24, under which components will be produced in *one-twentieth of the time and at one-tenth of the cost* of those currently being produced by the firm. The 48 people who will work in the new factory will have an output equivalent to a conventional factory equipped with more than 300 machine tools.

In the specially-built plant—probably the world's first for automatic batch production as opposed to mass production—batches of two to fifteen components will be produced at a time, and the machines will then change to another component.

Typesetting Telephone Directory

AH Phillips*

Computer Typesetting is the generic term used to describe a complex range of processes which assist the typesetting function. In its simple application computer typesetting is concerned with automatic justification, hyphenation and the advantages associated with storage of data on paper tape for subsequent typesetting in different measures, typefaces and sizes, on a range of typesetting equipment. In a more sophisticated approach computer typesetting includes display, updating, page makeup, sorting, merging, and the use of tape generated during data processing runs, thus avoiding re-skey boarding which is necessary for conventional typesetting.

Her Majesty's Stationery Office is introducing to its printing activities a number of computer typesetting developments. After the necessary experimental phases, cost effeciveness or other distinct advantage must be demonstrated before the new techniques are applied to a particular range of work. The future role of computers within the printing organisation is being investigated; this requires the detailed analysis of systems using a range of peripheral equipment, including filmsetters, and programme requirements.

ONE PROJECT IS CONCERNED WITH THE production of telephone directories. Typesetting of directories, which requires ›ntinuous production of entries in standard ›rmats, is an ideal iob to automate. An appro- point at which to evaluate existing pro- ›n methods came in 1966, when increased for United Kingdom telephone ›ry typesetting was required. This was to a natural expansion of the service and introduction of all-figure-number telephone ›ences in place of exchange names combined number codes.

The existing method of typesetting used ›ally operated linecasters, but it was consi- ›ed that productivity could be increased by ›e use of improved techniques. Teletypeset- which is the operation of linecasters the control of coded paper tape, was ›iced. The specification of the equipment required that the equipment should be capable of integration into a computer-based system as a second phase of the development. The modules which met this requirement were KS Paul Purdy-McIntosh Teletypesetting keyboards and calculators, and Addo punches which provided-eight channel, centre sprocket computer compatible paper tape, with six information channels, to drive specially adapted Intertype C 4 linecasters. The use of teletypesetting techniques enabled the linecasters to be run between two-and-a-half and three times faster than by manual operation, and the choice of PM keyboards gave further advantages which can be best measured in terms of keystrokes saved. An average telephone directory entry requires 64 keystrokes on a conventional keyboard; the PM keyboard reduced this to 54 keystrokes by the application of automatic shift and unshift conditions and a double leader facility. Nevertheless, it is interesting to note that the advance of the technology required for keyboards and associated equipment is such that these keyboards have

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been superseded by a new range of keyboards manufactured by KS Paul & Associates Ltd., now a subsidiary company of the Mergenthaler Linotype Company.

The introduction of computer techniques enabled the number of keystrokes in an average entry to be reduced to 38. In January 1968 the keyboards and punches were linked on-line to a computer, and the present configuration is as follows :

- Elliott 903B Computer, with Control Unit
- 12-channel Multiplexor/Distributor
- 12 PM (Purdy McIntosh) Keyboards
- 12 Addo Paper Tape Punches (capable of operation at up to 18 characters per second)
- 1 Elliott Paper Tape Reader (capable of operation at up to 250 characters per second)
- 1 Westrex Paper Tape Punch (capable of operation at up to 110 characters per second)
- 4 Intertype C 4 Linecasters with Reading Unit
- 1 Intertype Monarch Keyboardless Linecaster

In addition Eliott Automation Systems Ltd. market a number of peripheral devices which may be used with their 903 computers, including industry compatible magnetic tape decks which could be used for updating directories and processing at an increased speed.

The 903B is a small, but powerful, digital computer, with 8,192 18-bit words of core store, to which additional modules of magentic core may be added. The on-line operation is effected via a multiplexor unit which accepts the signals from up to 12 keyboards, acts as an interface with the computer, and outputs signals to the appropriate punches. Approximately half the store is used as buffer areas for input, processing and output, and the remainder is used for the computer programme. On-line operation enables one paper tape stage to be dispensed with; more economical manning of the equipment is a further advantage of this mode of processing.

The fast reader is used to read in the computer programmes and also accepts unjustified data on paper tape prepared off-line at punches linked directly to the keyboards. The off-line mode outputs justified tape at the fast punch. The third method of operation allows on-line operation from up to eleven keyboards and concurrent off-line processing of unjustified tape.

The three operating programmes were written by Elliott Automation Systems Ltd. from specifications prepared by H.M. Stationery Office. The programming language used was SIR (Symbolic Input Routine), the 903 assembly language which enables programmes to be written in a near machine code with a number of facilities not available in machine code, including the reference to locations in computer store by meaningful names chosen by the programmer, instead of identifying the absolute address. Included in the software support supplied with the computer are compilers for the high level languages, ALGOL and FORTRAN II.

The operating system accepts minimum keystrokes, in a single case, which are processed by the programme to insert leaders, capitals and the various formats required for the different types of entries and telephone sequences. Capitals are introduced by programme after a space, comma, full point, parenthesis, indent, quotes, solidus, quadding and entry and codes. Each surname need be input once only in each directory; thereafter the name and following space is obtained by pressing one key. The operator are also relieved of a number of decisions, including breaking long entries into more than one line. This operation and the layout of each line and justification calculations are supervised by the programme. The interword spacing is calculated within narrow limits, providing a more evenly spaced line than is normally possible under operator control.

The operator keyboards "blind" in that he has no hard copy output from the keyboard. In some quarters this is considered to be practice but the printing industry has used this method of preparing paper tape for "Monotype" equipment for over half a century, and in practice the technique is effective. Acoustic feedback to the operator is in the form of a bleep and indicates that a keystroke has been accepted by the system.

Parity checking facilities give a three-stage check: at the keyboards, multiplexor computer and punches. The information is conveyed to the operator by means of colour coded lights at the keyboard. The principle of assisting the keyboard operators in every way has been extended to the provision of copy holders with the movement of the copy actuated by foot-operated microswitches and automatic tape rewinding units. Character, word and entry deletion facilities are also under keyboard control. These features have been devised to ensure that the operator's skill is concentrated wholly on productive key strokes and that he is not distracted by unnecessary movements.

The output of the computer system provides the input to the tape driven linecasters. The computer-processed tape has no erase codes, no unnecessary blank tape and no tight lines, the presence of which would result in inefficient running and stoppages of the linecasters.

The equipment has now been in operation for six months, which is a sufficiently long period to justify a preliminary evaluation of the techniques used. Programs are being flow-charted for other work to ensure that the system is exploited to the full. The computer system is sound and the cooperation of everyone concerned, especially the keyboard operators, has laid the groundwork for successful operation.

The next stage which H.M. Stationery office is about to enter is the full computerisation of Telephone Directory composition involving the acceptance of magnetic tape as "copy" and a full page film setter output. ●●●

Computer Marriage

LINTHWAITE (ENGLAND), MAY 5 (AP)—Former South African diplomat and his pretty British bride were honeymooning today after a marriage arranged by a computer.

Triquet Dory, 27, said after the wedding in a Yorkshire village church on Saturday:

"I couldn't have made a better choice myself."

Dory was introduced to Elizabeth Firth, 23, in New York 18 months ago after taking part in a computer experiment.

The computer owned by Harward University was fed with details about hundreds of people and it decided that Elizabeth and Triquet were well matched.

"I rang up Elizabeth and we went out for a drink and dinner," said Dory.

The meeting bloomed into a romance.

Computers in Higher Education

John W Hamblen[1]

Long before the often-mentioned Rosser Report[2] was completed it became obvious to many government agency officials of the United States that a very rapid expansion of the computer facilities of colleges and universities was in the offing. The nation's research and development programmes, particularly those related to defence and space efforts, were already heavily dependent upon the computer. The need for more and more computers in the colleges and universities was foreseen in order for their research programmes to keep pace with governmental and industrial research activities, and for their *graduates to be knowledgeable as to their use.* At the same time it was predicted that the nation's higher institutions must begin to educate thousands of computer scientists and computer technologists.

THE MATHEMATICAL SCIENCES SECTION of the National Science Foundation developed and tested a questionnaire which could be used to provide the kind of information needed for future planning of the relevant government agencies. This questionnaire, with only minor revisions, was used in the survey reported on in this document*.

Purpose of Survey

How much are colleges and universities spending for computers in their research and instructional activities and where does the money come from? What computers do they have, and expect to have, how is the research and instructional usage distributed over academic area and undergraduate *v.* graduate use? What degree programmes are being offered in computer science and how many students are getting computer education? These were some of the questions answered by the results of a statistical survey carried out during the 1967 fiscal year by the Computer Sciences Project of the Southern Regional Education Board with the support of the National Science Foundation. Fiscal year 1965 was used as the base year for actual expenditures and sources of funds, and fiscal year 1969 was used for projections by the institutions.

A stratified random sample of approximately 700 of the 2200 institutions of higher education was employed to obtain estimates for the entire population.

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1. Computer Director, Computer Sciences Project

2. *Digital Computer Needs in Universities and Colleges* (Rosser Report) National Academy of Sciences, National Research Council, Washington, D.C., 1966, p. 176

*Report of the Southern Regional Education Board, Atlanta, Georgia, (U.S.A.)

Total Expenditure

$103 million was spent on computer equipment and its operation for research and instructional purposes by the nation's colleges and universities during fiscal year 1965. An additional $41 million was contributed by the computer manufacturers in the form of educational allowances on purchases and rentals, gifts of equipment and other assistance. For the fiscal year 1969 the institutions expect to spend $276 million for the same purposes. The manufacturers will contribute an additional amount which is not likely to be too different from the 41 million of 1965 because of the recent lowering of educational discounts. During the fiscal year 1965, $30 million was spent on salaries for approximately 5000 staff members at all levels with an expected increase to $69 million for FY'69 on twice as many staff. Nearly $50 million, or almost one-half of the total expenditure, was spent on computers and peripheral equipment in the form of purchases, maintenance, and rentals. To this should be added the more than $40 million contributed by the manufacturers which brings the total value to $90 million for computer equipment used by the higher institutions for research and instruction during FY '65. For FY '69 the total value of hardware is estimated to be approximately $180 million with the manufacturers contributions remaining at about the $40 million level (This is a calculated guess, not a statistical estimation). Total capital expenditure, i.e. cost of purchases of equipment (including computer purchases), buildings and furniture are expected to increase from around $25 million in FY '65 to about 70 million in FY '69.

Sources of Funds

Of the $103 million expended by the institutions in FY '65, over $43 million (40%) came from Federal Government agencies in the form of contracts and grants. Nearly $25 million of these Federal funds were designated "primarily for computer activities". General institutional funds contributed $51 million (47%). For FY '69 the institutions are expecting $109 million (39%) of the $276 million total to come from Federal sources and to increase "their own" expenditures to $142 million (51%).

