Computer Socie

Fifth Annual Meeting in Ma

For Greater Flow of Information

By Lt. Col. A. Balasubramanian

(President, Computer Society of India)

DIGITAL computers made their appearance in India around 1956, a decade after their appearance in the U.S. with the installation of the HEC 2M at the Indian Statistical Institute, Calcutta. The growth in the number of systems was initially rather slow. However, since 1962 the numbers have increased rapidly and to-day there are over 120 installations in the country.

It was at the initiative of Prof Harry D. Huskey, a well-known name in the field of computers, who was in India as a Visiting Professor at the IIT Kanpur, that an organisational meeting of computer users was called at the IBM Education Centre in Delhi on June 6, 1964. This was attended by 16 persons from various institutions and the All-India Computer Users Group (AICUG) was formed. The primary aims of the Group were to organise, develop and support computational activities and improve the efficiency of computational processes in the country.

OBJECTIVES

The AICUG met for the first time at the TIFR in Bombay in October 1964. At its second meeting at Kanpur in December, 1964, it was generally felt that there was a vital need for a professional body which would have broader objectives than functioning merely as a Users' Group. The AICUG was, therefore, reformed into the Computer Society of India (CSI) in December, 1964, with the following objectives:

(1) To organise, develop and support computational activities and improve the efficiency of computational processes in India;

(2) To increase the flow of information for the benefit of all;

(3) To exchange the benefits of the experience gained in the field of computer and information processing.

(4) To take active steps in educating people in the field of computers

(5) To spread computer know-how and applications.

(6) To create a brotherhood amongst the personnel engaged in such pursuits.

The CSI has rapidly grown in strength and also in its activities. At present, it has 70 institutional members and 275 individual members. The major computer installations, manufacturers, design groups and other users are represented on the Society.

During the current year, the CSI has significantly enlarged its activities by the formation of Chapters at Bombay, Calcutta, Jamshedpur, Hyderabad and Ahmedabad. More Chapters are coming up at other centres of computer activity such as Delhi and Bangalore. The Chapters have been organising monthly meetings and seminars and generally fostering the understanding of computers.

The Society currently relies for the furtherance of its aims on the medium of meetings that enable communication through personal contact. These meetings which are held on a monthly basis at the Chapters culminate in an annual three-day conference. Judging by the active participation and contributions at these conferences which have been held at Bombay, Calcutta, Hyderabad, Kanpur and Trivandrum over the previous years, and the interest evinced in this year's meeting at the College of Engineering, Guindy, in Madras on January 8, 9 and 10, 1970, the Society can look back with a sense of achievement on its growth during these formative years.

The CSI publishes a quarterly News-Letter. These News-Letters, apart from providing information on the activities of the various Chapters and on the trends in the computer field in the country, contain articles of a technical nature dealing with application areas, programme development and so on. The News-Letter it is to be hoped, would soon evolve into a quarterly journal.

TREMENDOUS POTENTIALITIES

Computers, the most significant products of technological endeavour in this era of 'Intelectronics', forming part of the electronic age have contributed to the extension of human intellect by electronics. In a developing economy such as ours, we cannot avoid falling in line with the developed countries in adopting the tremendous potentialities gained by these advances in solving our day-to-day problems. This adoption will naturally make considerable demands on our educational systems, research and development and manufacturing activities in the country. Our next generation will have to develop a sense of appreciation of computers and their capabilities in the same way as the present generation has of machines, radios, and so on.

Most of the members of the Society have been involved directly in their individual capacities in the improvement of the efficiency of computer processes and education. While early in 1962, the potential users had to be entirely guided by the manufacturers' representatives with regard to selection and implementation of suitable systems, the conditions to-day are altered. The expertise in system analysis is no longer the prerogative of the manufacturers. Users can handle these problems competently by and large. The Computer Society could also further contribute directly in helping the users in this regard.

As early as in December, 1965, the Computer Society of India had advocated the setting up of regional computation centres to maximise the return on our investment in computers on a national basis. This concept, which is generally finding acceptance now, will call for considerable co-ordination and organisational effort in planning.

USER LIAISON

Manufacturing programmes that are currently in vogue in the country would need restructuring based on user experience and potentialities for further areas of application. The Computer Society of India should bring about the necessary user liaison, and provide feedback into the manufacturing area for improvement in systems hardware and software.

In the field of education, there has been much confusion caused lately by the proliferation of organisations teaching programming, systems analysis, etc. While one cannot have any valid objection to any organization imparting training and getting paid for it, there are cases in which applicants are misled with prospects of employment with four-figure salaries at the end of a 3-month course. It is only an insignificant proportion of those who go through these courses that get employed, and that too perhaps only because they were already associated with an organization which had installed a computer. The majority of the students who had hopefully diverted themselves for a career as programmers from other opportunities get disillusioned.

The time is not yet ripe in the country for "Freelance programming". Whilst the elements of programming can be learnt through such courses, training in systems analysis cannot be easily obtained through casual courses. Systems analysis is an area where expertise has to be built up in every organization primarily from 'within' to match up with its particular requirements.

BROAD-BASED APPROACH ESSENTIAL

The adage "specialisation leads to triviality" is true in computer sciences, in spite of the rapid expansion of information growth in the various disciplines. Interrelation between these various disciplines has made a broad-based approach very necessary. The Computer Society should create an atmosphere wherein all disciplines that form part of the computer sciences are brought together to form a professional activity which may be termed Computer Engineering. Based on the broad definition of Engineering as the application of science to increasing prosperity of mankind, such an acticity would include fields such as medicine, psychology, sociology, economics, education and management.

The Society should, therefore, strive to create this broad-based understanding and also establish high professional standards. Professional standards are not precisely definable but there is no doubt that we should endeavour to build up ethics, professional behaviour and social responsibilities amongst the members in order to establish the CSI as the accepted professional body in the computer field in the country.

There is no doubt that computing and information processing activities have attained sufficient maturity in India. The Society should enlarge its activities towards the achievement of its objectives purposefully. Our obligations as specialists and competent professional personnel are very clear.

The Computer Society of India acknowledges gratefully the co-operation of The Hindu and the advertisers in the production of this Supplement.

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Guindy Eng.

By Prof. K. S

Principal, College of

THE establishment of a computer centre at the College of Engineering, Guindy, with an IBM 1620 marked the beginning of full-scale digital computer activities in Madras.

Since 1965, the College has been offering courses in programming, numerical analysis and computational methods to engineering students and teachers at appropriate levels. The College has been the pioneer centre for three advanced Summer Schools on computer programming and numerical analysis at an all-India level since 1966. Computer time is also available for research by students and staff of this College, as well as other educational and research institutions.

Through such courses and extension of facilities and by its own direct involvement, the College has stimulated considerable amount of computer-oriented research and development.

By way of an administrative application, the centre has developed a computer programme for

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Computer Design And Development in India

By Dr. B. Nag

(Professor of Electronics and Computer Science, Jadavpur University, Calcutta)

ACTIVITY in the area of electronic computer development started in India in 1954 at the Tata Institute of Fundamental Research (TIFR), where a pilot model general purpose computer was completed in 1956. Subsequently, a full-scale version was commissioned in 1960. This machine, named TIFRAC, was in operation till 1964 and many early computer users in the country had their first experience of automatic computing using TIFRAC. The pioneering project TIFRAC helped to spread computer consciousness among the research scientists of TIFR as well as other institutions.

The fifth annual general conference of the Computer Society of India is being held in Madras for three days from to-day at the College of Engineering Guindy. Dr. B. D. Nag Chaudhuri, member, Planning Commission, will inaugurate the conference. Mr. P. Sivalingam, Director of Technical Education Tamil Nadu, will be in the chair at the inaugural session.

(Programme on Page IV)

The TIFRAC project, carried out in the first generation computer era, used the electronic hardware readily available at that time, namely, vacuum tubes, semiconductor diodes and the ferrite core memory. The design of TIFRAC was in pace with the state of the art of the time. But the spectacular and rapid progress of the computer technology elsewhere made it an obsolescent first generation machine by the time it was completed, along with all other machines of the period.

The first attempt in India to develop a general purpose second generation computer was undertaken jointly by the Indian Statistical Institute (ISI) and the Jadavpur University in Calcutta in 1963.

