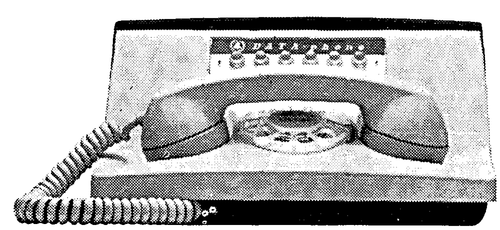
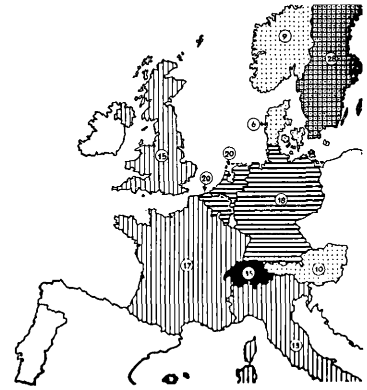
September, 1963

computers and automation

Western Europe and Computers





The front cover shows number of computers installed per million of the working population (adjusted) on January 1, 1962. Articles and features relating to computers in Western Europe appear in this issue on pages 5, 6, 10, 16, and 20.

computers and automation

SEPTEMBER, 1963 Vol. XII, No. 9

computers and data processors: the design, applications, and implications of information processing systems.

In This Issue

In Every Issue

COMPUTERS AND AUTOMATION IS PUBLISHED MONTHLY AT 815 WASHINGTON ST., NEWTONVILLE 60, MASS., BY BERKELEY ENTERPRISES, INC. PRINTED IN U.S.A. SUBSCRIPTION RATES: UNITED STATES, $15.00 FOR 1 YEAR, $29.00 FOR 2 YEARS, INCLUDING THE JUNE DIRECTORY ISSUE; CANADA, ADD 50¢ A YEAR FOR POSTAGE; FOREIGN, ADD $1.50 A YEAR FOR POSTAGE. ADDRESS ALL EDITORIAL AND SUBSCRIPTION MAIL TO BERKELEY ENTERPRISES, INC., 815 WASHINGTON ST., NEWTONVILLE 60, MASS. SECOND CLASS POSTAGE PAID AT BOSTON, MASS.

POSTMASTER: PLEASE SEND ALL FORMS 3579 TO BERKELEY ENTERPRISES, INC., 815 WASHINGTON ST., NEWTONVILLE 60, MASS. CHANGE OF ADDRESS: IF YOUR ADDRESS CHANGES, PLEASE SEND US BOTH YOUR NEW ADDRESS AND YOUR OLD ADDRESS (AS IT APPEARS ON THE MAGAZINE ADDRESS IMPRINT), AND ALLOW THREE WEEKS FOR THE CHANGE TO BE MADE.

"We've found Extra Length Computer Audiotape definitely superior"

says Kenneth Sassaman, Data Processing Manager for Blue Shield Medical Service Association of Pennsylvania

"With 4½ million subscribers we process thousands of claims every week. Before we used Extra Length Computer Audiotape we frequently had to interrupt our claims payment runs to change reels because our program requirements exceeded 2400-ft. tape lengths. These frequent reel changes often caused print-out errors. But now we process all our claims on Extra Length Computer Audiotape and save time with less reel mounting and dismounting. With 50% more tape on the same size reels we require fewer tapes to store the same amount of information. As a result, we have less dollar value tied up in tape. We put the new tapes into operation in an existing program without making any modifications. In over six months of heavy use we haven't had a single permanent read-write failure. We've had *no* problems **with the tape.** We've found Extra Length Computer Audiotape definitely superior."

Extra Length Computer Audiotape uses a 1-mil "Tempered Mylar" base instead of conventional 1.5-mil polyester film. As a result you get 1800 ft. on 8½-inch reels, 3600 ft. on 10½-inch reels. Although thinner, the new tape is slightly stronger than 1.5-mil tapes. Like all Computer Audiotape, the new tape is 100% certified against defects and is offered with certification of 556 and 800 bits per track-inch. For additional information on Extra Length Computer Audiotape and regular Computer Audiotape, in Standard and Heavy Duty types, contact your local representative or write to Audio Devices, Dept.*

*DUPONT TRADEMARK FOR ITS POLYESTER FILM.

AUDIO DEVICES, INC. 444 Madison Avenue, New York 22, N.Y.

c&a
EDITORIAL

Number of Computers Per Million Persons

Elsewhere in this issue is an interesting report to the European Economic Community by three Netherlanders, W. K. de Bruijn, A. B. Frelink, and B. Scheepmaker, on behalf of the Netherlands Automatic Information Processing Research Centre in Amsterdam. In this report, among other ideas, is the statistic or index: number of computers per million persons of the working population (with or without agricultural and fishery workers). The index at the end of 1961 varies from about 18 in Austria, to about 36 in Germany, Belgium, and France, to about 68 in Switzerland, and 118 in the United States.