Of the $25 million in Federal funds which were labelled "primarily for computer activities" over $13 million was designated for rental or purchase of equipment and buildings; 7 million was spent for their operation; 3 million was used to pay for computer time for research, development and graduate instruction; less than 1/2 million was used to pay for computer time for undergraduate instruction, and nearly 1-1/2 million for Computer Science activities. For such purposes the schools are expecting a two to four-fold increase in assistance from federal and non-federal sources for FY '69. The total is estimated to go from 32 million in FY '65 to 86 million in FY '69. ●●●

5000 Housewives And One Computer Designed This Washing Machine

The ladies wanted :

The best washing results with every fabric. A fast spin drier for ironing-dry laundry. Automatic water level adjustment for less water with smaller loads. A drum they could open at the touch of a finger. Lots of washing programmes (in fact they got 15).

We had to call in a computer to tell us how to build such a machine and give it perfect balance . . .

—*The Economist* (London) Dec. 28, 1968

Market Forecasting by Computer

Lawrence D Copeland*

Using a computer to predict the future would seem to be stretching the capabilities of such devices to the ultimate. Foreseeing events to come is very much a matter of skilled judgement. It is a difficult (and often inaccurate) process for experienced human beings. How could a computer replace judgment? The answer is that—as with most computer applications—the computer does not replace judgement but it provides a powerful supplement. The author has given us the benefit of his experience in forescasting sales.

At the Northrop Nortronics Precision Products Department, computers have been used for the past 18 months as an aid in forecasting future sales. The forecasts cover a period of 5 years. Results to date show a marked improvement in forecasting accuracy. A number of interesting new extensions of the technique are also planned.

The Nortronics Precision Products Department, part of the world-wide Northrop Corporation, manufactures precision assemblies such as gyroscopes, gimbal assemblies, altitude reference units, accelerometers, etc. The products are used for a wide variety of programmes such as the Saturn space launcher, various satellites, and a number of military applications. Gyros from Nortronics Precision Products are used on such well-known international programmes as the TD1-TD2 satellite and the ELDO launcher. The department is located at Norwood, Massachusetts in the United States.

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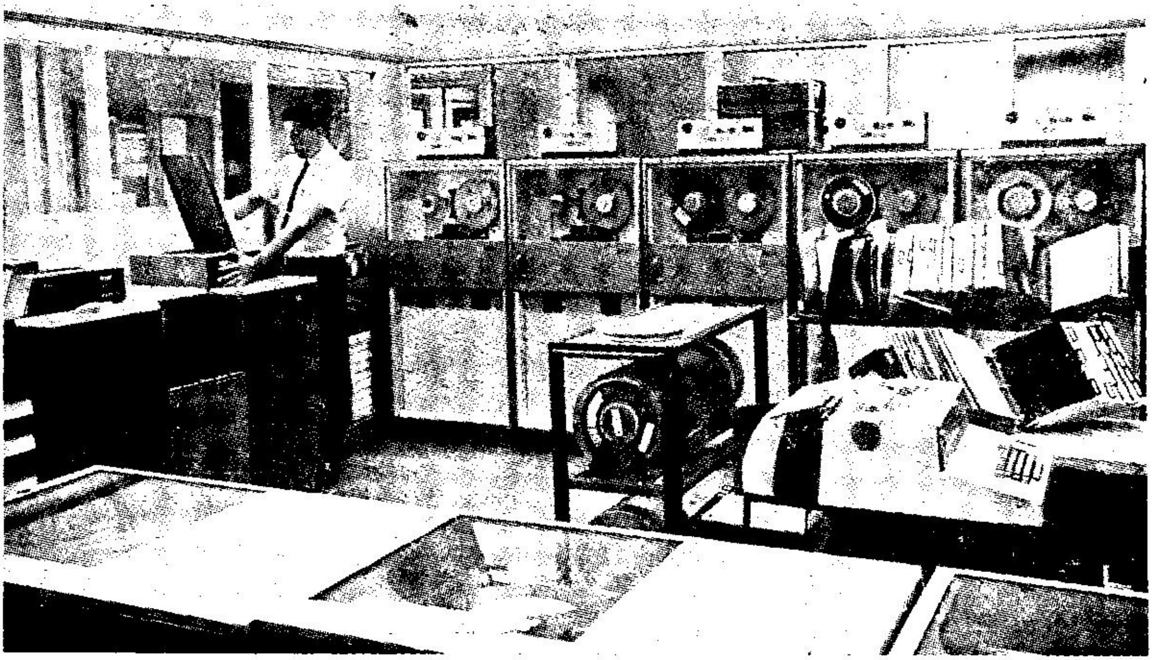
As with most companies in a rapidly changing area of technology and business conditions, Northrop plans its business years ahead. This means that each group within the Corporation must give its estimates, for at least five years in the future, in terms of such things as product mix, customers, selling price, delivery schedules, capital requirements, profit, etc. Estimating these things is a difficult enough problem for a manufacturer of, say, fence posts, but particularly thorny in the Nortronics kind of business with many customers, many products, and many programmes—all of them subject to the vagaries of politics, economics, and rapid technological shifts.

It became early apparent to Nortronics forecasters that a computer was not only an interesting idea for market planning—it was a necessity. The reason, of course, is that there was a situation calling for the collection, sorting, and display of a multitude of "bits" of information—the ideal operation for a computer.

The "Nortronics Computer Forecast" works as follows: Thousands of inputs relating to future market situations (such as estimates of programme volume, probable competition, esti-



mated date of award, probable pricing trends etc.) are collected and fed into the computer. Along with these "judgement" factors go the "hard" details such as geographical area, product description, applications engineer, etc.

The computer sorts information by product line, performs the necessary multiplication, and produces a five-year forecast showing both bookings and deliveries, by quarters, for the five-year period. The computer provides a five-year forecast once a month (oftener if needed). Customarily the forecast is in terms of sales and deliveries by product line, but a variety of analyses are possible: by geographical area, by customer, by individual applications engineer, etc. It ispossible to know 5 years in advance what volume is forecast for a given customer or what product line will be strongest.

The computer is a remarkable adjunct to forecasting because it can accept, analyse, and store great amounts of information. However, its most important effect in improving accuracy of forecast is the matter of speed. The question of **timely** information is the essence of forecasting in the precision assemblies business. The validity of information degrades very rapidly. The most accurate of inputs in one day may be only 50% accurate the following week. Apart from the critical question of the amount of information and its initial validity, there is the most important matter of getting inputs quickly to the people who must use it to update manpower, material, and financial plans.

We have stated that the computer is used to forecast. It turns out—as in all computer applications — that it is man who makes the forecast. The computer simply helps in its own specialised way. In this case it is acting, primarily, as a fast calculator and printer.

But the use of the computer in the area of business predictions is still new and untried. Nortronics forecasters are already at work on a system whereby the computer is used much as in military strategy—to weigh the probabilities (expressed in terms of myraid bits of information) and give its **own** prediction. With such an application still some time in the future, Nortronics expects that it will have arrived at the full potential of the computer in Market Forecasting. ●●●

The American Computerland

The Godard speceflight centre of America's National Aeronautics Space Administration near Washington recently announced its acceptance of one of the largest computers ever made.

Only two of IBM's model 95 computers have been built. They are both used by NASA and there will not be any more, but one statistic about them provides a gauge to the rate at which the computer business has been developing: this new machine is just 1,000 times as fast, 1,000 times as powerful as the largest of the so-called first generation of computers which were produced in 1954.

The Godard faculty alone has 100 computers, and the entire NASA organisation has 225 which makes it easily the biggest computing centre in the world. In sheer power it must come close to the entire computing stock installed in a country like Britain. The big computers at Godard are mainly employed on scientific tasks, studying solar flares, winds and radiation. Without them, as a NASA man laconically puts it, "We would wind up with fried astronauts." Actually the IBM model 95 was used to calculate the orbit of America's manned spaceflight in July 1968. A large screen on the wall monitors the rocket's flights and Godard can make corrections to keep it on course with rapidity needed for a vehicle travelling at 20,000 mph. Godard also has other large computers which do nothing but check for component failure before launching, usually one to each type of launcher. One complex of three computers acts merely as a telephone exchange, switching coded information rapidly from outlying tracking stations to the calculating and tracking computers.

If Godard is the most spectacular example of computing in the U.S.—it produces information on tape at the rate of 300 miles a day so that one wonders what is done with it all—it is in some rather more unlikely areas that the most interesting work is being done.

Take local government for example. The St. Louis police in Missouri have worked out a zoning system for their city and use a computer to calculate the rate and timing of every kind of crime by area. This tells a supervisor where to allocate his force of squad cars, when to have them on duty, and so on. In fact a very large proportion of all crimes occur within a few blocks in different parts of the city centre, and at week-ends particularly in the late evening. St. Louis police, under its very tough, but very bright Lt. Pauly have zoned in on these areas and have been able to see the crime fall out of that area and move gradually across the city.

Eventually, of course, they hope to predict exactly where and when crimes will occur and catch a much higher proportion of criminals red-handed. St. Louis also benefits from a peculiarity of the Missouri legal system which allows suspicious characters to be interrogated and recorded. The police computer keeps a store of all this information for up to a year, and it has resulted in several arrests. Teenage gangs, which usually operate within a very small area, are recorded as a group, which makes it surprisingly easy to identify them.

There is nothing particularly complex about this application of computing, but it is precisely the kind which produces dividends, and where a realistic operational need is resolved.

The people in Alameda County, California, have a computer that records information about traffic offences. It can be radioed and will give an immediate response to a patrol car. This way, traffic fines which were hard to enforce are collected more easily, and computer is reckoned to have paid for its in extra revenue from fines. But it has also saved policemen's lives as, for instance when a lone patrolman was recently warned that a car which he was about to interrogate contained desperate men.

Education is a field which remains potential rather than exploited even in the U.S. But several research projects, notably one linking a large number of Chicago schools is testing out ideas. Here, basically a computer acts as an individual tutor, with a student answering questions with a light pen on a television screen which gradually leads him through, say, addition or basic chemistry.

At the moment they are formidably expensive and there is a considerable shortage of trained people to work in producing programmes. But the University of Texas, for instance, has gone over to computer instruction and examination for all the qualifying exams in mathematics that its tens of thousands of students have to take.

One apparent advantage has already emerged, in that young school children who have a psychological block towards arithmetic for example, lose it when faced with a game to play on a television screen.

At Canada's University of Waterloo, students and even some 12-year old schoolboys on special release taught how to resolve maths problems with the aid of the university's large computer. And it is quite clear when one talks to these precocious youngsters that familiarity breeds ability.

One of the biggest developments in computer hardware over the last few years has been in cathode ray tube and screen devices which make communication with a computer far easier and faster. IBM's development laboratories at Kingston, New York, are working on the development of colour TV screens which can be linked to a computer. Basic research is also being done into holograms which reply on the wave pattern of light to build up three-dimensional images in space.

The small Beverly Bank in Chicago has pioneered the use of taped voice reply to terminals which resemble small push button telephones. An account holder can put his punched card into a slot at the top of the phone, press various keys and be told the state of his account overdraft, interest payments and so on. There is no trick of the computer imitating human speech here — the words, pre-recorded by a girl, come out in a curious clipped style as the computer pieces together its short sentences but it impresses the customer.

Computer can handle a variety of tasks commercially, when connected to automatic drafting machines. Boeing uses them to draft aircraft wing and fuselage sections and then to cut them with tape controlled machine tools: its planes now fit together better than they ever did.

At IBM's Kingston laboratories, drafting tools draw out circuit designs for printed circuits with great precision. These are then photographed, reduced considerably in size, and photo-engraved to make a very efficient manufacturing process.