The newly formed department of Electronics and Tele-Communication Engineering of Jadavpur University welcomed the idea of the Statistical Institute to take up a programme jointly to develop a small-to-medium sized computer. This project, while necessarily limited in scope because of considerations of cost, became operational in 1966 and was christened ISIJU-1 after the names of the two institutions.

Both the TIFRAC and the ISIJU-1 projects resulted in the growth of a hard-core of personnel in the country with professional know-how in the various facets of computer technology. The ISIJU-1 has been used in teaching programming and computer circuit design, as well as in solving research problems of moderate size. The limitations arise mostly from the limited memory size. A notable use of this computer has been in a U.N. project of industrial planning in South-East Asia.

Both TIFRAC and ISIJU-1 were built using imported electronic components and peripheral units. The semiconductor industry was started in India in the early 60's primarily to meet the needs of the entertainment industry. It is only in the last 2 years or so that semiconductor devices, suitable for high-speed reliable computer applications, have become available locally.

The Computer Division of the Electronic Group of the Trombay Atomic Energy Establishment, now known as the Bhabha Atomic Research Centre (BARC), developed a general purpose analog computer in 1960 for handling engineering problems primarily arising in connection with nuclear reactor designs. Subsequently, their production unit manufactured and sold analog computers to scientific and teaching institutions. The Computer Group investigated the possible applications of real-time computers in the various agencies within the Department of Atomic Energy (DAE) and elsewhere in India, and started a project in 1955 to develop such a computer. It was planned that the DAE's newly formed public sector undertaking — the Electronics Corporation of India (ECIL)—at Hyderabad, would later manufacture and sell these computers on a commercial basis.

Real-time computers, as distinguished from general purpose computers, are used to control the plant machinery of steel, petroleum, chemical and other plants, nuclear reactors, etc. They are also used in air-traffic controls and satellite tracking and communication. Such computers supervise the complex processes in a real-time environment by acquiring all vital data of operations in progress, and after processing them, by sending back control signals to direct or guide the various equipment of the complex almost instantaneously.

EDUCATIONAL PURPOSES

The BARC real-time computer (named TDC-12) became operational in 1969, and the group has already moved to ECIL to launch their production programme. The TDC-12 project has taken full advantage of locally available semiconductor devices and other electronic components. No more than 25 per cent of the direct cost of components and peripherals in producing these computers would be in foreign exchange. The TDC-12 computer, apart from meeting the need in India for real-time systems, would also be useful, according to the designers, for educational and training purposes. The production programme of computers at ECIL marks an important stage in Indian industry, as now the country is ready for the manufacture of computers completely designed in India.

The Computer Group at the Tata Institute of Fundamental Research turned its attention to the design of special purpose computers with indigenous electronic components after the installation there of a CDC 3600-160A system in 1964 to function as a national computational facility. To this effect, they also took up the problem of designing a real-time data processor, OLDAP (On-Line Data Processor), which has some similarities to the TDC-12 in its design approaches.

Apart from the developmental efforts we have been discussing so far, there have also been some specialised system and equipment development activities in India that fall in the category of computer techniques. The most significant of these are the message switching electronic exchange now under development at the Telecommunication Research Centre of the Post and Telegraph Department in New Delhi, and data-logging systems developed at the National Aeronautical Laboratory, Bangalore. Defence research laboratories may also be developing special purpose systems.

ELECTRONIC DESK CALCULATOR

Special purpose computers for nuclear research, and multichannel analysers have been developed. New projects continue to be taken up in these areas at the Atomic Energy Department's research centres, as well as at one or two universities. Another equipment on which much attention is now focussed is the electronic desk calculator. It may be expected that this will be followed by the development of midget computers.

The major problems that confront development projects in the area of computers in India at present, mainly arise from component and peripheral non-availability. The types of basic hardware items required in computers cover a wide range, viz., semiconductor devices, discrete resistors, capacitors and pulse transformers, printed circuit boards, edge connectors and cable connectors, to name some important ones. Integrated circuits and microelectronic packages were available in the West in the early 60's, and in substantial commercial quantities, about 1965. The third generation computers were ushered in around that time built out of integrated and hybrid circuits.

It is unfortunate that the ECIL programme, taking shape in the 70's, has to be based on second generation technology because of the non-availability, locally, of mi-

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By Prof. K. S. Hegde

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programme for processing the results of the examinations conducted by the Tamil Nadu Board of Technical Education. This programme has been in operation for the past few year.

Computing facilities have since been established at the Integral Coach Factory, Southern Railway, IBM, Binny's and the Physics Department of the University of Madras. The last one is chiefly devoted to scientific research, while the others are primarily concerned with management, production control and accounting.

Madras has thus recorded an all-round development in computer applications.

The College of Engineering Guindy, deems it an honour to have this opportunity to host the fifth annual conference of the Computer Society of India. It is our firm belief that the deliberations of this Conference, apart from their technical contribution, will serve to add considerably to the computer awareness among the students and the various professional members in this region.

Sophisticated 'Programmes: Good Scope

By Dr. Mathai Joseph

(Computer Group, Tata Institute of Fundamental Research, Bombay).

THERE are two components to the complex and sophisticated collection of equipment we call a computer system: first, there is the physical circuitry, the electro-mechanical devices and the memory devices which, together, represent the 'hardware' of the system; secondly, there is the corpus of programmes which provides the instructions for the sequences of operations to be performed by the computer. These programmes are now characterised by the term 'software'. Software includes not only the programmes to perform, say, a series of complicated calculations, but also the system programmes which allow a programmer to state his problem in an easily understood language. The reason one needs system programmes becomes clear when we consider how a computer works.

A computer is an electronic machine which has the capability of storing information and which can perform calculations using this information. For reasons of circuitry, the information which it stores is in the form of binary numbers. Some of these numbers represent instructions to the computer and some of them are the data on which these instructions are to be performed. The instructions are generally fairly simple and may perform such actions as addition, subtraction, multiplication or comparison, but a large number of more complex operations may be synthesized out of these elementary steps.

The drawback in using just these basic instructions is, however, that the programmer is required to break down his problem into a large number of minute steps, and to represent his problem as a series of numerically coded instructions. This requires not only painstaking accuracy but also fairly intimate knowledge of the internal working of the computer, making it a job for an expert. Programming the early computer was, therefore, a tedious job and it was evident that the use of computers would not spread until it was made easier for the average scientist, engineer or businessman, to write programmes.

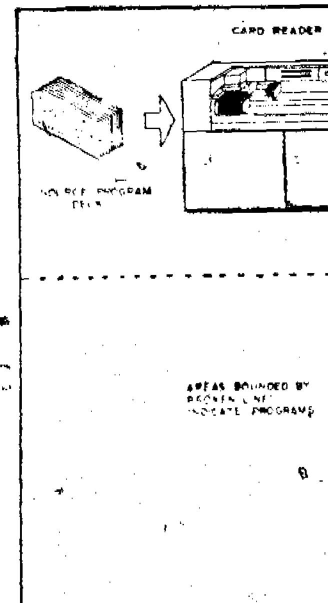
This situation was remedied around 1956 by the introduction of 'higher-level' programming languages. These are artificial languages often devised for the solution of particular types of problems, but which allow the programmer to give instructions in a more easily understood format than the basic instruction code. A problem coded in a higher-level language has, however, still to be converted to this basic instruction code before it can be executed by the machine, and this function is performed by a system programme called the compiler for that language. Thus, the computer is used not only for the actual solution of the problem but also for the translation of the problem from the higher-level language.

The higher level languages (such as FORTRAN and ALGOL) are designed to allow a general user to code his mathematical problems in a form more natural to him than mere numerical code. For example, algebraic equations can often be written down in standard algebraic notation and there are instructions such as PRINT and READ, etc. and the compiler in the computer will translate these instructions into the numerical code that the computer can execute. Thus, an engineer or a physicist can, within a few days, learn to programme his problem without being too concerned with how the computer works.

The next step up from higher-level languages was the introduction of standard programme packages to perform repetitive operations such as inventory control, the solution of particular type of differential equations, etc. These packages remove even the burden of programming from the user, and often all that is required is that the user specifies the particular characteristics of his problem.