Of course this index suffers from the lack of an agreed and comparable definition of "computer." But even so, the figure is interesting, and gives rise to several questions.

How high is this index now in the United States?

The Monthly Computer Census published in "Computers and Automation" shows total installations of computers for the manufacturers there reported; but it is not subdivided according to the country where the computer is installed. Suppose we estimate that 80% of the 15,000 installations reported there are in the United States. Suppose the applicable working population of the United States is taken as about 67 million. Then this index for the United States currently is about 180 computers per million persons.

How high will this index go in the future?

The future is a long time. Perhaps we had better talk about the next 30 years.

In the next 30 years (a period 50 percent longer than the 20 years that have seen the existing development of computers) a great many important new developments can be confidently expected.

The power of computers is increasing. The cost of them is decreasing. The size of them is decreasing. The number of kinds of applications -- over 600 now (see the list in the June Computer Directory issue of "Computers and Automation") -- is steadily increasing. The ways in which they can be used are becoming more and more understood and more and more convenient. The size of the computer field in factories, workers, etc., is bounding upward. Packaged programs are multiplying.

All these factors will greatly increase the number of computers, certainly by a factor of 10, probably by a factor of 100, and perhaps by a factor of 1000.

Even in our own small business which publishes "Computers and Automation," in which we employ twenty people full-time and part-time, we have two applications for computers: about 50 hours of clerical work per month dealing with figures, and about 300 hours of clerical work per month dealing with subscriptions. These small quantities of work to be done by a computer do not at present justify paying to get the problems into machine language and the results back out of machine language. But it is clear that these are temporary obstacles, and they may well disappear in the next 10 years; almost certainly, they will disappear in the next 30 years.

The cheaper that computing power becomes, including the costs of going into a computer and coming back out of a computer, the more sensible it will be for one to use a computer. The computer will be either in one's own premises or at a neighboring service bureau.

Just as electrical power permeates all advanced civilizations today, so will computing power.

In fact, I would estimate that the index of number of computers per million persons will change to an index of number of computers per thousand persons, and in the United States by the end of the next 30 years, will be on the order of 100 to 200 computers per thousand persons. In other words, by the end of the next 30 years, I would estimate that the index should multiply by 1000.

If we think over similar technological developments in the last 100 years, there come to mind telephones, automobiles, radios, and TV. Probably something like 40 million cars are on the roads in the United States, correlated with a working population of some 70 million. Or one car for every two persons working. Individual computers, it seems to me, are not likely to become quite as frequent as this, but computing power will become accessible to almost everyone. And in a great many cases a small, cheap, easily instructed, powerful computer at one's elbow will be more comfortable and convenient than dialing into a central computer.

We have only seen the beginning of the computer revolution.

Edmund C. Berkeley

EDITOR

c & a
READERS' & EDITOR'S FORUM

MAGNETIC INK CHARACTER RECOGNITION IN EUROPE

D. Hekimi
Secretary-General
European Computer Manufacturers Association
Geneva, Switz.

In the July, 1963 issue of **Computers and Automation,** Dick Utman gave a complete and extremely interesting review of the state of affairs of standardization in the computer field.

However I should like to add some remarks on the MICR situation in Europe.

There is in Europe no European Bankers Association (e.g., comparable to ABA). The Réunion Européenne d'Automatisme (REA) is a body grouping only a number of private bank associations. This group has proposed to its members to adopt the CMC-7 system, originally by the Compagnie des Machines BULL, but not at all based on BULL equipment. Numerous other manufacturers have developed suitable CMC-7 readers. This system has so far been adopted by French, Italian and Danish bankers only. It is by no means a Common Market Standard, the more so since such a class of standards does not exist.

The ECMA working Committee TC7 is now preparing a set of specifications which will allow a rapid introduction of CMC-7 in the banking industry. It is hoped that by the end of this year the full specification for the printed image of a complete alphanumeric set will be achieved. It is expected that this proposal will be supported by all members of our association.

"INFORMATION PROCESSING IN THE NATION'S CAPITAL"—ONE-DAY SYMPOSIUM, OCTOBER 17, 1963, COLLEGE PARK, MD.

J. H. Nichols
Bethesda, Md.

The Washington, D. C., Chapter of the Association for Computing Machinery and the University of Maryland, co-sponsors of the 4th Annual One-Day Technical Symposium, have announced that the Symposium will convene in the Ballroom of the Student Union Building on the College Park campus (near Baltimore) of the University of Maryland at 9:00 A.M. on Thursday, October 17, 1963.