Undoubtedly the biggest impact is going to be in the development of terminals which can link scattered parts of an enterprise and enable them to function as one. Terminals are still very expensive, costing as much as a small computer, and one estimate has it that there are only some 200 large terminals installed. But these will grow very fast, and the 1970s have already been forecast as the age of the terminal. Graphic devices, often linked with TV screens will increasingly be used to short-circuit design work, and this will extend into quite new areas.

Time-Life already has a rudimentary computer system which helps to set its copy into pages : eventually newspapers will be a natural area for terminals and plotters.

Simulation seems to be the other great area for expansion, whether it is simulation of a business, a chemical process, the workings of a heart, or perhaps a classroom physics experiment entirely done on the TV screen. ●●●

Forecasting the Weather with Computers

Thompson & Roberts*

Tracking the weather by computer at the U. S. Environmental Science Service Administration, scientists first analyse basic weather information and then transfer the data to punched cards to be put into the computer. Meanwhile, a mathematician outlines a computer programme which simulates actual weather. Then, the computer processes the data and prints weather flow pattern forecasts. Nowhere is the pace of change more evident than at the weather bureau's National Meteorological Centre in Suitland, Maryland (U.S.), where machine-assisted forecasts now are standard practice. We have printed below the interesting history of computerisation in weather forecasting.

THE LATE JOHN VON NEUMANN, ONE OF THE most brilliant and versatile mathematicians of our time, once made a significant remark to a small group of colleagues: ".... forecasting the weather for more than a day or two in advance was the most complicated and difficult physical and mathematical puzzle yet proposed or even thought of." That was in May 1956.

A little more than a decade ago, many leading meteorologists, though fully in agreement with von Neumann's sober appraisal of the nature and magnitude of the problem, said that it will ultimately be solved by a suitable marriage of human ingenuity and the sheer naked power of computers. Already progress is impressive, though but a token of things to come. Computing machines that were but visions a decade ago have today taken over major segments of the routine weather-forecasting job. These computers foreshadow, a decade hence, revolutionary extensions of the science and practice of meteorology. The giant new computers have given the skilled forecaster the ability to carry out the necessary millions of calculations essential to a modern forecast, and to do so in reasonable time.

Today's routine forecast weather map, product of man and machine, predicts sea-level weather two days in advance with about the same skill as the one-day, pre-computer forecasts of a decade ago. Since July 1967, numerical methods have permitted weather bureau forecasters consistently to break or tie all previous records for accuracy and range for surface weather forecasting and for jet-stream-level prediction as well.

In a few laboratories in the United States, still more advanced computer-based numerical

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*Dr. Philip D Thompson & Dr. Walter O Roberts are the Weather Computer Experts of the U.S. Environment Science Service Administration.

methods are under development and test. Many of these are global in scope and carry forward in time for many days and weeks—in fact, far beyond the range for which any forecast skill can yet be demonstrated.

In some centres, such computer-based numerical weather "models" are starting to take on aspects of an indoor weather laboratory. They are **permitting meteorologists to carry out a more realistic, world-scale, mathematical simulation of real atmospheric processes.**

In the current scientific jargon, this is called "numerical meteorological modelling", and different research centres in this field have their different numerical "models" emphasising different features of weather processes. In the computer "weather laboratory" or model, the modern meteorologist can hope to test out new forecast schemes as they are invented.

The goal of accurate forecasting for anywhere on earth and for longer time-scales is coming within sight. And with it is emerging another equally challenging goal, namely, to test safely by computer simulation possible schemes for modifying world weather and climate patterns.

In a world of increasing scientific generality and complexity, it is natural to ask what makes the problem of weather prediction so unique and so demanding in terms of human wit and machine force.

First, the atmosphere exhibits undulatory and whirling motions on a tremendous variety of length scales. These range from millimeter or centimeter-sized eddies, spinning along a wind-swept ground surface, to thousand-mile cyclones. Thus, many observations or "variables" are required simply to describe the details of the current weather.

Even assuming that the overall effect of very small-scale eddies is determined by events on a larger scale, it is conservatively estimated that the values of at least five variables (pressure, temperature, humidity, wind speed, and direction) would be required at 5,000 uniformly spaced points at each of ten different altitudes to provide sufficiently accurate description of the state of the atmosphere at a single instant. This makes a grand total of 250,000 pieces of basic data that must be filed away in a computer's storage or "memory", just to keep track of what's going on.

Another complicating factor is that the equations of atmospheric motion are, in mathematical language, "nonlinear". This mathematical characteristic has the significant and devastating implication that motions on one scale cannot be isolated and treated independently from motions on all other scales.

From the standpoint of computing, the salient fact is that a 24-hour forrecast must be built up as the last stage of something like 96 successive 15-minute forecasts simply to prevent small errors from compounding into larger errors.

The final difficulty is that of taking into account the many ways in which the atmosphere is heated or loses heat. All of them are about equally important. All are essential in making weather. None are completely understood.

They include release of heat when water vapour condenses into cloud droplets, absorption of the sun's radiant heat energy, loss of heat by radiation, and heating by conduction from a warmer land or sea surface. Possibly also there is some "valving effect" by which particles, shot out from the sun, control the outward escape of energy from the atmosphere.

Each of the mechanisms of heating is so individually complicated that it takes somewhere around 200 numerical operations to make a 15-minute forecast at each data point.

Owing to these basic difficulties, it takes **about a billion elementary numerical operations** to compute a 24-hour weather forecast for the whole of the earth. Herein lies the power of the high-speed computer.

Undaunted by a host of fundamental difficulties, and in 1956 still lacking a computing machine of sufficient speed and capacity, von Neumann put the forecasting problem to a bright and enthusiastic group of young scientists assembled at the Institute for Advanced Study in Princeton, New Jersey (U.S.). Virtually all of them now are eminent in the world of meteorology and geophysics.

At the time, they were bitterly aware of the difficulties. They even knew the foretaste of defeat, for all were familiar with the pioneering work of LF Richardson, an eccentric British genius who worked in such varied fields as economics, numerical methods, international politics, and weather forecasting.

In his account of the first genuine but unsuccessful attempt at mathematical weather prediction, made in the early 1920's Richardson concludes with a fanciful description of the "**weather factory.**" **It was a huge "orchestra" of 24,000 human automata punching desk calculators and directed by a "conductor" of computations.**

His final remark was, "**Perhaps some day in the dim future it will be possible to advance the computations faster than the weather advances and at a cost less than the saving to mankind due to the information gained. But that is a dream.**" ●●●

He was rushing out the door
With a scowl upon his face,
'Cause there was a great mechanical executive'

I Went Down...

Joe Glazer

Factories without workers? Machines without men? Offices without office girls? Fantastic! Yet that's what the world is coming to. Joe Glazer's song 'Automation', printed here, is typically American in its humour and its peculiar approach to the problems of Life and Technology.

I WENT DOWN, DOWN TO THE FACTORY
Early on a Monday morn.
When I got to the Factory
It was lonely, it was forlorn.
I couldn't find Joe, Jack, John or Jim,
Nobody could I see:
Nothing but buttons and
Bells and lights
All over the factory.

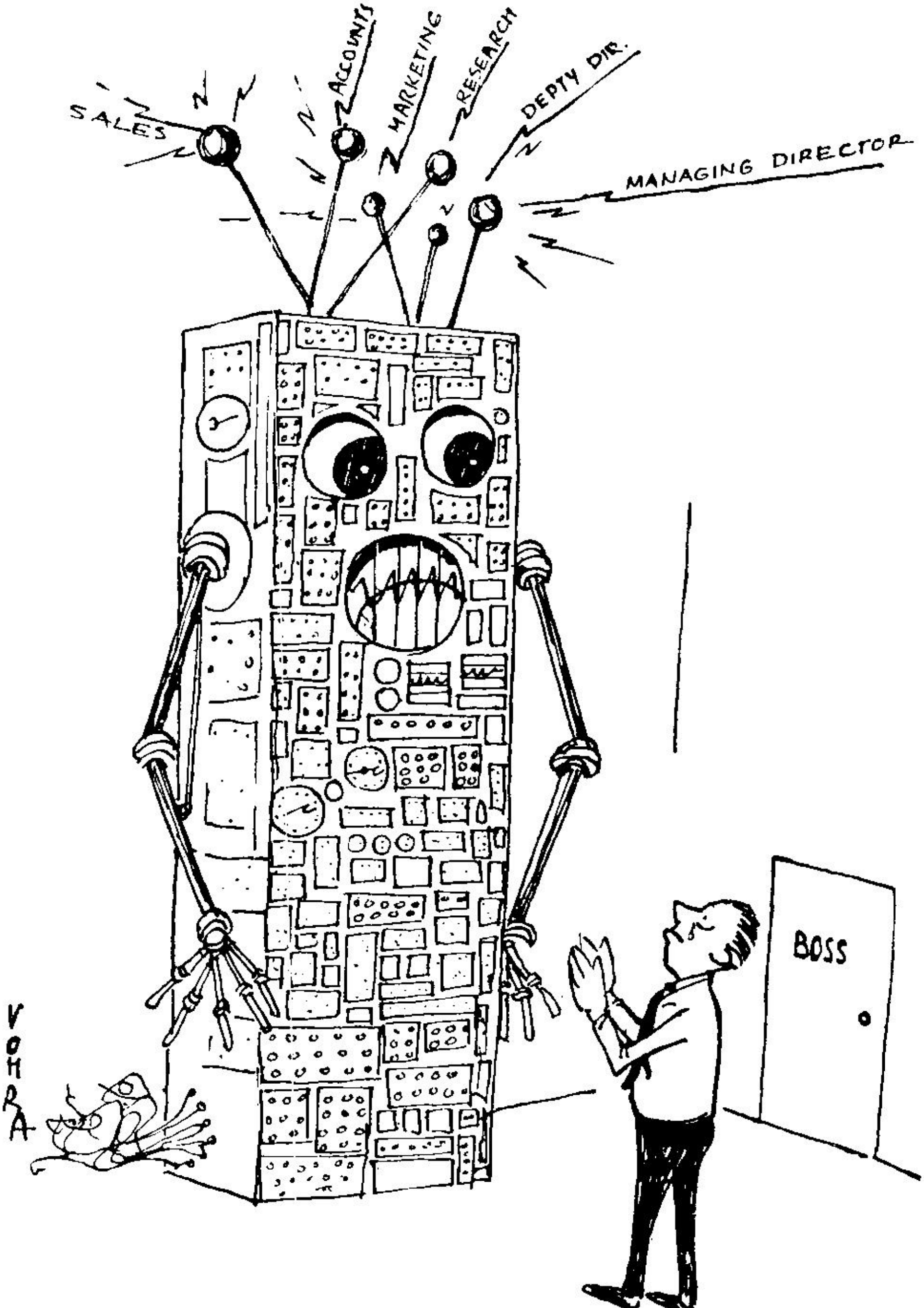
I walked, walked, walked
Into the foreman's office
To find out what was what
I looked him in the eye
And I said, "What goes?"
And this is the answer I got:
His eyes turned red, then green, then blue
And it suddenly dawned on me -
There was a robot sitting in the seat
Where the foreman used to be.