"MONITORS"

As computer systems grew larger and more complex, and as the number of peripheral devices (such as punched card readers, printers, magnetic tape units, etc.) increased, it became necessary to organise these devices so that they operated efficiently. This was a responsibility that could not be left to each individual user, so a supervisory system programme was allocated the duty of controlling their operation. 'Supervisors' or 'Monitors', as these programmes are called, are complex programmes which attempt to optimise the use of the facilities available in the computer system by allowing a number of activities to proceed concurrently. Thus, it became possible for the computer to be executing one programme while the cards for a second programme were being read on the card reader and while the output from a previously executed programme was being printed. In fact, in multiprogrammed computers, the supervisor arranges for several programmes to be running con-



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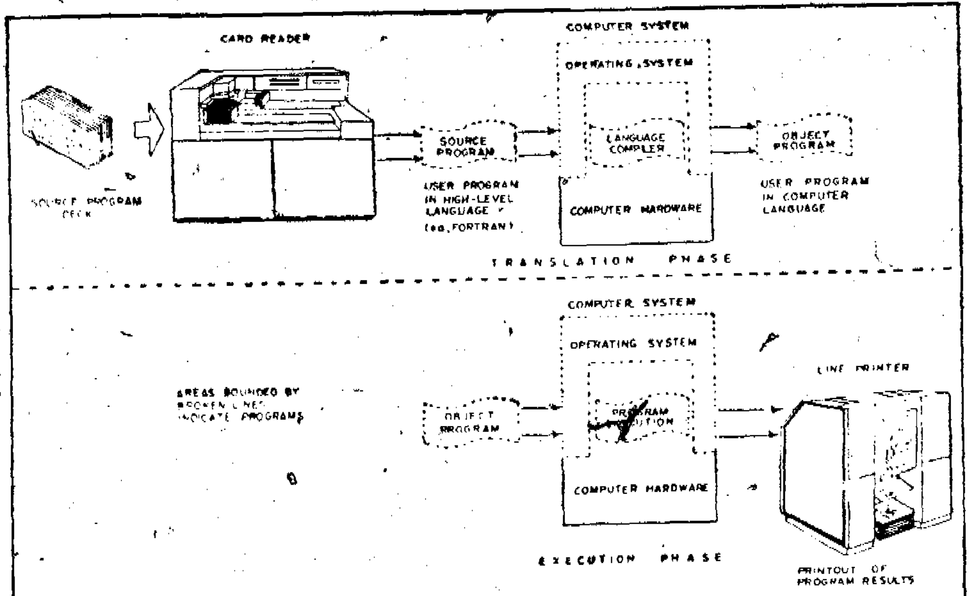

SCHEMATIC DIAGRAM SHOWING THE TRANSLATION OF A SOURCE PROGRAM FOLLOWED BY ITS EXECUTION

The higher-level languages (such as FORTRAN and ALGOL) are designed to allow a general user to code his mathematical problems in a form more natural to him than mere numerical code. For example, algebraic equations can often be written down in standard algebraic notation and there are instructions such as PRINT and READ, etc. and the compiler in the computer will translate these instructions into the numerical code that the computer can execute. Thus, an engineer or a physicist can, within a few days, learn to programme his problem without being too concerned with how the computer works.

The next step up from higher-level languages was the introduction of standard programme packages to perform repetitive operations such as inventory control, the solution of particular type of differential equations, etc. These packages remove even the burden of programming from the user, and often all that is required is that the user specifies the particular characteristics of his problem.

"MONITORS"

As computer systems grew larger and more complex, and as the number of peripheral devices (such as punched card readers, printers, magnetic tape units, etc.) increased, it became necessary to organise these devices so that they operated efficiently. This was a responsibility that could not be left to each individual user, so a supervisory system programme was allocated the duty of controlling their operation. 'Supervisors' or 'Monitors', as these programmes are called, are complex programmes which attempt to optimise the use of the facilities available in the computer system by allowing a number of activities to proceed concurrently. Thus, it became possible for the computer to be executing one programme while the cards for a second programme were being read on the card reader and while the output from a previously executed programme was being printed. In fact, in multiprogrammed computers, the supervisor arranges for several

gramme is, therefore, the salaries of the system designers and the coders.

Already, approximately 40 per cent of the cost of a computer system is spent on the software that is supplied by the manufacturer. As manufacturers begin to supply more software in the form of problem-oriented languages and special packages, and as the price of the hardware decreases with improved technology, the proportion of the total cost that is spent on software will increase rapidly.

But, more important, the types of applications and system programmes that users require are rapidly diversifying and after a point, these programmes have to be developed by the users themselves. With the lower salary levels of this country, there is the tremendously competitive possibility for system programmes and packages to be developed here and, possibly, even exported. This requires, primarily, the development of a large base of programming know-how so that specialised programme packages can be written. The drive for the local manufacture of computers has gained some momentum and it is imperative that a parallel development of software capabilities be initiated. Software development, unlike manufacture, is something that requires no foreign exchange and no imported know-how. Once a certain capability in writing software is established, the prospects are virtually unlimited for the development of sophisticated programmes for national requirements and for the export market. One could, then, envisage a future where foreign computer manufacturers and other organisations would assign software contracts to Indian organisations to capitalise on the lower software costs here.

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It is often forgotten that all programmes cost money and that system programmes cost a great deal of money. While the coding of programmes is a skilled job requiring some training, the design of how the problem is to be solved is the job of an expert. The system designer has to take a number of considerations into account when making the specifications for the design of the programme; following this, a coder can use well-understood techniques in writing the steps of the programme. One major component of the total cost of the programme is, therefore, the salaries of the system designers and the coders.

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# of Studying Behaviour

By Dr. R. Narasimhan

(Professor, Computer Group, Tata Institute of Fundamental Research, Bombay).

CAN computers replace human beings? Science-fiction thrives on the assumption that they can and that, in fact, they will, very soon. Recently, an extremely popular movie had, as its central character, a computer that could not only think, but laugh, and cry, and fall in love, and become jealous! Of course, what this proves is not necessarily that computers are human, but that our science-fiction and movie writers cannot easily transcend their anthropocentric imaginations. Still, is there any substance in these fantasies? How does this myth about computers replacing human beings arise?

Usually, when we talk of computing, we only have in mind numbers and arithmetic. Somewhat more sophisticated computer users may include solving matrix equations, differential equations, and so on, as aspects of computing. But, is this all there is to computing? Can digital computers compute only in this sense of dealing with numbers and performing operations on numbers? If this were true, there cannot be much substance in the claim that computers can replace human beings; for, a human being does very much more than merely deal with numbers. In fact, most human beings do not deal with numbers at all except in trivial ways; for example, counting their laundry items, and so on.

COMPUTING ON NUMBERS

In order to probe deeper into the relationship between the behaviour of computers and that of human beings, we have to formulate our original question somewhat differently. Instead of asking, can computers only compute on numbers?, we should ask what does one mean by computing on numbers? What is the nature of this process that we recognise (or refer to) as computation on numbers? What is its structure? What are its various aspects? If we can satisfactorily answer these questions, then we can proceed to enquire whether other types of behaviour (human behaviour, in particular) can be described in similar terms: thinking, for example, or problem-solving or reading handwriting, or generating speech; and, maybe even composing music, and constructing theories.

Assuming for a moment that we can, indeed, show that these varieties of behaviour can be described in ways similar to our description of a computation process on numbers, we come to the central question, does it then follow that machines can be constructed to exhibit these kinds of behaviour in much the same way as we know how to build machines to carry out a computation process on numbers? If we can, in fact, build such machines, will they look exactly like our present-day computers (i.e., have the same structure, and function similarly)? Or should their design be based on completely different principles?

In 1936, almost a decade before the first digital computers became operational, the English logician, A.M. Turing, published a seminal paper in which he provided definitive answers to our first set of questions concerning the nature of computational processes. He analysed the structure of a computation in terms of the behaviour of an extremely elementary type of computer. These machines are now known as Turing machines. Turing proved the remarkable result that there exist universal Turing machines that could imitate the behaviour of any other given Turing machine; and these universal Turing machines have exactly the same elementary structure.

At first sight, this result may seem somewhat paradoxical. For, intuitively, we tend to feel that universal machines have to be more complicated, in some sense, than any specific machine that is not universal. The paradox, however, disappears once we understand the nature of a computation process, and the manner in which a universal Turing machine imitates any other given Turing machine.