The program includes significant reports on recent developments by leading members of the information-processing community. Topics include time sharing, programming languages, list processing, information retrieval, automatic indexing and classification of documents, satellite data processing, character recognition, and a panel discussion "Our Resources in Information Processing—Where Are the Gaps?"

Dr. Alan J. Perlis, President of the ACM, will deliver an address "An Experimental Time-Sharing System." The Honorable Roman C. Pucinski, Representative from Illinois, will deliver the luncheon address. He is Chairman of the House of Representatives Ad Hoc Sub-Committee on a Research Data Processing and Information Retrieval Center. "The Thinking Machine," a movie featuring Dr. Jerome B. Wiesner and many other authorities in the computer field, will be shown.

Other papers being given include:

—List Processing on the IBM 1401, by A. Opler, Computer Usage Co.
—A Discussion of Chemical Information Searching Problems, by E. C. Marden, National Bureau of Standards
—Automatic Indexing and the Association Factor, by H. E. Stiles, Dept. of Defense
—Experimental Results of a Discrimination Method for Automatically Classifying Documents, by J. H. Williams, IBM
—Programming Languages: a Classification of Features, by W. Orchard-Hays, Systems Programming, Inc.
—Data Processing for the Orbiting Geophysical Observatory Satellite, by E. Habib and M. Mahoney, Goddard Space Flight Center
—Character Recognition in Context, by R. B. Thomas and M. Kassler, RCA

Because of the extensive interest in Congressman Pucinski's luncheon address, *pre-registration will be REQUIRED for the luncheon.* Luncheon registration will not be available at the door. The following schedule of fees has been established:

Pre-Registration	
Symposium and Luncheon	$5.00
Symposium only	$2.50
Late Registration (at the door)	
Symposium only	$3.00

Full-time students may register for the symposium at a fee of $1.00.

For additional information, write to J. H. Nichols, Dunlap and Associates, Inc., 7220 Wisconsin Avenue, Bethesda 14, Maryland.

CALL FOR PAPERS

The fifth Joint Automatic Control Conference will be held at Stanford Univ., Stanford, Calif., June 24-26, 1964. The deadline for receipt of 100-word abstracts is September 30, 1963. The deadline for receipt of full abstracts is November 15, 1963. Prospective authors who are not members of the sponsoring societies are also invited to submit abstracts. They should be marked "For 1964 JACC" and sent to: IEEE, 345 East 42 St., New York 17, N. Y.

CORRECTION

I. From Paul W. Howerton
Information for Industry, Inc.
Washington 6, D. C.

Thank you for the reprints of Dr. Léon E. Dostert's paper which appeared in the May issue of **Computers and Automation.**

I was surprised to find that you failed to indicate that the article had been reproduced by permission of the copyright owner, Information for Industry, Inc., and had appeared originally in "Vistas in Information Handling, Vol. I—The Augmentation of Man's Intellect by Machine." The reprints imply that you hold the copyright to Dr. Dostert's work.

Your original request for permission to reprint the article dated March 20, 1963 and addressed to Dr. Dostert suggested that the reprinting of the paper would draw attention to the book. In my letter of March 26, 1963 I approved your request and took note of the possible benefit to the book sale. I fail to see how such attention can be gained when the source of the original is uncredited.

Please rectify this omission by including this letter in your "Letters to the Editor" column.

II. From the Editor

Through a most unfortunate error, the May issue of **Computers and Automation** on page 24 omitted the acknowledgment that Dr. Dostert's article "Machine Translation and Automatic Language Data Processing" was reprinted with permission from the book "Vistas in Information Handling, Volume I—the Augmentation of Man's Intellect by Machine," edited by Paul W. Howerton and David C. Weeks, and published by Spartan Books, 6411 Chillum Place, N.W., Washington 6, D. C. That page of the May issue should have borne a note beginning "Reprinted with permission from" the foregoing reference. We greatly regret this error.

Distressing errors like these remind us once more of Murphy's Laws quoted in the "Scientific American," April, 1956, as applying not only to laboratories but also to editors:

I. If something can go wrong, it will.
II. When left to themselves, things always go from bad to worse.
III. Nature always sides with the hidden flaw.

The whole book "Vistas in Information Handling" is interesting. It contains nine papers by nine authors, on such subjects as conceptual frameworks, associative information retrieval, structural models of linguistic automation, the classification and identification of homographs, and the production of critical scientific data.