I walked all around, all around
Up and down
And across the factory
I watched all the buttons
And the bells and the lights -
It was a mystery to me.
I hollered "Frank, Hank, Ike, Mike,
Roy, Ray, Don, Dan, Bill, Phil, Fred, Pete!"
And a great big mechanical voice boomed out:
"All your buddies are obsolete."

I was scared, scared, scared
I was worried, I was sick
As I left that factory.
I decided that I had to see the president
Of the whole darn company.
When I got up to his office
He was rushing out the door
With a scowl upon his face,
'Cause there was a great mechanical executive
Sitting in the president's place.

I went home, home, home to my ever-loving wife
And told her 'bout the factory.
She hugged me and she kissed me
And she cried a little bit
As she sat on my knee.
I don't understand
All the buttons and the lights
But one thing I will say -
I thank the Lord that love's still made
In the good old-fashioned way.

(Courtesy: *American Labour*)



I CAME TO TELL YOU, I'M RESIGNING

Our Friend—The Machine

I Minsker*

If science fiction writers are to be trusted, man's destiny in the coming epoch is irrevocably bound with computers. *"Thinking" machines are gaining a firm foothold in man's life.* **Do we not set too much hope on them? What are they? Are they our friends eager to free us from hard and tiresome mechanical work or are they our treacherous rivals? These are some of the difficult questions this great Russian technologist seeks to answer in this article.**

THE FIRST COMPUTERS, WHICH APPEARED in the 1940s, were cumbersome structures. The first American computer MARK-I (1944), despite its impressive dimensions, could not memorise more than 72 numbers and took from 1 to 6 seconds to make an addition or subtraction: its counting speed had no significant lead over that of man.

The position is stupendously changed today. Take, for example, the average capacity of the Soviet computer "URAL-II." In spite of its smaller size, it can store in its memory nearly 8 million figures, making up to 50,000 additions a second. And there are such powerful modern computers which are capable of doing a million additions within a second!

Today practically every branch of science and engineering is using computers. Highly complicated but accurate computations are being effected today. Computations today include jobs like modelling of chemical and biological processes, processing of scientific observation results and search for information, computation of satellite trajectories, control over rockets and airplanes, planning of production and weather forecasts, medicinal diagnoistics and translation from foreign languages and this list of computer occupations could be continued *ad infinitum*.

Only quite recently the researcher was spending most of his time on laborious mechanical processing of observation and experimental results. **Now the scientists life has, so to speak, lengthened.** For instance, the computer DNEPR-1 installed on board the Soviet research ship "Lomonosov" effects, while the ship is at sea, the processing of all experimental data collected by the researchers. Previously it took a year and a half or two years to cope with the same task on shore.

Design of a boiler or a turbine for a large power station used to take months of collective work of a large number of qualified engineers. Today the job is done by a computer within hours, and what is more, **the computer can even examine several design versions and pick up the optimal one**!

Computers are finding a particularly large application in production management, starting with production planning for an entire industry and ending with control programmes for separate machine tool or a reactor.

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*The author is M.S. Technology, (APN). This article was obtained through the good offices of Mr. V. T. Sygankov, Press Information Officer of the Information Department of the USSR Embassy in India.

The computer system 'complex' effects full control over power sets of 200 thousand kilowatts. The machine keeps a vigilant eye for the readings of about 2,000 devices, immediately gives a signal in case of a fault, keeps up the required temperature and pressure without human help, computes technical and economic indices, starts and stops the power unit.

To be able to control a chemical plant, the despatcher must be informed about the progress of work in every plant department. The 'KASKAD' system based on the 'URAL-II' computer analyses the production situation at the plant and gives out a recommendation about what should be done to avoid a breakdown or to raise the plant efficiency.

The electronic computer DNEPR gives advice to the oil refinery operator. Another machine of this type is helpful to the steel founder in deciding on the optical smelting regime. Similarly a railway despatcher receives invaluable help from 'AUTODISPATCHER' computer arrangement to decide within seconds where to direct the incoming trains.

Another interesting example is that of a person, suffering from a serious ailment, coming to a middle-aged experienced physician for consultation. The "electronic physician" built on the basis of 'URAL-II' computer is very young, but, nevertheless, its experience and knowledge are something to be envied. For various heart ailments alone it holds in its memory about 1,000 symptoms. The machine examines the patient and results of diagnosing each new patient contributes to the experience of the automatic physician.

In many schools and colleges there have appeared the teacher's automatic aids—teaching machines. Thus, for instance, a teaching complex based on the DNEPR computer can teach at once as many as 150 students in various courses. The machine gives assignments to every pupil separately, controls his answers, points out mistakes, offers properly assimilated material for repetition and finally puts an absolutely objective mark. **It is impossible to deceive this examiner or expect clemency.**

Electronic computers do translation work into Russian from English, German, French and many other languages. True, there are technical translations; **poetry is yet beyond the computer power.**

But where is this all taking us? Thousands of engineers and scientists are being employed for rendering mankind's knowledge and experience in the computer language. Potentialities of "thinking facilities" are expanding every year. Does it mean that we shall in the end be replaced by automatic machine operators, steel founders, physicians and teachers?

We need not be afraid of this. **The emergence of excavators brought about the extinction of the earth diggers; with the advent of motor car the cabman sank into oblivion. As a substitute some new professions appeared: pilots, spacemen, physicists, and programmers.** Think of the many new, wonderful prospects opening up before the human mind freed from mechanical mental drudgery! Furthermore, why should we forget that the 'wisest' machine is nothing more than the product of human brain and hands. So, man need not be afraid. He is and will ever be the creator and ruler of all technology. ●●●

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IFOC-91

Impact of Computer on Organisational Structure

B Hartmann*

The traditional organisation of the firms is affiliated with the historic industrial development depending on the first industrial revolution. The concept of performing physical work was also adapted to business work. The computer is affecting the traditional structure of the firm due to its technology. Actually the computer and the commercial EDP represent new organisation systems. The clash of the computer requirements with the traditional organisational structure is unavoidable.

The scientific and practical problem is to reduce reliance on traditional approach, create new systems and adapt them to the needs of the individual firm. The new systems must include routine and creative functions (decision-making).

No other technical innovation has changed so many activities in business administration in so short a time as the computer. The EDP means an extension of man's brain power more than any implement man ever invented; it is also transforming administrative work.

FIRST INDUSTRIAL REVOLUTION REplaced hand work by machine work. It is estimated that up to now production ciency (rate of productivity) has increased 1,000 and 2,000 %. Considering istration work, the rate of productivity d not develop higher than about 100%.

Administration activities are mostly routine referring to thinking and also manual Administration work was, till the last supported by office machines like ypewriter, book-keeping machine, desk iter etc. The next step of development mechanical data processing by punched system and the last step during the last ade started a real revolution in business ration and management activity by puter-aided organisation systems.

Unique Implement

One thing that makes the computer unique among all technical implements is that it enforces to think how the work has to be performed with the greatest precision. All other devices ever invented can be handled by a certain routine programme of operating — even the most complicated implements like jet planes or submarines. EDP processing for business applications requires infinite creative work for making computer usage highly efficient. Two factors need consideration:

i. Computer costs (for purchasing or renting) are getting cheaper. Thus the break-even point for economic application on a broad scale is dropping down.

ii. The organisation of a firm is changing permanently due to changes of its programme and often continuously growing.

(To be continued in the next Issue)

*Dr. B Hartmann is Professor at the Technical iiversity, Berlin-West. He conducted for us a numof highly successful programmes on Electronic Processing.

The BLS* Data Bank and Information System

Rudolph C Mendelssohn

A data bank based on a computer system for storage, retrieval, and reduction of numeric information has been in use at the Bureau of Labour Statistics for nearly three years. Its major attribute is that it gives our social scientists direct use of the computer as a common tool in their analysis of economic affairs while bypassing the need for writing a computer language programme on a job-by-job basis.

INFORMATION IN OUR DATA BANK IS important in the nation's historic record. Monthly summary figures on local, State, and national employment, hours of work, pay and labour turnover are included. Figures compiled for BLS by the Census Bureau from the monthly current population survey are stored. These statistics include current and past labour force summary data on employment status, occupation, industry, class of worker, duration of employment, sex, age, colour, marital status, household relationship and education. Together, these two sets of manpower data comprise about 25,000 published monthly time series, as well as many unpublished series. The data cover mainly the post-World War II years, although some series span the period between the wars as well.

Other manpower figures collected on an annual basis are also stored. These data include, for example, cross section, or one-time statistics on employment of scientists, engineers and technicians by occupation and industry.

Most of the figures now in our data bank are generated by the Bureau's Office of Manpower and Employment Statistics. But statistics from other major Bureau programmes, such as information on wholesale and retail prices and occupational wage data, will eventually be included. It is estimated that our total file of BLS data alone may exceed 100,000 time series. Series compiled by other agencies are also stored. The Federal Reserve Board's current and past monthly figures on industrial production and the Office of Business Economics' annual gross national product data are examples. More data from outside our agency will be added as the needs of our economists dictate. The system itself sets no limit on the amount of data which can be banked.

Our social scientist has access to a large library of statistical programmes which will accept retrieved or calculated data. Each of these programmes will perform a unique statistical reduction on the values specified. The BLS Information System also provides a way of setting down computer instructions in words like those we use in our day-to-day work; they are employed by clerical personnel to make numeric tables, as well as by professional staff for sophisticated statistical analysis. (*To be continued in the next Issue*)

*Bureau of Labour Statistics, Ottawa, Canada

Manitoba's Victoria Hospital Project

BA Hodson*

ON FEBRUARY 12, 1968 AN EVENT OCCURRED in Manitoba which may have far-reaching effects on hospital care in North America and around the world.

On that date, Winnipeg's Victoria General Hospital went 'on line' for three hours per day with the University of Manitoba's large-scale IBM-360/65 computer located some 6-1/2 miles away. As programmes and systems are debugged this year, the 'on line' operation will be extended until it runs around the clock seven days a week.

This event also had significance for computer development generally. It was the start-up of one of North America's first general purpose computer utilities, operating an "on line" information system (Victoria Hospital) simultaneously with other remote and local terminals, the other terminals feeding all types of job activity to the central system, and plenty of it.

Some are located 75 miles away in the Canadian atomic energy research community at Pinawa, Manitoba. One is in the University's faculty of medicine, and others around the University's main campus doing research, teaching, and managerial jobs as well as controlling a smaller computer which is connected 'on line' to a cyclotron. A very large computer is made available to the Victoria Hospital project, but the cost is shared with hundreds of other projects.

*Director, Institute for Computer Studies, [U]niversity of Manitoba, Winnipeg, Canada

Why is this event so important in the hospital field? For the past several years a number of organisations in several nations have been attempting to establish a way to process by computer doctors' orders, progress notes, admitting and discharge functions, lab reporting and other hospital activities. The millions of dollars being put into these projects is little enough considering the benefits which will follow success in any one of them.

Although much remains still to be done before the Victoria Hospital system is fully operational, there is now enough experience with it to demonstrate that it can work. Doctors' orders and other hospital data are being entered into the hospital so well that it is expected to achieve better patient care.