A computation process (i.e., a fixed, specific, computation) consists in performing a sequence of well-defined computation steps; for example, read the next item; write it in the next square on the storage tape; add this to the last item read; write the sum in the place of the last read item on the tape; and so on. Let us call each of these steps an instruction. A computation process consists in executing a sequence of these instructions. Each instruction is, in fact, a statement in a language. In our example, all these statements have the form of a command: do this, do that, etc. In special cases, we could have statements which are of the nature of descriptions (e.g., the last read item is a number), or of the nature of questions (e.g., was the last read item a number?). Thus, a computation process is given (or described, or defined, or specified) as a sequence of statements in a language.

Turing's result can now be interpreted as follows. One can construct an extremely elementary language, in terms of whose statements all specific computations could be described. Thus, a universal language. For, then, to get it to imitate any specific Turing machine, all we have to do is to write down the sequence of statements that defines this specific machine; (a specific machine carries out a single, fixed, computation process). The universal machine can, then, read these statements one by one, and carry out the intended operations. By so doing, it precisely imitates the first machine. This performance is something analogous to that of an actor trying to imitate another actor, by reading the portion of the script intended for the latter, and mimicking his actions.

STRUCTURAL COMPLEXITY

Our present-day computers are enormously more complicated than Turing machines. But this complexity has nothing to do with their theoretical power. They are no more powerful than universal Turing machines. What their complexity buys us is the ease with which computational specifications can be written for them; (incidentally, this is the activity that is usually referred to as programming).

Another way of looking at this complexity is as follows: It is extremely difficult for human beings to function in a language that does not have a certain minimal complexity. Hence, computers, to be a good match to human beings, must be built to understand languages of this minimal complexity. This automatically makes them complex structurally also.

Can computers imitate human beings? The answer is 'yes', provided we know how to describe the human behaviour that is sought to be imitated as a sequence of statements in some well-defined language; that is, in other words, as a programme for a computer. (The catch is in the technical notion: 'well-defined language.' What is a well-defined language? We know one class of well-defined languages, namely, computer languages. Are there other classes of well-defined languages?)

Do we know, at present, how to specify such programmes for any interesting set of behaviours? The answer is "yes-and-no"; more 'no', than 'yes', unfortunately. However, of 'artificial intelligence studies', has been slowly picking up momentum. Programmes that enable a computer to play board-games (like chess, checkers, go), solve word problems as found in high school science and mathematics text-books, read handprinted letters and numerals, scan and analyse pictures of a restricted variety, and so on, have been more or less successfully designed. During the last few years, several groups in the U.S. have been experimenting with artificial hands driven by computers provided with a TV camera to serve as an eye. Tasks such as picking up toy cubes and building towers with them have been successfully attempted. Speech generation and analysis, using computers, have been demonstrated.

Needless to say, only the most rudimentary aspects of behaviour in any modality have so far been tackled. We still have a long way to go before computers can function like a human stenographer, and convert a dictated letter into a typescript; or, like a human draughtsman, and convert a rudimentary sketch with marginal comments into an engineering drawing.

Our primary motivation for wanting computers to imitate these tasks is, of course, not to get them to replace human beings. Ultimately, our concern is to study behaviour and understand it. Imitation is one efficient method of studying behaviour. In fact, it is not clear that, where cognitive behaviour is concerned, any method, other than successful imitation, is available as a viable methodology.

In spite of the spectacular progress of science in the last 200 years, very little is known about the functioning of the human brain. We do not even have an adequate language in which we can discuss its behaviour. The sterile philosophic problems associated with the mind-brain dichotomy merely testify that we have yet to learn to discuss (describe) cognitive behaviour in other than metaphorical terms. There is a reasonable hope that computers and behavioural studies that use computers as effective tools may teach us how to do this.

Imitation as A Method of Studying Behaviour

By Dr. R. Narasimhan

(Professor, Computer Group, Tata Institute of Fundamental Research, Bombay).

CAN computers replace human beings? Science-fiction thrives on the assumption that they can and that, in fact, they will, very soon. Recently, an extremely popular movie had, as its central character, a computer that could not only think, but laugh, and cry, and fall in love, and become jealous! Of course, what this proves is not necessarily that computers are human, but that our science-fiction and movie writers cannot easily transcend their anthropocentric imaginations. Still, is there any substance in these fantasies? How does this myth about computers replacing human beings arise?

Usually, when we talk of computing, we only have in mind numbers and arithmetic. Somewhat more sophisticated computer users may include solving matrix equations, differential equations, and so on, as aspects of computing. But, is this all there is to computing? Can digital computers compute only in this sense of dealing with numbers and performing operations on numbers? If this were true, there cannot be much substance in the claim that computers can replace human beings; for, a human being does very much more than merely deal with numbers. In fact, most human beings do not deal with numbers at all except in trivial ways; for example, counting their laundry items, and so on.

COMPUTING ON NUMBERS

In order to probe deeper into the relationship between the behaviour of computers and that of human beings, we have to formulate our original question somewhat differently. Instead of asking, can computers only compute on numbers?, we should ask what does one mean by computing on numbers? What is the nature of this process that we recognise (or refer to) as computation on numbers? What is its structure? What are its various aspects? If we can satisfactorily answer these questions, then we can proceed to enquire whether other types of behaviour (human behaviour, in particular) can be described in similar terms, thinking, for example, or problem-solving or reading handwriting, or generating speech; and, maybe even composing music, and constructing theories.

Assuming for a moment that we can, indeed, show that these varieties of behaviour can be described in ways similar to our description of a computation process on numbers, we come to the central question, does it then follow that machines can be constructed to exhibit these kinds of behaviour in much the same way as we know how to build machines to carry out a computation process on numbers? If we can, in fact, build such machines, will they look exactly like our present-day computers (i.e., have the same structure, and function similarly)? Or should their design be based on completely different principles?

In 1936, almost a decade before the first digital computers became operational, the English logician, A.M. Turing, published a seminal p[...] vided def[...] first set [...] the natur[...] behaviour of an extremely elementary type of computer. These machines are now known as Turing machines. Turing proved the remarkable result that there exist universal Turing machines that could imitate the behaviour of any other given Turing machine; and these universal Turing machines have exactly the same elementary structure.

At first sight, this result may seem somewhat paradoxical. For, intuitively, we tend to feel that universal machines have to be more complicated, in some sense, than any specific machine that is not universal. The paradox, however, disappears once we understand the nature of a computation process, and the manner in which a universal Turing machine imitates any other given Turing machine.

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Turing's result can now be interpreted as follows. One can construct an extremely elementary language, in terms of whose statements all specific computations could be described. Thus, a universal Turing machine need only know how to execute the operations defined by the statements of this language. For, then, to get it to imitate any specific Turing machine, all we have to do is to write down the sequence of statements that defines this specific machine; (a specific machine carries out a single, fixed, computation process). The universal machine can, then, read these statements one by one, and carry out the intended operations. By so doing, it precisely imitates the first machine. This performance is something analogous to that of an actor trying to imitate another actor, by reading the portion of the script intended for the latter, and mimicking his actions.

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Do we know, at present, how to specify such programmes for any interesting set of behaviours? The answer is "yes-and-no"; more 'no', than 'yes', unfortunately. However, in the last ten years, in the computer sciences, research in this area, which goes under the name of 'artificial intelligence studies', has been slowly picking up momentum. Programmes that enable a computer to play board-games (like chess, checkers, go), solve word problems as found in high school science and mathematics text-books, read handprinted letters and numerals, scan and analyse pictures of a restricted variety, and so on, have been more or less successfully designed. During the last few years, several groups in the U.S. have been experimenting with artificial hands driven by computers provided with a TV camera to serve as an eye. Tasks such as picking up toy cubes and building towers with them have been successfully attempted. Speech generation and analysis, using computers, have been demonstrated.

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unnecessarily, and there is also the danger of stock-outs of other forgings which are made on the same press.

If the production run is too short, then a considerable amount

sary to have appropriate tooling ready at the right time. The Tool Room in the Auto Division makes dies, jigs, fixtures, etc. Each job or work order is of a different type. Some of these work orders

able computers.

The consumer market in electronics to-day in India is mainly in the entertainment field. As such, in general, our manufacturers have not had much incentive to exercise superior quality control over electronic components. Professional grade equipment like computers and other sophisticated system in Defence, call for the use of very high grade components. Most of these components are at present imported. It is thus necessary for our industry to invest in the production of high grade components for these professional needs.

Peripherals take up a substantial part of the cost of a computer. The very nature of the peripheral equipment makes their pro

know-how for their products. They should be in a position to take up some of these feasibility studies.