CHANGING FROM ELEVEN TO TWELVE ISSUES PER YEAR

I. From Stephen E. Laurens
Cincinnati, Ohio

I have been a subscriber of yours for a little less than a year, and I would like you to know that I consider your publication an excellent and highly informative one. I would like to make two requests of you:

First, at the time I entered my subscription, I chose not to receive your June Computer Directory and Buyers' Guide. I now see the error of my ways, and would very much like to have a copy of your latest one. Could you sell me one? If so, please send it and bill me.

Secondly, could you send me information on your advertising rates? I am particularly interested in the "per column inch" rate for those pages divided into three columns.

II. From the Editor

To change a subscription from eleven issues per year of **Computers and Automation** leaving out June, to all twelve issues per year including the regular June Computer Directory and Buyers' Guide costs theoretically the price of the Directory by itself, $12.00. But during July in each year we invite our non-directory subscribers to include the Directory issue into their subscription at no surcharge, simply the difference ($7.50) between the $7.50 and the $15.00 annual subscription rates. In practice, during the rest of the year, if any subscriber sees a copy of the Directory and promptly writes us and says please may he change, we would be much inclined to make the change at no surcharge.

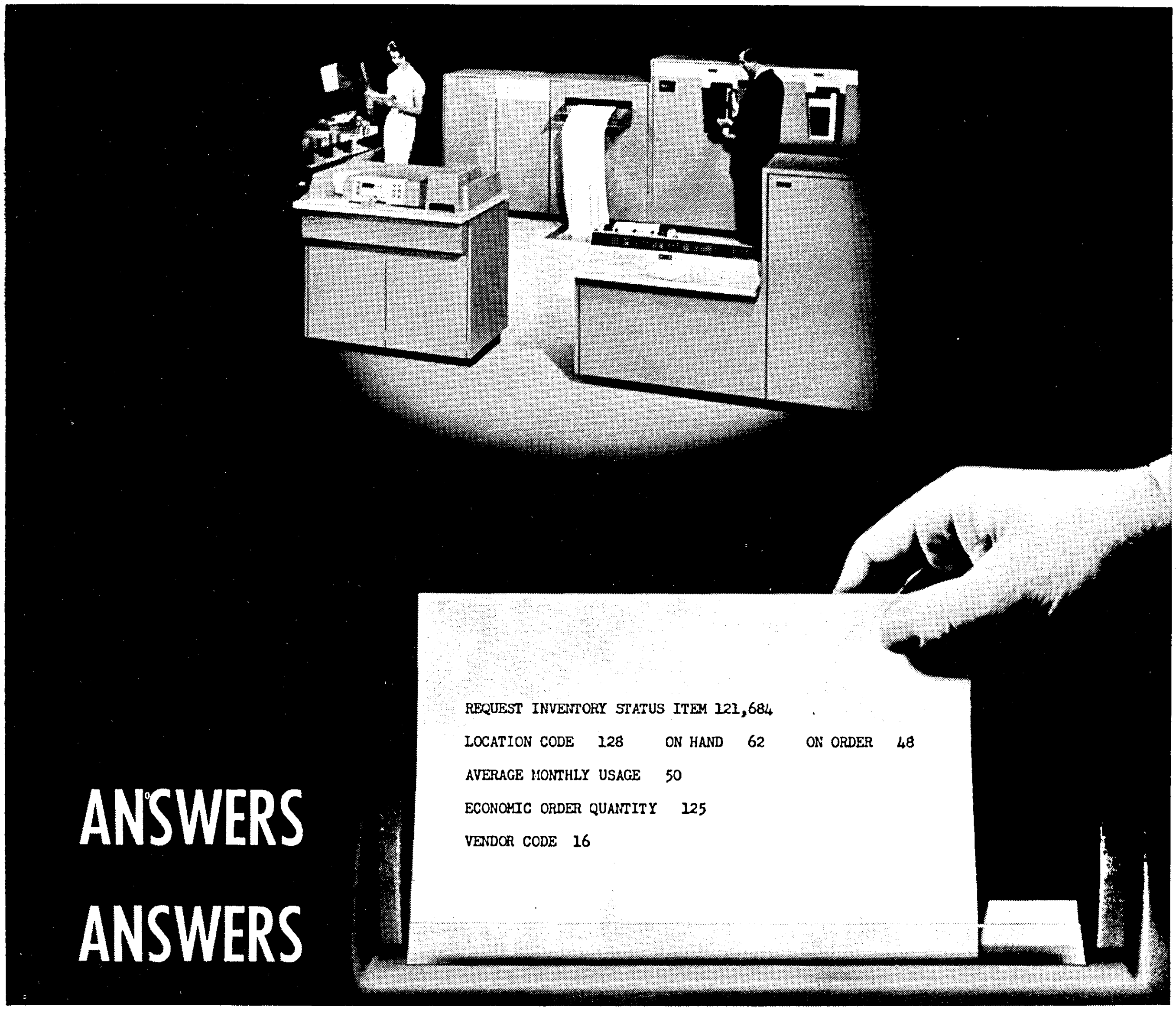
COMMUNICATION TO THE SUBSCRIPTION DEPARTMENT

M. W. Bass
Univac Division of Sperry Rand
Washington, D. C.

Apparently there are two listings for me in your record file. Under CA 7877, "Remington Rand" was changed to "UNIVAC, Division of Sperry Rand" on 2-year renewal in March, 1963. Current file number is CA 14343 and previous is obsolete. Please update accordingly and don't worry about my dropping your informative magazine.