At the present time one complete ward is being used in the development of the hospital system. Through several Cathode Ray Tubes (CRTs)—similar to a household television screen—doctors, nurses and other hospital personnel can enter hospital transactions into the computer system, operating in what is termed a conversational mode. As an example, six responses to information presented by the computer on a television screen in the ward can order 50 mg of codeine to be given to Mrs. Jones in Bed 14, three times a day for two days. This two-way communication takes 45 seconds, an abnormally slow time for the computer because it is accepting data at a speed suited to the humans who must be in touch at every point. The computer will automatically generate that order in the pharmacy, note it on the patient record, advise the nurse on each of the six occasions, reduce the inventory record in the pharmacy and advise when a new supply of codeine needs to be ordered. At every step it will carry out checks to ensure that no overdose has been ordered and that no allergies are being forgotten.

While earlier systems needed dozens of computer programmes, a single computer programme carries out all this activity. This economy in programming has been achieved by developing what is termed a generalised system and matching it with a generalised computer programme. It is possible to alter the system readily and use it with English, French, German and other languages presented on the cathode ray tube. Use of the system can be taught quite quickly, as can ways of modifying the system; one group of practising doctors at the hospital have been developing their own screen data for presentation on the CRTs.

In addition to its potential for better control of patient care, the system eliminates much clerical activity now carried out by professional personnel in the conventional hospital setting. Nurses are able to return to the bedside.

The system is even expected to slow increases in hospital costs. With a shared computer facility, computing costs themselves can be kept low. A number of new staffing patterns being tried in conjunction with the automated system offer various potential benefits, including both cost efficiency and better care.

Computers Boost Air Traffic

Picture yourself about to fly in a $ 21 million superjet. Weighing 350 tons, it is nearly double the size of today's biggest jets, and its 195-foot wing-span would reach more than half the length of a soccer pitch. The pilot is perched three storeys high; the tail is as tall as a five-storey block of flats.

Four great turbines, with 43,500 pounds of thrust each (about 20,000 horsepower), send this superjet roaring down the runway, and you settle back to a feature-length film, television, stereo music, or the day's news and stock-market quotations via communcations satellite. There, "no-wait" baggage handling delivers your luggage to you in five minutes.

Following a year's rigorous testing, they will go into service around the world in late 1969. At the four main airports in India—Calcutta, Madras, New Delhi and Bombay—plans are being made to handle jumbo-jets.

Air Passenger travel is expected to treble in the next ten years, and air freight to increase eight to ten times. Experts predict that by 1980 some 600 million people will be travelling by air. If that many passengers used present-size aircraft, the world's airports would be choked with an impossible 24 million plane departures a year. But with the 747 and other planes of comparable size in service, the number of departures by 1980 can be held to 15 million.

Because the 747 will operate at 30 to 35 per cent less cost per seat-mile than today's big jets, it is likely to lead to reduced air fares: And, with its 110-ton cargo capacity and lower break-even point, it might well revolutionise air freight in terms of bulk and cost Boeing will produce an all-cargo model whose automated equipment will load or unload it in 30 minutes. It should mark the coming of age for efficient containerised freight service.

Behind the Boeing 747 is one of the biggest engineering gambles in aviation history. The Stakes: a potential $8 thousand million in sales. Anticipating mounting air traffic, Boeing began to plan the jet in 1963. In time, the company assigned 2,500 engineers to the project, chalked up ten million man-hours in basic engineering, spent more than $ 1 thousand million on research and facilities. For example, engineers dealt with some 20,000 pieces of data in designing the nose section alone. Each aeroplane will require 273,000 parts, as well as about 200 miles of wiring To provide all this, Boeing computers already catalogue over 200,000 million different bits of information.

Applied Cybernetics in Poland*

Speaking about Polish achievements in cybernetics it would seem only natural to begin from a review of theoretical work in this field. Since, however, the very interesting things which are being done are so much connected with the good traditions of the Polish mathematical school, we have decided to concentrate rather on a few selected works from the field of applied cybernetics which are much easier to present in an understandable way to readers who must not necessarily be experts in the subject.

AUTOMATIC DIAGNOSING IN DISEASES IS THE first example of cybernetic experimental and research work we should like to discuss in this feature. Work on this problem in Poland is concentrated in the Prognoses Methods Section of the Computing Centre of the Polish Academy of Sciences in Warsaw.

Mathematical Model

As a matter of fact, the problem is confined to the development of a mathematical model which might provide a basis for preparing a perspective programme for a computer. Such a model should stimulate, as accurately as possible, the mental process occurring in the brain of a doctor before he puts forward a diagnosis. In this process the data collected during the patient's examination are the initial material and a concrete medical diagnosis is its final result. The task would be relatively easy to fulfil, should the symptoms in a given disease have an unambiguous character and be related only with a specific disease. In medical practice, however, it is often the case that identical symptoms occur in various diseases. To develop a mathematical model, it is, therefore, necessary to calculate statistically the frequency of occurrence of a specific symptom in the disease in question. Medicine has so far no statistical data of this kind and these had first to be collected by the Section's staff.

For over a year a group of several researchers were working on the theoretical side of automatic diagnosing. The result of this work was a programme which enabled automatic diagnosing in the individual types of diabetes and on the basis of proteinograms and electrocardiograms. In 90% of cases the diagnoses put by a computer were identical with clinical diagnoses.

Why Diagnose With Computer ?

Someone may ask what for all this was necessary? The answer is simple. Even the best specialist may commit errors, may be mistaken. **His work cannot be replaced completely even by the best machines;** still, a machine may be very helpful in reducing to a minimum the number of errors.

*By a Correspondent from Poland, Polish Agency Interpress : The manuscript was made available through the good offices of the Polish Embassy in New Delhi.

Modern methods of examining a patient provide such an enormous amount of information about the state of human organism that it is hardly possible for a doctor to remember it or to analyse it. Jozef Wartek, M. D., and Head of the Prognoses Methods Section said: "A doctor is often swamped with an abundance of data which often say nothing to him."

There are also other reasons that speak for the use of computers in diagnostics. Computers make it possible to avoid various diagnostic mistakes which are usually unavoidable in traditional medical practice and which mostly are due to the lack of time, on the part of a doctor, for analysing all diseases which give the symptoms found in a patient. The diagnosis put by a doctor may also be wrong because of the doctor's actual psychical predispositions, excessive optimism, pessimism, etc.

Computers are particularly helpful in diagnosing—especially for doctors with a short clinical experience, for ship's doctors and those accompanying geological or polar expeditions and (in a more distant future) also for the space vehicle doctors. Computers also make it possible to automatise certain examinations and test procedures, e.g. biochemical checks, which do not require the participation of a doctor. Let us believe, Dr. Wartek concluded that the use of computers in medicine will not break completely the links of personal contact between a patient and a doctor—the contact which so far has been playing an important psychotherapeutic role.

Fields of Research

The examination of living creatures in order to establish analogies between their behaviour and the functioning of machines has been one of the most important fields of cybernetic research. Cyberneticians watch the circulation of information in the world of living nature and utilise the results of their observations in building various technical devices.

The human brain, this finest product of nature, is one of the main subjects of concern for cybernetics. Our present knowledge about the structure and functions of the human brain is fairly modest and various models built in an attempt to imitate these functions (electronic brains) can hardly withstand competition with the natural model. This is just the problem, a very complicated one with which the researchers from the Institute of Automation in Warsaw are concerned. **In cooperation with neurologists, they have built an electronic model of a neuron—the living cell and the basic element in the central nervous system. Forty models of neurons have been made into an experimental neuron network.** This work, according to Docent Andrzej Straszak, Deputy Director of the Institute, is a starting point for a wide research pro ramme which is also important for the national economy as a whole. The rapid progress in industrial automation calls for better and better automation instruments and plant, capable of replacing man in a growing number of functions of a more and more complex nature and in taking complicated decisions in various doubtful cases and when the cause of a breakdown must be automatically found and repaired. **This versatility and flexibility are an inherent feature of the human central nervous system.** It consists of **millions of neurons** and our specialists try to build models capable of simulating their functions. On this road they seek solutions to many problems connected with the automatic control of production processes in industry.

It is worthwhile emphasising that the building of models, the task of which is to imitate various physiological phenomena occurring in the nervous system so important for the theory of automation, may also be very useful for biologists and neurologists; for these models may facilitate the verification of their hypotheses about the functions of the individual parts of the nervous system.

Machine That Reads

A machine which can be taught how to read is called by the experts a "percepthron". Such a machine is now under construction in another section of the Institute of Automation.

Until recently the "intelligence" of machines had rather weak foundations due to the lack of the machine's own cognitive organs. All information from the outer world can be received by the machines in a very simple, ready-to-use and absolutely legible form of elementary electrical signals. The machines can solve complex logical and mathematical problems but at the same time they are helpless when it comes to a self-dependent distinguishing of the individual digital symbols which is done so easily by a little child who knows nothing about higher mathematics.

The matter is fairly complicated. It would be difficult for a machine or rather for its designer to decode even the content of electric signals supplied from a hand-operated torch in Morse code. The duration of the dash symbol should then be exactly three times as long as that of the dot symbol. But this is hardly possible in practice. A man can understand an information supplied by a signal irrespective of the signal's accidental deflection just as he distinguishes a "flattened circle" from a "rounded ellipse" or as he distinguishes the individual letters irrespective of the handwriting or the print type used.

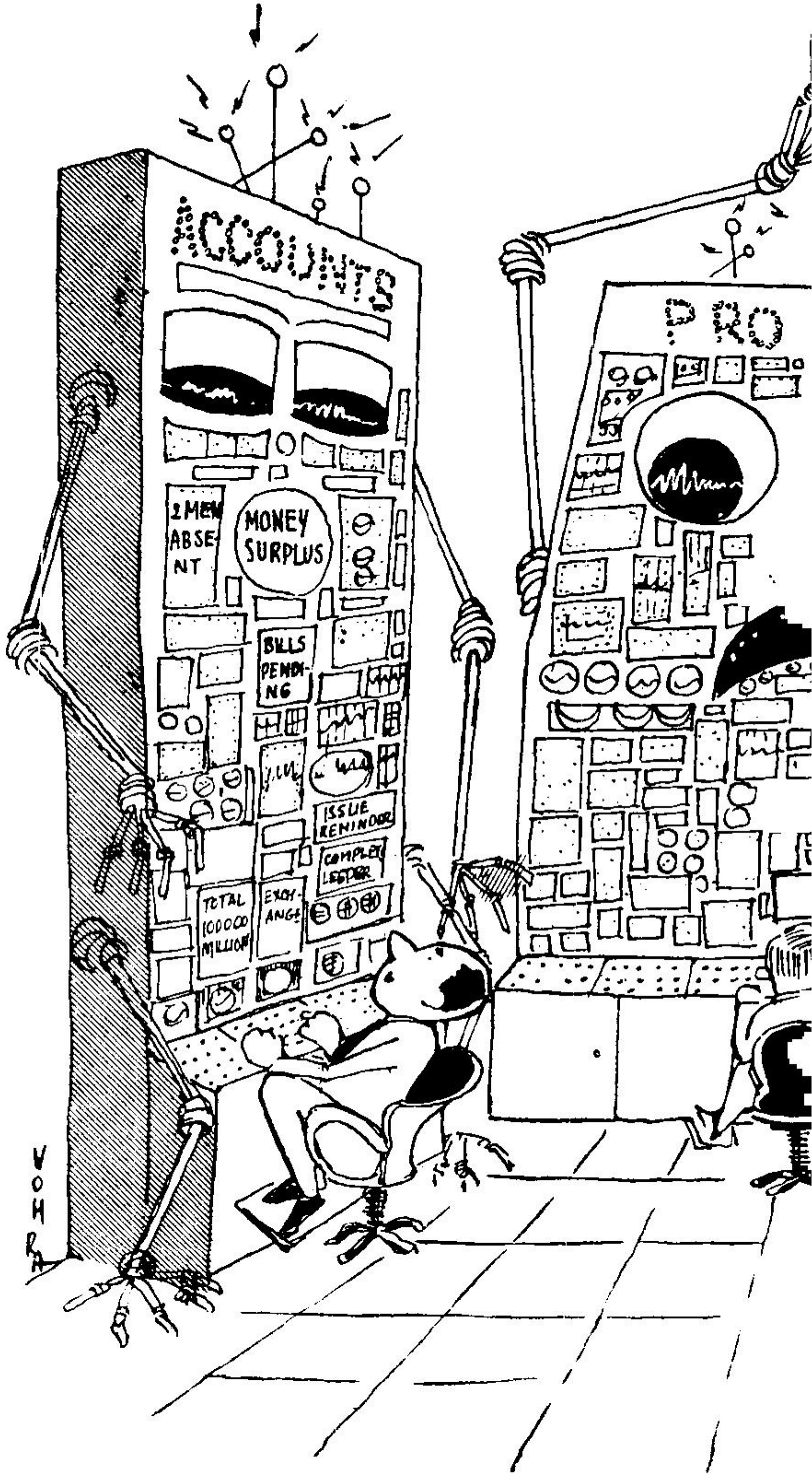
To build a machine capable of transforming abstract information into concrete information —an ability which until recently was an exclusive domain of human brain—is the problem on which the designers of the "percepthron" are working presently. The main problem to be overcome is how to develop a programme for a machine which would make it possible for it to suitably classify the information on the basis of comparison with the memorised standards with the due consideration of the probability a factor which comes in question when we have to distinguish shapes which for this or that reason are dubious or ambiguous.