Ferrite cores are likely to dominate the field as memory elements for several more years. The core fabrication technology has developed to such an extent that very high-speed switching cores can be purchased to-day at a cheap price in bulk quantities. The National Physical Laboratory, New Delhi, has been trying to develop computer grade ferrites for several years. If the NPL makes available cores that conform to the requisite standards they could be fabricated into memory planes and modules. This is a highly labour intensive activity with low

Emergence of a New Discipline

By V. Rajaraman

(Professor of Electrical Engineering and Head, Computer Centre, Indian Institute of Technology, Kanpur.)

DEVELOPMENTS in computer technology during the last two decades have demonstrated that it is a misconception to think that computers are useful only in complex and engineering calculations. Computers have become invaluable tools in diverse areas like economic planning and medical diagnosis. The technical and sociological implications of the widespread use of computers have not yet been fully understood, but it is certain that their impact will be more significant and will occur over a much shorter period as compared to the first industrial revolution.

It is, thus, important to look at the growth of an entirely new discipline called computer science and understand how computers have affected the existing methods of formulation and solution of problems.

With the advent of highly complex software packages, two important areas of study in computer science have developed. The first area, with immediate practical application, is that of systems programming or software engineering. This subject deals with the design of programming language translators and operating systems. Important problems like the optimisation of the translation procedure and the mechanisation of translator writing systems are discussed in this subject and, thus, this area of study is vital for professional computer programmers and scientists. Inasmuch as a major portion of the work of a modern computer is the translation of user-oriented languages it is important for the computer designer also to be familiar with this subject.

COMPUTATIONAL LINGUISTICS

A parallel development in computer science of fundamental theoretical interest, is the theory of programming languages. The main topics in this area of study are the formulation of the syntactic and semantic description of programming languages. A number of concepts from linguistic theory of natural or spoken languages are borrowed and refined to suit the description of programming languages and, thus, this area of study is also known as computational linguistics.

Even though programming languages have been instrumental in catapulting computers to their present eminent position historically computer science development was initiated by computer designers who were primarily electrical or electronic engineers. We will now consider the areas of study which arose during this phase of the development of computer technology.

Computer logic and systems design: The design of a computing system may be broadly divided into three areas. These are: (i) The design of the electronic circuits of a computer; (ii) The specification of the logic to be performed by a computing unit and the realisation of this logic by individual blocks each of which can perform an elementary logical operation; (iii) The interconnection of the logic blocks and other facilities such as memories and input output devices to realise a computing system.

This area of study deals with the abstract modelling of computing devices with a view to determining their fundamental limitations. Questions regarding the existence of algorithms, i.e., well specified rules for solving certain types of problems on an idealised model of a computer, are answered. This area of study is important as it clarifies what kind of problems cannot be solved by computers.

The design of individual electronic circuits which make up a computer is not the real concern of a computer scientist. This area is of interest to electronic engineers, and with the advent of integrated solid-state circuits, logic and systems design have become more important even for electronic designers.

Non-numerical computation: Computers were originally conceived to operate on numbers and mainly perform numerical calculations. Thus, numerical analysis is one standard topic in Computer Science. However, it was soon realised that computers could be meaningfully employed with non-numerical data inputs. In fact, the translation of a user-oriented language to the machine language is itself a non-numerical computation, as character strings, corresponding to the user language, constitute the data and the programme operates on this to produce the machine language.

The interest in non-numerical computation began with attempts at translating one natural language (like English) to another (like Russian). This problem is quite difficult due to the ambiguous nature of spoken languages and the sensitiveness of the meaning of the words to their context and is, as yet, not satisfactorily solved. It, however, gave rise to interest in natural language input to computers for problems in information retrieval and for general problem-solving.

RECOGNITION OF PATTERNS

Another group of researchers started working on computer programme to play games. The idea was to investigate if some "intelligence" could be endowed to computer programmes. Another related area of interest is pattern recognition. This subject includes diverse recognition problems such as recognising hand-written characters, recognition of landmarks from aerial pictures, recognition of bacterial colonies in medical slides, recognition of finger prints, etc. Special programming languages for expressing patterns and statistical techniques for recognising them are in their developmental stage. This is fast becoming an important area in computer science.

Applications of computer sciences: Almost all areas have gained by the advent of computer science. The main impact in engineering design and scientific research has been the feasibility of realistic formulation of problems. Before computers became widely available, a number of unnecessary assumptions were made to simplify solution to a problem as otherwise the sheer enormity of calculations or the lack of mathematical tools would have made the problem intractable.

India's Future and the Computer

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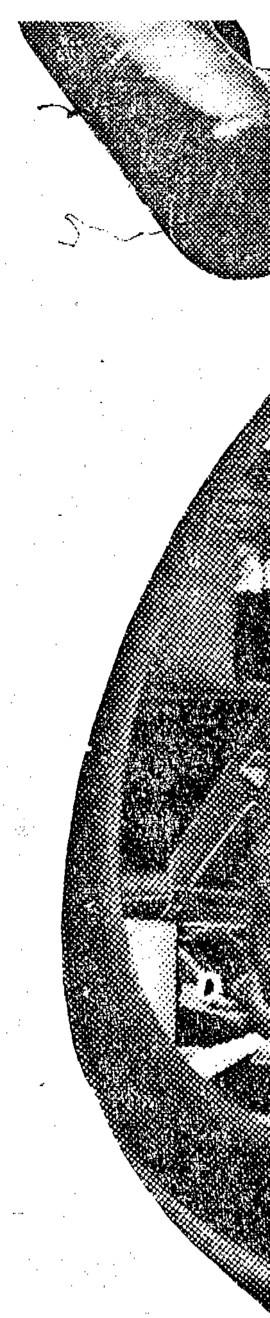
The greatest contribution of computers in the behavioural science has been the injection of quantitative techniques into these areas. As behavioural systems are complex non-linear systems which are quite often only statistically describable formal mathematical methods have not been successfully applied. The advent of computers, however, has made the simulation of systems feasible and experimentation on the simulation models has proved very useful for giving an insight into the problem. Another important contribution of computers in social science research is the ease of processing data obtained from surveys by using these machines and the practical feasibility of using statistical techniques in the analysis of such data.

Finally a large number of special purpose computers are used for the control of processes and systems and their use is increasing particularly because the cost [illegible] computer is going down and [illegible] performance [illegible] [illegible] knowledge of computers [illegible] the [illegible] of process and other control systems. It can be safely said that the [illegible] of the new discipline of computer science would be [illegible] into every other discipline within the next decade.



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Applications of computer sciences: Almost all areas have gained by the advent of computer science. The main impact in engineering design and scientific research has been the feasibility of realistic formulation of problems. Before computers became widely available, a number of unnecessary assumptions were made to simplify solution to a problem, as otherwise the sheer enormity of calculations or the lack of mathematical tools would have made the problem intractable.

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Finally a large number of special purpose computers are used for the control of processes and systems and their use is increasing particularly because the cost of computers is going down and superior performance becomes feasible with an on-line computer. Thus a good knowledge of computers has become essential to the designers of process and other control systems. It can be safely said that some aspects of the new discipline of computer science would be integrated into every other discipline within the next decade.

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...g: To make it is neces... priate tooling ... ne. The Tool ... vision makes ... tc. Each job ... a different work orders are fairly complicated, requiring several components to be made, subassembled, and then put together for final assembly. The problem is scheduling of each operation of each component in such a way that machine idle time is minimised and deadlines are kept. Without computers, this becomes very difficult as there may be thousands of work orders pending at any given time.

The problem is further complicated by the fact that some work orders have higher priorities than others. It is necessary to take this into account while scheduling. The computerised system for Shop Loading and Monitoring (SLAM), developed in TELCO, ensures proper tool room scheduling.

Planning in other industries: Computers can also be used to solve the problems of production planning and scheduling in industries other than those making engineering products. For example, The Tata Iron and Steel Co. makes steel products such as flats, sections, and other rolled products, wheels, tyres, etc. In order to make these products, TISCO has its own collieries and mines, blast furnaces, steel melting shops and rolling mills.

Iron is made by feeding blast furnaces with a mixture of limestone, iron ore, coke, etc. The molten iron is sent to steel melting shops where it is converted into the requisite quality of steel depending upon the ultimate product which has to be rolled. Steel is next poured into ingots and sent to various rolling and finished mills where the finished product is rolled out in the shapes and sizes ordered by customers and despatched.