BASIC PROGRAMMING LANGUAGE

"We've done our best to keep the programming within the average stenographer's capabilities."



ANSWERS . . . with CRAM and Remote Inquiry

provided by the NCR 315 Computer System

The NCR 315 CRAM (Card Random Access Memory) Computer System is more than just another back-office electronic accounting machine.

In industry, for example, Inquiry Units can be located at dozens of remote locations, enabling people to communicate with the computer files . . . even from hundreds of miles away. With the NCR 315 you will be able to keep a "current finger" on the pulse of your business . . . to get immediate answers to questions about inventories, production, sales . . . and a host of other timely facts people must have to effectively manage . . . and to act while the "iron is hot."

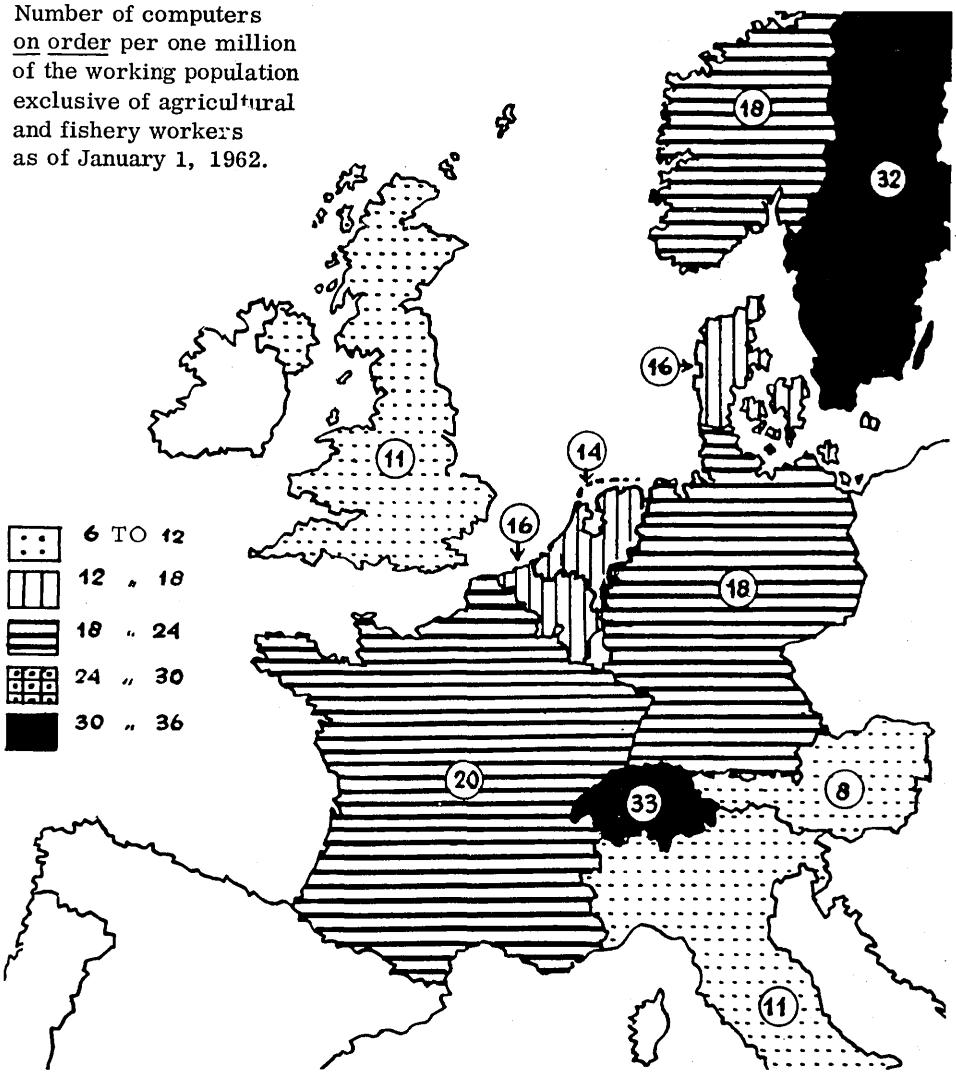
For more information, call your nearby NCR representative or write to The National Cash Register Company, Data Processing Systems and Sales, Dayton 9, Ohio.