It should be emphasised that these are the first steps in the new realm of research, a domain which for many reasons seems to be very promising. Its development may also contribute to a better understanding of the physiology of the preception processes, so close practically to everyone of us and still so distant as regards the knowledge of rules directing them. ●●●

Cabled From Peking In Mandarin And Interpreted By A Computer

"As a conscious means of hopefully competent participation by humanity in its own evolutionary trending while employing only the unique advantages inhering exclusively to the individual who takes and maintains the economic initiative in the face of the formidable physical capital and credit advantages of the massive corporations and political states I seek through comprehensively anticipatory design science and its reduction to physical practice to reform the environment instead of trying to reform man also intend thereby to accomplish prototyped capabilities of doing more with less whereby in turn the wealth-regenerating prospects of such design science augmentations will induce their spontaneous and economically successful production by world-around industrialisation's managers all of which chain reaction-provoking events will both permit and induce all humanity to realise full lasting economic and physical success plus enjoyment of all the Earth without one individual interfering with or being advantaged at the expense of another.

—*Fuller's Earth* by Alan Brien, *New Statesman*, 1 March 1968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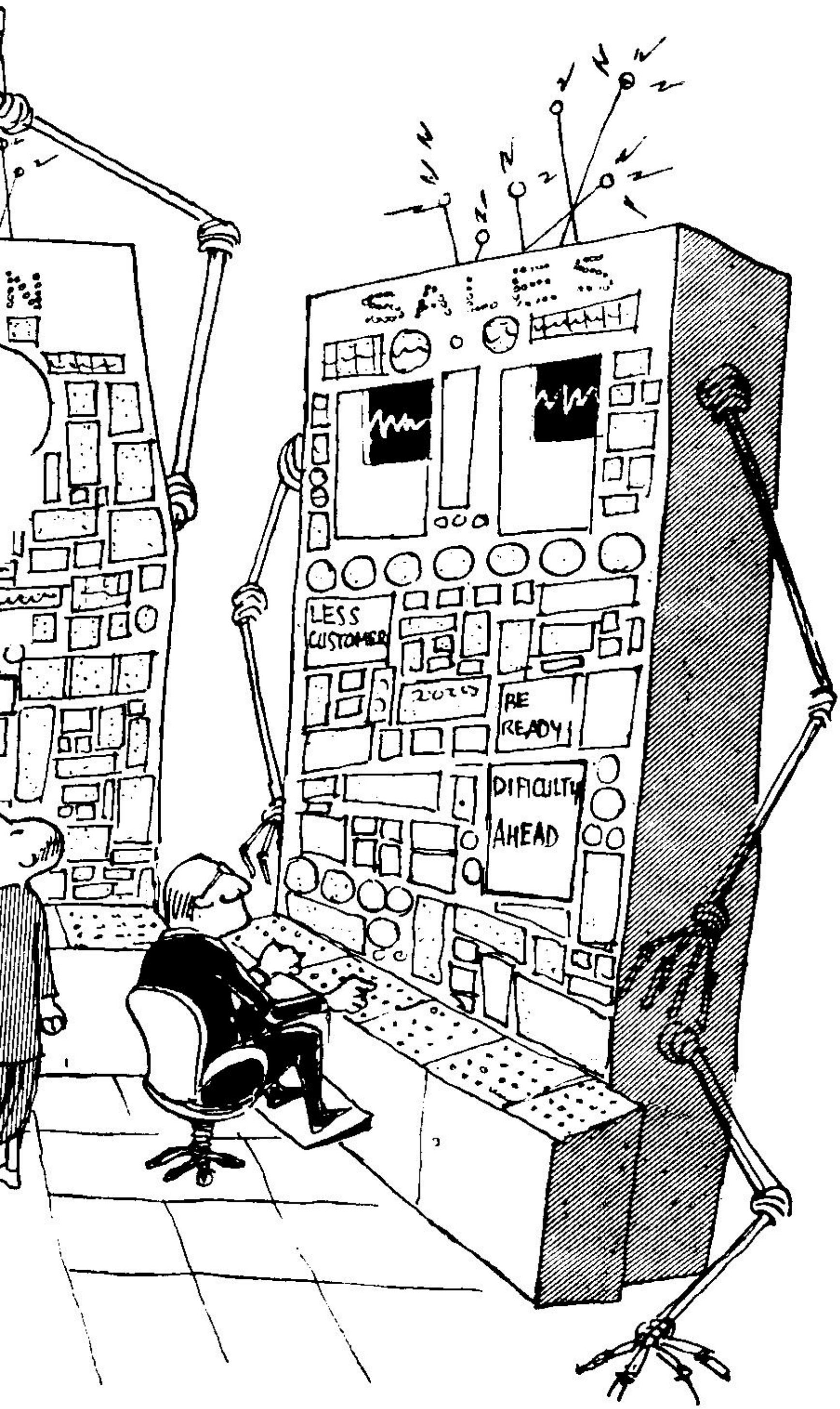
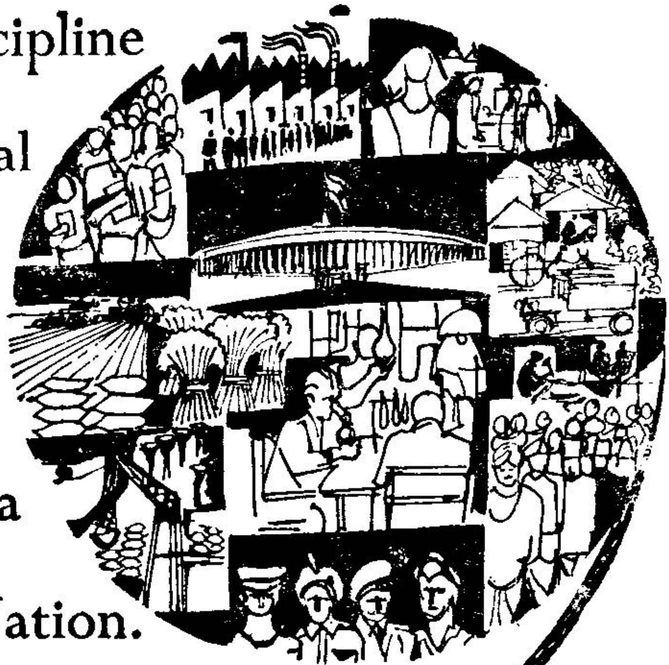

LESS CUSTOMER
BE READY!
DIFICULTY AHEAD

Discipline builds the Nation

"Mass Discipline is an essential condition for a people who aspire to be a great Nation."

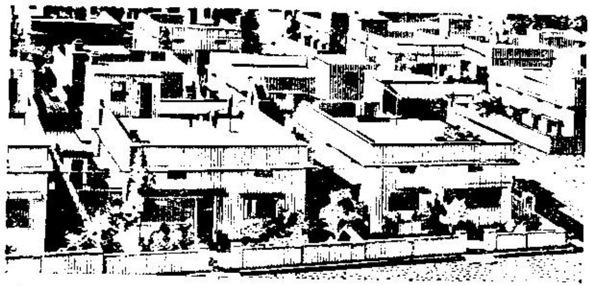


MAHATMA GANDHI

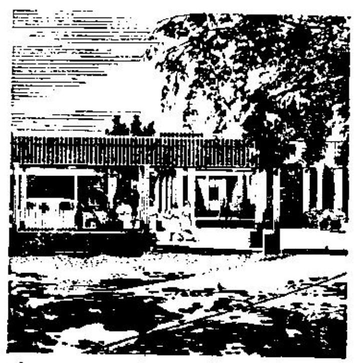
MAHATMA GANDHI
BIRTH CENTENARY
OCT. 2, 1968 TO
FEB. 22, 1970
महात्मा
गांधी
जन्म शताब्दी
अक्तूबर 2, 1968 से
फरवरी 22, 1970

The Garden city 60 years ahead of its time

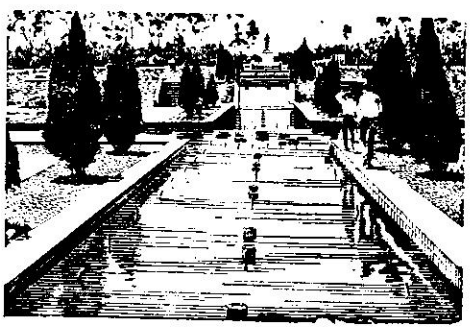
Jamshedpur, the steel city, is full of trees and flowers! In fact, it is one of India's most beautiful cities. And the amazing thing is that Jamshedpur was conceived and planned exactly as it is today, more than 60 years ago, long before planned cities became common even in the West.



Sonari—an underdeveloped area transformed. Under a phased programme, Tata Steel has helped the people to convert 20 underdeveloped areas into beautiful localities, with well-lighted roads and adequate water supply.



The Tata Main Hospital. In addition to this well-equipped 600-bed hospital, Tata Steel has contributed to the setting up of an 82-bed TB hospital with a special children's ward.



Jubilee Park. "Flowers, parks, and trees supply something which is, I imagine, of more basic importance to human beings and the human spirit than even iron and steel and it was a very happy thought to... provide this beautiful park."

Jawaharlal Nehru

Our strength is in our people as much as in our steel.

TN 4438

TATA STEEL

Automatic Data Processing in Israel

Dov Chevion*

Automation in management and for scientific use in Israel is growing by leaps and bounds. Every year when we take an inventory of our computers and count the "possessions" that we have accumulated, we find once again that our rate of development is quite impressive. In the period of time between 1963 and 1968 the number of computers has been five times as great and it is expected that by the end of 1970 the number will be ten times as great or more.