PRODUCTION AND SALES CONSTRAINTS

Thus, the production planning problem is to determine the best rolling programme for the mills such that output is maximised. In order to do this, the following constraints have to be taken into consideration:

(a) Production constraints, such as the rolling rates of each type of product, the rolling and ancillary facility capacities, the minimum and maximum restrictions on the tonnage that can be rolled at a given time, etc.

(b) Sales constraints, such as customer requirements, priorities and commitments, and modifications.

However, it will be unrealistic to determine a rolling programme without taking into account steel making restrictions. Thus, the problem is one of not only determining rolling programmes but also giving related schedules for steel making, taking into account production restrictions at the steel melting shops. Further, the actual steel production may occasionally differ from what was ordered for, and, thus, decisions have to be made for allocating steel to mills.

Simulation studies: Computers are also used to conduct simulation studies. Consider, for example, the problem of determining the optimum number of ladles to carry hot metal from blast furnaces to the steel melting shops. Basically, if there are too few ladles, then blast furnaces have to wait. Thus, production of iron suffers. If there are too many ladles, queues build up at various places, the hot metal starts cooling and solidifying, and may have to be scrapped. Also, extra ladles cost more money to procure and maintain.

Computers were used to simulate actual working conditions for several months. Each simulation experiment was conducted using a different number of ladles. Thus, the optimum number of ladles, which can minimise the total cost, could be determined.

Optimum production planning and scheduling involves the use of complex mathematical and statistical techniques such as linear programming, regression analysis, economic batch analysis, queueing theory and simulation. Computers are needed to carry out these extensive calculations.

It must also be stressed that the values of variables, such as stock position, production and rejection rates, efficiencies, requirements, etc., keep changing, often on a daily basis. Unless there is a comprehensive and up-to-date information system, the use of sophisticated operational research techniques is severely hampered. Therefore, the computer's data processing ability is also essential.

Programme

JANUARY 8, 1970:

10-00 hrs: Inauguration—By Dr. B. D. Nag Chaudhuri; 11-45 to 12-30: "Computer Education"—Prof. V. Rajaraman, IIT, Kanpur; 14-00 to 15-30: 1 Operating Systems and Compilers; 15-45 to 16-30: "Software" — Dr. Mathai Joseph, TIFR, Bombay.

JANUARY 9, 1970:

9-00 to 9-45: "Hardware" — Dr. S. Srikantan, ECIL, Hyderabad; 9-45 to 11-15: 2a Switching Logic; 2b. Applications General; 11-30 to 13-00: 3a. Operations Research; 3b. Electrical Engineering 1; 3c. Numerical Techniques 1; 14-30 to 16-00: 4a. Electrical Engineering 2; 4b. Numerical Techniques 2; 4c. "Computer Education"; Moderator: Prof. K. S. Hegde, Principal, Engineering College, Guindy; 18-00 to 19-00: Popular Lecture on Computers — Prof. R. Narasimhan, TIFR, Bombay.

JANUARY 10, 1970:

9-00 to 10-30: 5. Management.

Computer Design

Continued from Page 1

...croelectronic devices. The integrated circuits area should interest the existing semi-conductor manufacturers and new entrepreneurs. A reasonable-sized computer programme in the country, along with various other uses of integrated circuits in the existing and new equipment, should make the manufacture of integrated circuits economically viable. Integration of circuits would make requirements of other passive components much less in computer applications, and result in more reliable computers.

The consumer market in electronics to-day in India is mainly in the entertainment field. As such, in general, our manufacturers have not had much incentive to exercise superior quality control over electronic components. Professional grade equipment like computers and other sophisticated system in Defence, call for the use of very high grade components. Most of these components are at present imported. It is thus necessary for our industry to invest in the production of high grade components for these professional needs.

Peripherals take up a substantial part of the cost of a computer. The very nature of the peripheral equipment makes their production capital intensive. Producing these locally may not be an economical proposition at present. However, it should be possible to award long-term and short-term development contracts to work out the production feasibility of at least some items of peripherals. These could be undertaken by a public sector unit or a national laboratory. One could make a beginning with console typewriters, paper tape equipment and some other selected items. The Hindustan Teleprinters, Madras, who make the teleprinters for P. and T. applications, are known to have made some development efforts themselves apart from buying the know-how for their products. They should be in a position to take up some of these feasibility studies.

Ferrite cores are likely to dominate the field as memory elements for several more years. The core fabrication technology has developed to such an extent that very high-speed switching cores can be purchased to-day at a cheap price in bulk quantities. The National Physical Laboratory, New Delhi, has been trying to develop computer grade ferrites for several years. If the NPL makes available cores that conform to the requisite standards, they could be fabricated into memory planes and modules. This is a highly labour intensive activity with low overheads and hence is exceptionally well suited for a country like India.

The nature of a computer system is such that it is impossible to manufacture all parts of it indigenously. Even the world's giant computer industries have to depend on other specialised industries for the manufacture of subsystems, peripherals and components. Thus, our policy must be to concentrate on specialising in systems engineering indigenously. This must be done using our own engineers and scientists so as to exploit, to the maximum extent, locally manufactured components and subsystems. Only subsystems not locally available should be imported. Here again all interface electronics should be indigenously carried out.

Such an effort would provide intellectually challenging tasks to the highly qualified engineers and scientists coming out of Institutes of Technology and universities. Indigenously undertaken systems engineering would also provide an expanding market to our own local industries. A concerted and properly guided effort at the governmental, industrial and institutional levels, should, within a period of about 5 years, enable us to build a viable technological framework in India to meet much of our computer requirements.

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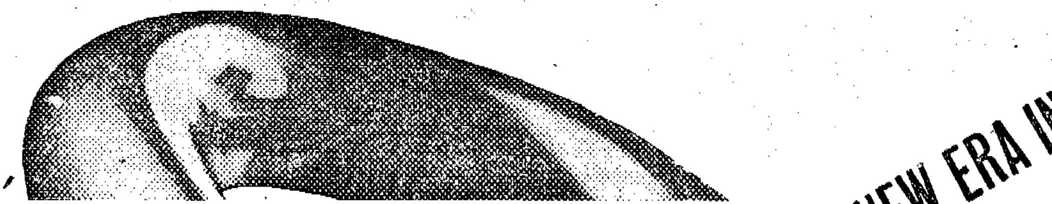
India's Future and the Computer



Computer Societ[y]

Fifth Annual Meeting in Madr[as]

For Greater Flow of Information

By Lt. Col. A. Balasubramanian

(President, Computer Society of India)

DIGITAL computers made their appearance in India around 1956, a decade after their appearance in the U.S. with the installation of the HEC 2M, at the Indian Statistical Institute, Calcutta. The growth in the number of systems was initially rather slow. However, since 1962 the numbers have increased rapidly and to-day there are over 120 installations in the country.

It was at the initiative of Prof Harry D. Huskey, a well-known name in the field of computers, who was in India as a Visiting Professor at the IIT, Kanpur, that an organisational meeting of computer users was called at the IBM Education Centre in Delhi on June 6, 1964. This was attended by 16 persons from various institutions and the All-India Computer Users Group (AICUG) was formed. The primary aims of the Group were to organise, develop and support computational activities and improve the efficiency of computational processes in the country.

OBJECTIVES

The AICUG met for the first time at the TIFR in Bombay in October 1964. At its second meeting at Kanpur in December, 1964, it was generally felt that there was a vital need for a professional body which would have broader objectives than functioning merely as a Users' Group. The AICUG was, therefore, re-formed into the Computer Society of India (CSI) in December, 1964, with the following objectives:

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(3) To exchange the benefits of the experience gained in the field of computer and information processing.

(4) To take active steps in educating people in the field of computers.

(5) To spread computer know-how and applications.

(6) To create a brotherhood amongst the personnel engaged in such pursuits.

The CSI has rapidly grown in strength and also in its activities. At present, it has 70 institutional members and 273 individual members. The major computer installations, manufacturers, design groups and other users are represented on the Society.

During the current year, the CSI has significantly enlarged its activities by the formation of Chapters at Bombay, Calcutta, Jamshedpur, Hyderabad and Ahmedabad. More Chapters are coming up at other centres of computer activity such as Delhi and Bangalore. The Chapters have been organising monthly meetings and seminars and generally fostering the understanding of computers.