NCR PROVIDES TOTAL SYSTEMS—FROM ORIGINAL ENTRY TO FINAL REPORT—
THROUGH ACCOUNTING MACHINES, CASH REGISTERS OR ADDING MACHINES, AND DATA PROCESSING
The National Cash Register Co.•1,133 offices in 120 countries•79 years of helping business save money

NCR

Circle No. 4 on Readers Service Card

THE DEVELOPMENT OF THE COMPUTER MARKET IN EUROPE (Part 1)



Number of computers on order per one million of the working population exclusive of agricultural and fishery workers as of January 1, 1962.

W. K. de Bruijn,
A. B. Frelink, and
B. Scheepmaker
Netherlands Automatic Information Processing Research Centre
Amsterdam, Netherlands

Though the first computers in Europe came into use sometime about 1951—the EDSAC at Cambridge and the FERRANTI MARK I at Manchester—and the first on the continent round 1954, in a discussion of the development of computer application the year 1957 can be considered the starting point. The development in Great Britain was about two years ahead of that on the continent due to the continuous strain during and after the second world war and the establishment of a native computer industry. The first computers were inherently built for scientific calculations. The first so-called business computer—the LEO computer developed by Lyons—was not operational before 1953. At the end of 1956 and in the beginning of 1957 the first administrative machines were installed on the continent. These were machines of the IBM-650 type. From that moment the development was such that the number of computers installed at the end of each year was 160 to 220 per cent of the number at the beginning of that year. The dates of instalment of the machines are often not exactly known and very difficult to retrace, if only through the fact that the date of instalment given by the manufacturer often lies many months ahead of the date mentioned by the user. In extreme cases the difference is as much as six months.

(Based on a report "Development of the European Computer Market," prepared by the Centre at the request of the European Economic Community, and reproduced with permission)

The trend in the use of computers is approximately as shown in Table I. Though these figures suggest a certain gradual development, in practice this was not so. During the first years this might indeed have been the case. In those years there were only a few types of machines available and of those, already so small in number, some were offered in only one single country, or, at any rate, not in all European countries. Most of the British types were hardly sold outside the Commonwealth, just as nearly all the originally European types were not available outside the countries where they were manufactured. Examples are: ZUSE, SIEMENS, STANDARD ELECTRIC (Germany), SEPSEA (France), OLIVETTI (Italy) and FACIT and WEGEMATIC (Sweden . Besides the most important USA types (IBM and REMINGTON), till then BULL (France) and ICT (Great Britain) were the only manufacturers who were able to gain a part of any importance of the market.

In the last two years a clear change has been taking place: many manufacturers are now trying to conquer a market outside their own countries as well. The difficulty, however, in obtaining experts and trained staff proves a serious obstacle when trying to set up branches in other countries. Besides the efforts of European manufacturers, USA producers have recently increased competition in the European markets. NCR and RCA, like IBM and SPERRY RAND, are very active, RCA mainly through agreements with European manufacturers. For some time also HONEYWELL (in Great Britain) and GENERAL ELECTRIC (in France) have established outposts in Europe.

Rapid progress has been made in the last two years, in the first place due to the introduction of the IBM 1401. This machine, which came on the market in 1959, was at once enormously successful and caused a peak in orders. Deliveries began in the second half of 1960 and got well under way in 1961. In 1962 also a large number of machines of this type were installed, but the climax is now over, causing a considerable change in the ratio of computers installed and on order. It may be assumed that by the end of 1962, at least 40% of all computers installed in Europe were of this type, of which a total in Europe of more than 1000 were ordered; some of these have still to be delivered in 1963.

Factors that have played a more or less important part in this development, include these:

—the existence of a computer industry in the country concerned. This factor was mainly of importance in Great Britain, but in Germany also the presence of a manufacturer as ZUSE appeared to be significant, especially when certain applications (in this case cadastral work) proved successful;

—the existence of heavy industry and precision industry. They are in fact an important group of buyers who need both business data processing and scientific calculations by computers. Moreover, those companies are often sufficiently large and have enough financial capacity to be able to acquire these expensive machines;

—the existence of organizations which stimulate this development, either by supplying information or by providing opportunities for the exchange of experiences and ideas. Examples are: The British Computer Society (Great Britain), The Netherlands Au-

Table I

	Computers installed in Europe at the end of:						
	1955	1956	1957	1958	1959	1960	1961
European Economic Community	5	15	55	135	250	470	985
Great Britain	20	35	75	130	170	240	340
Rest of Western Europe	—	5	10	35	65	100	220
Europe	25	55	140	300	485	810	1545