THE NUMBER OF COMPUTERS INSTALLED by the end of 1967 was 80: this naturally includes computers of all sizes and capabilities. By the end of 1970, the number of computers functioning will reach 130, an increase of 65% over the present situation (see Table 1).

TABLE I

Computers by unit and rate of growth 1963-68

Year	Number of Computers	Rate of Growth	
End of 1963	13	50	100
End of 1964	27	100	200
End of 1965	40	148	300
End of 1966	70	258	540
End of 1967	80	296	615

Of course, one cannot regard the number of computers as a realistic figure since the capacity of the computer is not taken into consideration. That is, the complex computer is counted as one unit, the same as for a much simpler one. Therefore it is preferable that we calculate the expected growth, taking into account either the size of the investment or the variations in the total monthly rentals. Actually, on the basis of monthly rentals, the anticipated growth is only 45% which represents a sizable percentage of growth as well (see Table II).

TABLE II

Computers by unit and estimated monthly rentals

Year	Number of Computers		Equivalent of Computers in monthly rentals	
	Number	Rate of Growth	U.S. Dollars	Rate of Growth
End of 1965	40	100	355,000*	100
End of 1967	80	175	515,000	145
Absolute Growth	40	—	160,000	—

*Chairman of the Information Processing Association of Israel

*Does not include about 125,000 dollars for punched-card machine equipment

The difference in the percentage of growth for the near future illustrates, first and foremost, **the increasing tendency to use small and medium-sized computers** rather than the large, powerful ones. A second factor which comes into consideration here, a commendable new improvement of the third- and fourth- generation computers over the second-generation computers, is the **comparative decrease in cost of power** and even of power greater than that typical of most of the computers presently maintained in the country.

The addition of small and medium-sized computers, which in most cases replace punched-card installation, has raised the question whether or not this method of automation development in management is correct. From the standpoint of organisation of computer units and of planning and systems analysis we cannot overlook the new and special problems that accompany this tendency.

In any case, Israel is coming closer and closer, in its number of computers per million workers (excluding agricultural labourers) to catching up to the more developed European countries. **The number of computers per working million, not including agricultural workers has increased from 37 in 1964 to 53 in 1965, and 97 by the end of 1967.** This is a great achievement in comparison with the rate in smaller European countries.

A glance at Table III will immediately illustrate the fact that the rate of growth in the number of computers in the years 1964-67 in absolute number is equal to the rate of growth attained from the ratio of computers per million workers (agricultural workers excluded).

This will change towards 1970 assuming that the number of computers per million of working non-agricultural population will amount to 150, the same as for the countries of the Common Market.

Because of the relatively large growth in population in Israel the absolute number of computers will have to reach 480, while the ratio of computers per million working population will be only 405. It seems that a definite under estimation was made in the predictions put out through the research sponsored by the Common Market countries.

On the other hand, this pace has aroused **the basic question whether the advancement of automation in management and for scientific use is basically quantitative or qualitative.** The value of automatic data processing is dependent on the answer to this question. Of equal importance are other questions that have put the development

TABLE III

Computers by unit and by relation to million working population (1964-70)

Year	Number of Computers		Computers per million working population (not including agricultural workers)	
	Number	Rate of growth	Number	Rate of growth
End of 1964	27	100	37	100
End of 1965	40	148	53	143
End of 1967	80	258	97	262
End of 1970	130*	480	150	405

*Computed under the assumption that the number of computers per million workers (excluding agriculture) will be equal to that of the countries of the Common Market which is 150, as the special research that was sponsored by the Common Market showed. In Israel, by 1970 (under assumption of 3 million population) there will probably be 130 computers. If the rate of growth remains as it is, there is no doubt that there will be a greater number of computers. Also the number in relation to a million working population will be higher than 150. As it appears, the forecast of the research by the Common Market reveals an underestimation. We do not assume that we will exceed the countries of the Common Market in this field by 1970.

of automation in Israel to a difficult test during the last year:

Has there been advancement in the areas of training and manpower capacity?

Has there been an increase in the diversity of the fields of applications?

Have we developed in our standards of organisation and in methods of planning and programming for the computing systems?

Last but not least, has theoretical research in data processing methods progressed during the past year?

Let us try to examine the development in the field of electronic data processing in the light of these questions.

No single condition is more important for the productivity of data processing than the presence of manpower on a high professional level, which is able to manage, plan and programme the work for the computer. As obvious and reasonable as it may seem, we find in practice that the decision regarding the expenses of acquiring or renting equipment, which far exceed the cost of training professional manpower, is much more readily taken than that regarding the expenses of training. The cost of new computer equipment is expected to rise to 18 million pounds in the next two years (see Table II). We can assume that the training of the systems analysts and computer programmers for the successful operation of this expensive equipment will cost two million pounds, which is 10-11 of the entire investment. Although this is a relatively small expense and objectively a necessity—it is doubtful that the members of the administrative staff who account for expenditures, are prepared to agree wholeheartedly on the additional expense to **ensure productive use of these expensive tools.**

However, this gap regarding the needs of professional manpower necessary for developing systems planning and programming, is due not only to the **lack of understanding by the administrative staff of the need of training,** but also to the lack of a stable and defined course of instruction. There are **no recognised programmes in the study of data processing on or above the high school level.**

The IPA (Israel Information Processing Association) began taking steps towards solving this problem in conjunction with the competent authorities: the Ministry of Education, the Labour Department, and the Universities. Special training committees were organised. Progress has been made, but the results are not as yet satisfactory. Despite the definite increase in the number of professional workers in the country, there is a broad gap between what is needed and what actually exists. The solution to the problem of the value of automation in management lies in narrowing this gap in relation to professional manpower.

As we continue to establish defined programmes for suitable instruction of data processing on various levels, including universities, high schools and instructional seminars, successful automation in management will increase.

We are now witnessing a period of transition to a new stage in automatic data processing, that is, **a change from book-keeping systems to information systems.** Therefore, a dynamic approach is needed to employ scientific tools in management and create coordination and compatability between the various data systems within undertakings and institutions. The greater the delay in advancing to a higher level of data processing in management and the more we abstain from varying the applications to their maximum ability, the greater will the future development of automation in our country be affected.

Although we have learnt a lesson from the experience of countries developed in the field of data processing, our approach concerning organisation of computer systems and planning of work methods is still far too conservative. **Our thinking has been, to a great extent, within the framework of manual and conventional equipment.** No change has taken place as yet—except for a few exceptional cases—with regard to the forms of input/output, or in other words, the methods of information and data transfer. The problems of communication have not yet received sufficient attention and examination in Israel. Along with the noticeable tendency toward the growth of small computers, there is a neglect (which might be destructive) of time-sharing methods, of the necessity for the use of methods of planning and languages of programming that should be as independent as possible of the type of computer, and finally of the promising possibilities in many cases of use in Service Bureaus and Computation Centres.

In all these fields there is a **need for original Israeli research,** which is still absent. There is an essential need to nurture this research and to **free the organisation and methods of data processing in this country from the bonds of conservatism.**

Progress in research in the field of data processing is the key to the productive exploitation of the computer.

A heavy responsibility, to obtain the full benefits of automation in management and scientific research, lies on public management and mainly on government management. This does not refer to legal supervision but is a result of the dominant role this sector plays the field of data processing in this country which is much greater in comparison to the United States and Western Europe. At the end of 1965, 55% of the number of computers were in the hands of the government, its municipalities, and companies, while 70% were in government ownership in terms of investment. However, there are positive indications that there will be a steep (relative) decrease in this sector, as the number of private computors increase markedly. By the end of 1967 the number of computers in public management decreased about 46% or in terms of investment, to 57% of the total sum.

The different rates of growth of public administration and the other branches is depicted in Tables IV and V. In the years

TABLE IV

Number of Computers by branch in the years 1964-67

Branch	Installed at the end of 1964		Installed at the end of 1965		Installed at the end of 1967		Rate of Growth		
	Unit	%	Unit	%	Unit	%	1964	1965	1967
(1) Public Administration including companies*	16	60	22	55	37	46	73	100	168
(2) Other Branches**	11	40	18	45	43	54	61	100	238
Total Sum	27	100	40	100	80	100	66	100	200

*Includes government, municipalities, national institutions, universities and government companies
**Today includes: banks, union installation, cooperatives, and private service bureaus

TABLE V

Monthly Rentals by branch, 1965-67

Branch	Monthly rental at end of 1965		Monthly rental at end of 1967		Rate of growth	
	$	%	$	%	1965	1967
(1) Public Administration including companies	236,000	70	295,000	57	100	121
(2) Other branches	117,000	30	220,000	43	100	188
Total Sum	353,000	100	515,000	100	100	145

1965-67 there was a growth of 68% in terms of the number of computers in public management, or, in respect to investment, a growth of 21%. The percentages for all other branches are 138 and 88 respectively.

Despite the expected decrease in public investment, as a result of the increase in the number of small-and medium-sized computers, the correct and productive development of automation in Israel, especially in the field of data processing, is dependent mainly on leadership from public administration. Proper government action in the field of automation taken by its central bodies—the Committee on Automation and the Computation Centres in Military and Civil Administration will offer a significant guarantee that the future development of data processing will be not only quantitative, but also qualitative.

A large measure of responsibility lies with educational institutions of the high school level and above. The infusion of a deep awareness of automation into the top-level managerial staff, and the acquisition of knowledge, based on authoritative courses for automatic data processing for professional levels—systems analysts and programmers are now a **must.**

We must rapidly close the gap between progress in automatic data processing and supply of manpower. Closing this gap is necessary for the sake of assuring the development of automation, especially in a country that is poor in natural resources. Automation can play a major role in Israel's economic development.

In conjunction with all other proper authorities, IPA is trying to contribute its share to the advancement of automation in management and scientific research. This Convention represents the outcome of these efforts. In its framework the key problems of data processing are considered: education, the need for broadening application to social sciences, the future of time sharing, and general programming languages. ●●●

Einstein on Computer

Albert Einstein was interested in almost everything, and gave every topic and visitor his undivided attention. But sometimes he would rise abruptly—even in the middle of a sentence—and say apologetically," I have to work now." Whereupon he would retire to his study, leaving his wife and secretary to entertain the guest. There was nothing offensive about this; it was obvious that Einstein's brain had started to spin, and that he "had to work." It seemed as though he had received orders from elsewhere . . . .

Computer Controlled Water Supply in Israel

Frank Moser[1] & Ilan Kroch[2]

ISRAEL IS A SEMI-ARID COUNTRY. RAINfall occurs mainly during the four or five winter months and ranges from a thousand mm. annually in the mountainous north to under two hundred mm. in the arid south (known as the Negev) which contains most of the country's arable land. Most of the crops depend on artificial irrigation, which has become the primary limiting factor to the expansion and intensification of agriculture. Surface water sources, such as springs and streams, are relatively rare, and water is obtained by drilling into aquifers—the water-holding rock formations. This water is supplied to the consumers through a network of pipelines, boosters and reservoirs.