The Society currently relies for the furtherance of its aims on the medium of meetings that enable communication through personal contact. These meetings which are held on a monthly basis at the Chapters culminate in an annual three-day conference. Judging by the active participation and contributions at these conferences which have been held at Bombay, Calcutta, Hyderabad, Kanpur and Trivandrum over the previous years, and the interest evinced in this year's meeting at the College of Engineering, Guindy, in Madras on January 8, 9 and 10, 1970, the Society can look back with a sense of achievement on its growth during these formative years.

The CSI publishes a quarterly News-Letter. These News-Letters, apart from providing information on the activities of the various Chapters and on the trends in the computer field in the country, contain articles of a technical nature dealing with application areas, programme development and so on. The News-Letter it is to be hoped, would soon evolve into a quarterly journal.

TREMENDOUS POTENTIALITIES

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As early as in December, 1965, the Computer Society of India had advocated the setting up of regional computation centres to maximise the return on our investment in computers on a national basis. This concept, which is generally finding acceptance now, will call for considerable co-ordination and organisational effort in planning.

USER LIAISON

Manufacturing programmes that are currently in vogue in the country would need restructuring based on user experience and potentialities for further areas of application. The Computer Society of India should bring about the necessary user liaison, and provide feedback into the manufacturing area for improvement in systems hardware and software.

In the field of education, there has been much confusion caused lately by the proliferation of organisations teaching programming, systems analysis, etc. While one cannot have any valid objection to any organization imparting training and getting paid for it, there are cases in which applicants are misled with prospects of employment with four-figure salaries at the end of a 3-month course. It is only an insignificant proportion of those [illegible] ses that get employed and that too perhaps only because they were already associated with an organization which had installed a computer. The majority of the students who had hopefully diverted themselves for a career as programmers from other opportunities get disillusioned.

The time is not yet ripe in the country for "Freelance Programming". Whilst the elements of programming can be learnt through such courses, training in systems analysis cannot be easily gained through casual courses. Systems analysis is an area where expertise has to be built up in every organization primarily from [illegible] to match up with [illegible] requirements.

BROAD-BASED APPROACH ESSENTIAL

The adage "specialisation leads to triviality" is true in computer sciences, in spite of the rapid expansion of information growth in the various disciplines. Interrelation between these various disciplines has made a broad-based approach very necessary. The Computer Society should create an atmosphere wherein all disciplines that form part of the computer sciences are brought together to form a professional activity which may be termed Computer Engineering. Based on the broad definition of Engineering as the application of science to increasing prosperity of mankind, such an activity would include fields such as medicine, psychology, sociology, economics, education and management.

The Society should, therefore, strive to create this broad-based understanding and also establish high professional standards. Professional standards are not precisely definable but there is no doubt that we should endeavour to build up ethics, professional behaviour and social responsibilities amongst the members in order to establish the CSI as the accepted professional body in the computer field in the country.

There is no doubt that computing and information processing activities have attained sufficient maturity in India. The Society should enlarge its activities towards the achievement of its objectives purposefully. Our obligations as specialists and competent professional personnel are very clear.

The Computer Society of India acknowledges gratefully the co-operation of The Hindu and the advertisers in the production of this Supplement.

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Computer Centr[e] [at] Guindy Eng. Co[llege]

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Computer Design And Development in India

By Dr. B. Nag

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The fifth annual general conference of the Computer Society of India is being held in Madras for three days from to-day at the College of Engineering, Guindy. Dr. B. D. Nag Chaudhuri, member, Planning Commission, will inaugurate the conference. Mr. P. Sivalingam, Director of Technical Education Tamil Nadu, will be in the chair at the inaugural session.

(Programme on Page IV)

ACTIVITY in the area of electronic computer development started in India in 1954 at the Tata Institute of Fundamental Research (TIFR), where a pilot model general purpose computer was completed in 1956. Subsequently, a full-scale version was commissioned in 1960. This machine, named TIFRAC, was in operation till 1964 and many early computer users in the country had their first experience of automatic computing using TIFRAC. The pioneering project TIFRAC helped to spread computer consciousness among the research scientists of TIFR as well as other institutions.

The TIFRAC project, carried out in the first generation computer era, used the electronic hardware readily available at that time, namely, vacuum tubes, semiconductor diodes and the ferrite core memory. The design of TIFRAC was in pace with the state of the art of the time. But the spectacular and rapid progress of the computer technology elsewhere made it an obsolescent first generation machine by the time it was completed, along with all other machines of the period.

The first attempt in India to develop a general purpose second generation computer was undertaken jointly by the Indian Statistical Institute (ISI) and the Jadavpur University in Calcutta in 1963.

The newly formed department of Electronics and Tele-Communication Engineering of Jadavpur University welcomed the idea of the Statistical Institute to take up a programme jointly to develop a small-to-medium sized computer. This project, while necessarily limited in scope because of considerations of cost, became operational in 1966 and was christened ISIJU-1 after the names of the two institutions.

Both the TIFRAC and the ISIJU-1 projects resulted in the growth of a hard-core of personnel in the country with professional know-how in the various facets of computer technology. The ISIJU-1 has been used in teaching, programming and computer circuit design, as well as in solving research problems of moderate size. The limitations arise mostly from the limited memory size. A notable use of this computer has been in a U.N. project of industrial planning in South-East Asia.

Both TIFRAC and ISIJU-1 were built using imported electronic components and peripheral units. The semiconductor industry was started in India in the early 60's primarily to meet the needs of the entertainment industry. It is only in the last 2 years or so that semiconductor devices, suitable for high-speed reliable computer applications, have become available locally.

The Computer Division of the Electronic Group of the Trombay Atomic Energy Establishment, now known as the Bhabha Atomic Research Centre (BARC), developed a general-purpose analog computer in 1960 for handling engineering problems primarily arising in connection with nuclear reactor designs. Subsequently, their production unit manufactured and sold analog computers to scientific and teaching institutions. The Computer Group investigated the possible applications of real-time computers in the various agencies within the Department of Atomic Energy (DAE) and elsewhere in India, and started a project in 1965 to develop such a computer. It was planned that the DAE's newly formed public sector undertaking—The Electronics Corporation of India (ECIL)—at Hyderabad, would later manufacture and sell these computers on a commercial basis.

Real-time computers, as distinguished from general purpose computers, are used to control the plant machinery of steel, petroleum, chemical and other plants, nuclear reactors, etc. They are also used in air-traffic controls and satellite tracking and communication. Such computers supervise the complex processes in a real-time environment by acquiring all vital data of operations in progress, and after processing them, by sending back control signals to direct or guide the various equipment of the complex almost instantaneously.

EDUCATIONAL PURPOSES

The BARC real-time computer (named TDC-12) became operational in 1969, and the group has already moved to ECIL to launch their production programme. The TDC-12 project has taken full advantage of locally available semiconductor devices and other electronic components. No more than 25 per cent of the direct cost of components and peripherals in producing these computers would be in foreign exchange. The TDC-12 computer, apart from meeting the need in India for real-time systems, would also be useful, according to the designers, for educational and training purposes. The production programme of computers at ECIL marks an important stage in Indian industry, as now the country is ready for the manufacture of computers completely designed in India.

The Computer Group at the Tata Institute of Fundamental Research turned its attention to the design of special purpose computers with indigenous electronic components after the installation there of a CDC 3600-160A system in 1964 to function as a national computational facility. To this effect, they also took up the problem of designing a real-time data processor, OLDAP (On-Line Data Processor), which has some similarities to the TDC-12 in its design approaches.

Apart from the developmental efforts we have been discussing so far, there have also been some specialised system and equipment development activities in India that fall in the category of computer techniques. The most significant of these are the message switching electronic exchange now under development at the Telecommunication Research Centre of the Post and Telegraph Department in New Delhi, and data-logging systems developed at the National Aeronautical Laboratory, Bangalore. Defence research laboratories may also be developing special purpose systems.

ELECTRONIC DESK CALCULATOR

Special purpose computers for nuclear research, and multichannel analysers have been developed. New projects continue to be taken up in these areas at the Atomic Energy Department's research centres, as well as at one or two universities. Another equipment on which much attention is now focussed is the electronic desk calculator. It may be expected that this will be followed by the development of midget computers.