The development in the separate European Economic Community countries during the last 5 years has been approximately as follows:

	Computers installed at the end of:				
	1957	1958	1959	1960	1961
Belgium/Luxemburg	5	10	20	35	65
Germany	20	45	85	170	390
France	15	35	60	125	260
Italy	10	25	55	100	200
Netherlands	5	20	30	40	70
European Economic Community	55	135	250	470	985

tomatic Information Processing Research Centre (Holland), and the Comité d'Action pour la Productivité dans l'Assurance (CAPA) (France). The latter organization is only interested in the insurance field;
—labor shortage and the level of wages can also have a considerable influence on the development. These factors had considerable influence in Switzerland and Sweden especially;
—the fear of a recurrence of the crisis of the 1930's and coupled with it the need to put companies in as strong a position as possible, was an important factor in Germany especially.

The situation at the end of 1961, which will be the starting point of the forecast for the coming years, is shown in Table II. This starting point is not so definite as one might wish, since the data used are not altogether reliable, nor in every respect comparable. Unlike other types of machines, there is no common measure by which the capacity of computers can be expressed. The borderline between computers and conventional information processing equipment (calculating machines, etc.) is not drawn alike by all concerned. The figures about the number of computers installed and on order have been given as accurately and as completely as possible, all available sources having been considered. To indicate that, nevertheless, they have no absolutely reliable value, the numbers have been rounded off to multiples of 5.

Table II

Computers Installed and Ordered -- End of 1961

	Installed	Ordered
Belgium/Luxemburg	65	50
Germany	390	385
France	260	300
Italy	200	165
Netherlands	70	50
Total European Economic Community	985	950
Great Britain	340	260
Switzerland	70	65
Austria	25	20
Sweden	70	80
Norway	10	20
Denmark	10	25
Other countries (Finland, Ireland, Spain, Portugal and Greece)	35	?
	1,545	1,420

In order to get an insight into the meaning of the data on computers installed and on order in the several countries, see Table III showing the computer situation at the end of 1961 as compared with the population data for 1960. (The population data are taken from several sources, such as the "Statistisches Jahrbuch für die Bundesrepublik Deutschland 1960," the "Demographic Yearbook 1959 U. N." and data from the Netherlands Central Bureau of Statistics.)

This table clearly shows that the situation differs widely from country to country. Especially when one looks at the number of computers per 1,000,000 of the working population, marked differences are to be seen. The leading countries are Switzerland and Sweden. The explanation seems to be that in these countries especially the situation on the labor market is most critical, so that automation is as it were enforced by lack of personnel. Also remarkable are the arrears of Great Britain as compared with most of the EEC countries. The cause of this can be found partly in the intermittent development which is almost traditional in this country, and partly in the fact that automation started earlier here, and so many companies are now in a stage of transition to bigger and more modern machines. This, however, can at the moment not yet be seen in the numbers of computers ordered. The late arrival of American manufacturers on the British market may also be a cause of the arrears in Great Britain. Although there is an important native computer industry, the production capacity is not as great as it may appear.

For the change from 1960 to 1961 in computers installed per 1,000,000 of the working population, see Table IV. Switzerland and Sweden show the greatest progress, while Switzerland is clearly the leading country. The increase in the Swedish figure is even surpassed by the increase in the Danish one, this country rapidly making up its arrears. The situation in the USA, based upon the census of John Diebold Associates shows the following figures:

Installed at the end of 1960: 4718 machines
Installed at the end of 1961: 7445 machines

Converted into a comparison between the number of machines and the working population exclusive of agricultural and fishery workers in 1959 (63.2 million), it shows per 1,000,000 of this population in 1960, 75 computers and in 1961, 118 computers. When the USA figures are compared to those of Europe, it is clear that the lead of the USA is still very considerable. It may be estimated at five years.

The contrast between USA and EEC is remarkable, taking into account the only slight difference in population figures between the two entities. When comparing these figures for 1960 and 1961, it is indeed striking that the percentage progress in the European countries is much higher than in the USA. In several European countries it is more than 100 per cent, whereas in the USA there has been a progress of not even 60 per cent. It has, however, to be taken into account that a progress of 60 per cent in the USA in absolute figures means a much larger number of machines (2727) than in Europe (1510 — 848 + 662). It will certainly be a long time before Europe has made up its arrears in this respect. It is indeed a question whether this will even be possible as long as the discrepancy between the rate of exchange and the buying power of the dollar on the one hand and the rate of exchange of the European currencies on the other is still as large as it is now. This discrepancy is of importance here, because most of the computer prices in Europe are still based upon dollars and so, relatively, the same machine is considerably more expensive in Europe than in the USA.