During the early days of Jewish settlement, water supply problems existed only on a small scale and were solved locally by farmers and communities drilling wells on their property. In the 1920s, a number of cooperative water-supply companies were organised. As the rate of agricultural settlement rose, the problem became more acute and in 1936 the Jewish authorities founded a national water company, **Mekorot,*** which grew rapidly over the years. Its scope included the construction of water works, their operation and maintenance, as well as supply to consumers, who were generally villages or towns rather than individual farmers.

During the early fifties, local supply in the Negev was practically exhausted. Water import was possible from only two areas—the springs of the Yarkon River in the centre of the country and the upper Jordan River and Lake Tiberias in the north. The Yarkon-Negev Project was designed to carry water from the former area. It became operative in 1954, but within a few years prolonged droughts and over-pumping caused a heavy depletion of its sources. Simultaneously, a new Government agency named Tahal (Water Planning for Israel) was created for hydro-

1. Dr. Moser was born in 1930 in Winnipeg and immigrated to Israel in 1952. He received an MSc in geology from the Hebrew University and an MSc in mathematics and a PhD in geology from the University of Michigan. From 1955 to 1959 he was employed by the oil division of the Geological Survey of Israel. He has been with the Mekorot Water Co. since 1963, first as a mathematician, then as head of the operations research department and, since 1965, as EDP manager.

2. Ilan Amit (Kroch) was born in 1935 in Haifa and was a member of Kibbutz Yuvalim (now Yodfat) until 1958. In 1962, he graduated in mathematics at the Technion, Israel Institute of Technology, at Haifa, where he taught mathematics for two years. Starting work with the operations research department of Mekorot, he became its director in 1965. He is co-author of Vectors, Matrices and Analytic Geometry, published by the Technion and of translations into Hebrew from the writings of Kierkegaard.

*The Hebrew word *makor* means a source : *mekorot* is the plural.

logical research and the planning of water projects. Together with Mekorot, it undertook the design and execution of the National Water Carrier Project. This was designed to pump water from Lake Tiberias at 210 metres below to 117 metres above sea-level and carry it through a succession of channels, tunnels, reservoirs and pipelines to connect with the Yarkon-Negev system. The two systems together today form the National Water Carrier.

In 1962, the execution of the national carrier approached its final stage. The engineering staff at Mekorot was entrusted with its operation and integration into the national network. It became apparent to this staff that the operational philosophy for the past twenty years for small-scale independent water-works would not suit a large interconnected system. When it was discovered that the salinity of Lake Tiberias was too high for certain crops, it was decided to dilute the water of the Jordan project along its way south with less saline water from the northern aquifer. This would be pumped into the carrier from bore-holes by boosters distributed along the pipeline. They now constitute the Mixing System. Under pressure from farmers and agricultural communities, the Government passed a law defining the tolerated salinity in water supplied by the national carrier. The increasing demand for water made it necessary to pump the maximum amount from the Lake, which meant approaching the tolerated limit as closely as possible. A delicate balance would have to be maintained for which advanced control and calculating devices were needed.

In addition, the energy consumption of the water distribution system was evidently going to be extremely high. Efficient control of current energy expenditure, which had not played a big part till then, could no longer be avoided. Finally, the scope of the new system made it possible to consider large-scale manipulation in case of faulty conditions and breakdowns which could not be carried out locally. It was decided, for example, to discharge quantities of water underground during the winter as artificial replenishment and storage. All these considerations indicated a need for centralised operational control and planning. It was decided that the new techniques of operations research, systems analysis and the use of computers should be employed in attacking these problems. Experience in Israel of these techniques was limited at that time, and the management of Mekorot concluded that it should seek expert advice from abroad. An international tender was issued outlining the problem and the help required. Of the five most serious bids received, a member of the Elliott Automation Group from Britain was chosen. A joint Elliott-Mekorot team was formed in the summer of 1963. In 1964, the national water carrier went into operation.

The joint team functioned until 1965. It laid the foundations for the operations research department and the computer unit in Mekorot. It initiated work on both the scientific analysis of operational problems and the systems analysis of the company's administrative and commercial activities. It introduced the systematic use of computers. The salinity problem was solved by a computer programme which simulated the activity of the actual system. This made it possible to examine operational plans and to choose the most adequate. A hydraulic simulator was developed as a first step towards more efficient energy control. A basic master plan for control was outlined and the design of the first centralised regional control centre was put in hand. The team was instrumental in the establishment of an operational control centre at the headquarters of the company in Tel Aviv, to supervise and coordinate the operation of the national carrier.

In 1965, Mekorot decided to rent an IBM 360 model 30 computer, for delivery in January 1967. Work on the scientific analysis of operational problems continued in the operations research department. The hydraulic energy simulation programme for the national carrier was completed, as also an automatic optimisation programme for one-reservoir systems. A new method of consumption forecasting was developed and tested. All these efforts were integrated in the plan for a pilot project, where information would be automatically transmitted to the computer, which would display, log and analyse it for more efficient control. This pilot project was developed with the aid of IBM and is at present being considered in detail by the management of Mekorot. According to present plans it should be operative this year. By 1970, we may be able to control the central section of the water distribution system of Israel by means of a computer connected on-line to the system. At the same time the same computer will be performing commercial data-processing work. ●●●

Computer for the Ministry of Commerce

The Union Ministry of Commerce is concerned at the inordinate delays in collection and processing of foreign trade statistics and their adverse effects on policy-making at the Centre.

The Ministry is of the definite view that quicker inflow of commercial intelligence and information on trends in commodity exports will enable it reshape its policies to meet changing situations.

At present in New Delhi it takes no less than three months to get complete commodity-wise statistics of exports, shipped from Bombay, Calcutta, Madras and other major ports in the country.

Part of the delay is attributed to the arduous process of customs verification at the major ports and to the time taken by the Directorate-General of Commercial Intelligence at Calcutta in collating the figures and tabulating them commodity-wise

For instance, New Delhi is now practically in the dark about the performance of individual commodities on the exports front in the last three months, as detailed statistics are yet to be received for the period after October 1968.

This would mean that no corrective action can be taken in respect of any commodity that might have suffered a serious setback in this period due to difficulties which, in normal course, could be easily diagnosed and resolved.

On the other hand, there is every likelihood of a small setback growing in magnitude and defying easy solution if there is undue delay in remedial action. For example, if an important commodity is known to have been priced out in a major foreign market in a particular month, a marginal relief in excise or export duty might enable it to retrieve its position in the following months. But if the same situation is allowed to operate for three to four months, the remedial action might have no impact at all.

In view of the encouraging trend in exports in recent months the Commerce Ministry is keen that a cell should be set up in New Delhi for quick data processing and commodity-wise analysis of export performance each month. The objective is to have a "quick analysis" in the first week of every month of exports in the preceding month.

It is, however, realised that the objective could be secured only by machanisation of the process of data collection and analysis and this would mean installation of a number of computers both in Bombay and Calcutta. This will entail a large expenditure and may provoke unnecessary controversy on the wisdom of automation in this sector.

The Commerce Ministry is, therefore, toying with the idea of having a single computer system at its process cell in New Delhi to process data received from the major ports. The ports will, in turn, be asked to use punch-card system for their day-to-day compilation of statistics. When these statistics are fed to the centralised computer system in New Delhi, the required information on the performance of indivial commodities will readily become available to the Ministry. The information thus available to the Ministry will also help Indian trade and industry to adjust or accelerate their production and export programmes as and when necessary.

***Times of India*, dated Jan. 10, 1969**

Computer for the Bhabha Atomic Research Centre

An electronic digital computer (TDC 12) having a wide use, particularly for the defence of the country, was formally commissioned by Dr. Vikram Sarabhai, chairman of the Atomic Energy Commission, in Bombay, in January.

The first real time digital computer to be developed in the country, the sophisticated scientific tool was designed and built by the electronics division of the Bhabha Atomic Research Centre. The fast computer is capable of performing 25,000 additions and subtractions in a second.

Dr. Sarabhai said it would have a wide spectrum of utility, particularly for the defence of the country. For example, it would help compute the interception of paths of aircraft in the event of an air attack.

Unlike the other computers, the real time computer would keep track of the aircraft even if they change the course.

Built at a cost of Rs. 7,08,000, it had a foreign exchange content of Rs. 1,35,000, Dr. Sarabhai said. Commending the project, he said it was a forward-looking action on the part of BARC.

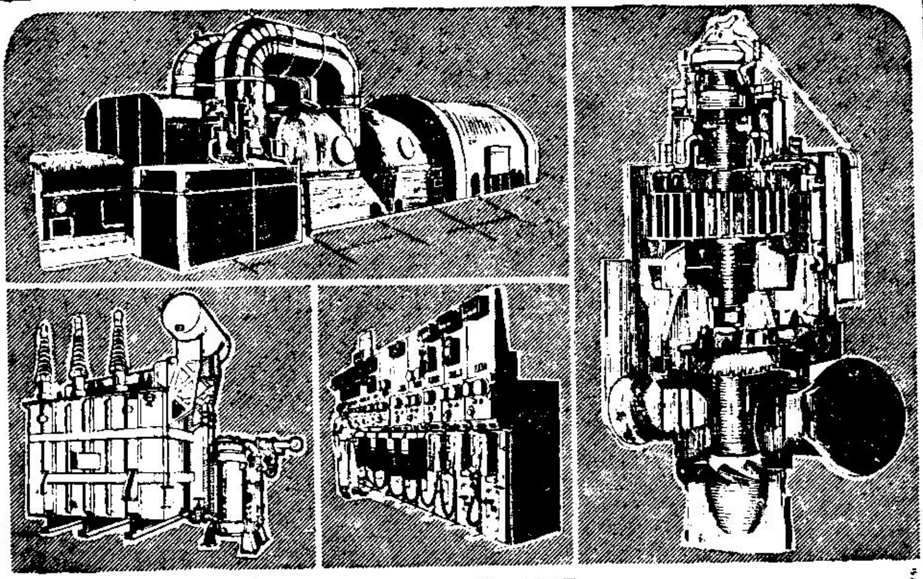
The most precious ingredient of the programme of BARC was the link between basic research and its industrial application, he said.

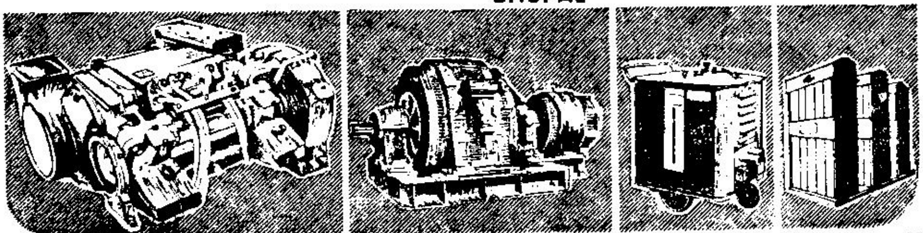
Low Production Cost

India was in a position to compete with the advanced countries in many sectors because of the low cost of production of scientific instruments. The instruments not only served the purpose of import substitution but also earned foreign exchange eventually, he added.

Dr. H. N. Sethna, director, BARC, said the computer had made available a radiation measurement instrument which would be very useful in the development of the centre's programme.

The Electronics Corporation of India, a public sector undertaking under the Atomic Energy Department, will now undertake commercial production of the machine. The first commercial unit is expected to be ready by the middle of next year and, thereafter, about 10 machines will be produced every year. It is estimated the cost will be competitive compared to the imported machines . . . . .





beneath the armour, high mettle— and Dunlop equipment

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