The major problems that confront development projects in the area of computers in India at present, mainly arise from component and peripheral non-availability. The types of basic hardware items required in computers cover a wide range, viz., semiconductor devices, discrete resistors, capacitors and pulse transformers, printed circuit boards, edge connectors and cable connectors, to name some important ones. Integrated circuits and microelectronic packages were available in the West in the early 60's, and in substantial commercial quantities, about 1965. The third generation computers were ushered in around that time built out of integrated and hybrid circuits.

It is unfortunate that the ECIL programme, taking shape in the 70's, has to be based on second generation technology because of the non-availability, locally, of mi-

Continued on Page IV

· Centre at

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rof. K. S. Hegde

ollege of Engineering, Guindy)

processing the results of the examinations conducted by the Tamil Nadu Board of Technical Education. This programme has been in operation for the past few years.

Computing facilities have since been established at the Integral Coach Factory, Southern Railway, IBM, Binny's and the Physics Department of the University of Madras. The last one is chiefly devoted to scientific research, while the others are primarily concerned with management, production control and accounting.

Madras has thus recorded an all-round development in computer applications.

The College of Engineering Guindy, deems it an honour to have this opportunity to host the fifth annual conference of the Computer Society of India. It is our firm belief that the deliberations of this Conference, apart from their technical contribution, will serve to add considerably to the computer awareness among the students and the various professional members in this region.

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TREMENDOUS POTENTIALITIES

Computers, the most significant products of technological endeavour in this era of "Intelectronics", forming part of the electronic age have contributed to the extension of human intellect by electronics. In a developing economy such as ours, we cannot avoid falling in line with the developed countries in adopting the tremendous potentialities gained by these advances in solving our day-to-day problems. This adoption will naturally make considerable demands on our educational systems, research and development and manufacturing activities in the country. Our next generation will have to develop a sense of appreciation of computers and their capabilities in the same way as the present generation has of machines, radios, and so on.

Most of the members of the Society have been involved directly in their individual capacities in the improvement of the efficiency of computer processes and education. While early in 1962 the potential users had to be entirely guided by the manufacturers' representatives with regard to selection and implementation of suitable systems the conditions to-day are altered. The expertise in system analysis is no longer the prerogative of the manufacturers. Users can handle these problems competently by and large. The Computer Society could also further contribute directly in helping the users in this regard.

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(Programme on Page IV)

ACTIVITY in the area of electronic computer development started in India in 1954 at the Tata Institute of Fundamental Research (TIFR), where a pilot model general purpose computer was completed in 1956. Subsequently, a full-scale version was commissioned in 1960. This machine, named TIFRAC, was in operation till 1964 and many early computer users in the country had their first experience of automatic computing using TIFRAC. The pioneering project TIFRAC helped to spread computer consciousness among the research scientists of TIFR as well as other institutions.

The TIFRAC project carried out in the first generation computer era, used the electronic hardware readily available at that time, namely, vacuum tubes, semiconductor diodes and the ferrite core memory. The design of TIFRAC was in pace with the state of the art of the time. But the spectacular and rapid progress of the computer technology elsewhere made it an obsolescent first generation machine by the time it was completed, along with all other machines of the period.

The first attempt in India to develop a general purpose second generation computer was undertaken jointly by the Indian Statistical Institute (ISI) and the Jadavpur University in Calcutta in 1963.

The newly formed department of Electronics and Tele-Communication Engineering of Jadavpur University welcomed the idea of the Statistical Institute to take up a programme jointly to develop a small-to-medium sized computer. This project, while necessarily limited in scope because of considerations of cost, became operational in 1966 and was christened ISIJU-I after the names of the two institutions.

Both the TIFRAC and the ISIJU-I projects resulted in the growth of a hard-core of personnel in the country with professional [illegible] of computer technology. The ISIJU-I has been used in teaching programming and computer circuit design, as well as in solving research problems of moderate size. The limitations arise mostly from the limited memory size. A notable use of this computer has been in a U.N. project of industrial planning in South-East Asia.

Both TIFRAC and ISIJU-I were built using imported electronic components and peripheral units. The semiconductor industry was started in India in the early 60's primarily to meet the needs of the entertainment industry. It is only in the last 2 years or so that semiconductor devices, suitable for high-speed reliable computer applications, have become available locally.

The Computer Division of the Electronic Group of the Trombay Atomic Energy Establishment, now known as the Bhabha Atomic Research Centre (BARC), developed a general purpose analog computer in 1960 for handling engineering problems primarily arising in connection with nuclear reactor designs. Subsequently their production unit manufactured and sold analog computers to scientific and teaching institutions. The Computer Group investigated the possible applications of real-time computers in the various agencies within the Department of Atomic Energy (DAE) and elsewhere in India and started a project in 1965 to develop such a computer. It was planned that the DAE's newly formed public sector undertaking —the Electronics Corporation of India (ECIL)—at Hyderabad, would later manufacture and sell these computers on a commercial basis.

Real-time computers, as distinguished from general-purpose computers, are used to control the plant machinery of steel, petroleum, chemical and other [illegible] nuclear reactors, etc. They are used in air-traffic controls, satellite tracking and communications. Such computers supervise the complex processes in a [illegible] vironment by acquiring all vital data of operations in progress, and after processing them, by sending back control signals to direct or guide the various equipment of the complex almost instantaneously.

EDUCATIONAL PURPOSES

The BARC real-time computer (named TDC-12) became operational in 1969, and the group has already moved to ECIL to launch their production programme. The TDC-12 project has taken full advantage of locally available semiconductor devices and other electronic components. No more than 25 per cent of the direct cost of components and peripherals in producing these computers would be in foreign exchange. The TDC-12 computer, apart from meeting the need in India for real-time systems, would also be useful, according to the designers, for educational and training purposes. The production programme of computers at ECIL marks an important stage in Indian industry, as now the country is ready for the manufacture of computers completely devised in India.

The Computer Group at the Tata Institute of Fundamental Research turned its attention to the design of special purpose computers with indigenous electronic components after the installation there of a CDC 3600/160A system in 1964 to function as a national computational facility. To this effect, they also took up the problem of designing a real-time data processor OLDAP (On-Line Data Processor), which has some similarities to the TDC-12 in its design approaches.

Apart from the developmental efforts we have been discussing so far there have also been some specialised system and equipment development activities in India that fall in the category of computer techniques. The most significant of these are the message switching electronic exchange now under development at the Telecommunication Research Centre of the Post and Telegraph Department in New Delhi, and data-logging systems developed at the National Aeronautical Laboratory Bangalore. Defence research laboratories may also be developing special purpose systems.

ELECTRONIC DESK CALCULATOR

Special purpose computers for nuclear research, and multichannel analysers have been developed. New projects continue to be taken up in these areas at the Atomic Energy Department's research centres, as well as at one or two universities. Another equipment on which much attention is now [illegible] culator. It may be expected that this will be followed by the development of midget computers.

The major problems that confront development projects in the area of computers in India at present, mainly arise from component and peripheral non-availability. The types of basic hardware items required in computers cover a wide range, viz., semiconductor devices, discrete resistors, capacitors and pulse transformers, printed circuit boards, edge connectors and cable connectors, to name some important ones. Integrated circuits and microelectronic packages were available in the West in the early 60's, and in substantial commercial quantities, about 1965. The third generation computers were ushered in around that time built out of integrated and hybrid circuits.

It is unfortunate [illegible] programme, taking shape in the 70's, has to be based on second generation technology because of the non-availability, locally, of mi-

Continued on Page IV

ter Centre at Eng. College

By Prof. K. S. Hegde

(College of Engineering, Guindy)

[illegible] the College nay, with an he beginning al computer s llege has been programming and computa- gineering stu- at appropriate has been the hree advanced computer pro- rical analysis al since [illegible] also available te.ts and staff well as other search institu- urses and ex- s and by its ent, the Col- e considerable er oriented re- ment inistrative ap- e has develop- rogramme for

[illegible] conducted by the Tamil [illegible] Board of Technical Education. This programme has been in operation for the past few years.

Computing facilities have since been established at the Integral Coach Factory, Southern Railway, IBM, Binny's and the Physics Department of the University of Madras. The last one is chiefly devoted to scientific research, while the others are primarily concerned with management, production control and accounting.

Madras has thus recorded an all-round development in computer applications.

The College of Engineering Guindy, deems it an honour to have this opportunity to host the fifth annual conference of the Computer Society of India. It is our firm belief that the deliberations of this Conference, apart from their technical contribution, will serve to add considerably to the computer awareness among the students and the various professional members in this region.