THE EXTENT TO WHICH THE SEVERAL BRANCHES OF INDUSTRY ARE USING COMPUTERS AND THE EXPECTATIONS REGARDING FUTURE USE

When one tries to get an insight into the extent to which the several sectors of society have progressed in the field of automation, we can reasonably classify as follows:

A. Universities, scientific institutions, technical high schools;
B. Insurance companies (private as well as social insurance);
C. Transport;
D. Service centers;
E. Industrial companies;
F. Trading concerns;
G. Banks and Clearing agencies;
H. Public utilities;
I. Governmental institutions;
J. Local government;
K. Miscellaneous.

SECTORS THAT ARE OR WILL BE ENGAGED IN AUTOMATION

A. Universities

This was one of the first groups to use computers. Many universities are now in possession of a small scientific machine. Within the EEC 67 universities are known to have together 109 machines. When we add to this the scientific institutions of which some are directly or indirectly connected with universities, the figures mentioned rise to 123 institutes and universities with a total of 182 machines. Of these 182 machines 97—more than half—may be called smaller scientific machines (for instance ZEBRA, CAB 500, ZUSE 22, LGP 30, IBM 1620). The great variety of machines is striking; the 182 consist of 34 different types, the nine self-built machines not included, so that the total is actually 43 different types. The types most common are ZUSE 22 (24), CAB 500 (20), IBM 650 (19) and IBM 1620 (18). Of each of fifteen types only one institute is using them, and the number of none of the types not mentioned exceeds nine.

The number of large computers used by universities is still very limited, but there is a marked tendency to begin using machines with a greater capacity and more possibili-

Table III

The Computer Situation at the End of 1961

Survey of the relationship between the computers installed (A) and on order (B) in Europe at the end of 1961, and the total population (I), the working population (II), and the working population exclusive of agricultural and fishery workers (III).

	Computers			Population x 1,000,000		
Country	A	B	Total	I	II	III
Belgium	65	50	115	9,1	3,6	3,2
Germany	390	385	775	53,4	25,6	21,7
France	260	300	560	45,5	20,5	15,2
Italy	200	165	365	50,8	21,3	14,9
Netherlands	70	50	120	11,5	4,3	3,5
European Economic Community	985	950	1935	170,3	75,3	58,5
Great Britain	340	260	600	52,4	24,1	22,9
Norway	10	20	30	3,6	1,5	1,1
Sweden	70	80	150	7,5	3,7	2,5
Denmark	10	25	35	4,4	2,1	1,6
Switzerland	70	65	135	5,3	2,4	2,0
Austria	25	20	45	7,1	3,7	2,5

	Computers per 1,000,000 I			Computers per 1,000,000 II			Computers per 1,000,000 III		
Country	A	B	Total	A	B	Total	A	B	Total
Belgium	7	5	12	18	14	32	20	16	36
Germany	7	7	14	15	15	30	18	18	36
France	6	7	13	13	15	28	17	20	37
Italy	4	3	7	9	8	17	13	11	24
Netherlands	6	4	10	16	12	28	20	14	34
European Economic Community	6	6	11	13	13	26	17	16	33
Great Britain	6	5	11	14	11	25	15	11	26
Norway	3	6	9	6	13	19	9	18	27
Sweden	9	11	20	19	22	41	28	32	60
Denmark	2	6	8	5	12	17	6	16	22
Switzerland	13	12	25	29	27	56	35	33	68
Austria	4	3	7	7	5	12	10	8	18

Table IV

Machines Installed per 1,000,000 of the Working Population Exclusive of Agricultural and Fishery Workers

Country	1960	1961
USA	75	118
Switzerland	16	35
Sweden	14	28
Belgium	12	20
Netherlands	12	20
Germany	9	18
France	11	17
European Economic Community (average)	9	17
Great Britain	10	15
Italy	6	13
Austria	5	10
Norway	5	9
Denmark	1	6

ties. A considerable increase in the number of computers in this group may be expected on the following grounds:

—Many universities or comparable organizations have not yet ordered or installed computers.

—There is a growing need for this type of education which will cause an increase in the number of universities.

—In many of the universities with computers the situation is still such that the machine is only used by one faculty or special institute of the university, whereas a growing number of faculties will need to have a computer available.

—According to an American statement 138 universities or comparable institutes had their own machines in use at the end of 1961. 20 per cent of these were using smaller scientific computers and another 20 per cent large-scale systems.

—There is an ever growing field of application possibilities where it is discovered that computers can help to solve questions which have given trouble for many years. So far most computers have been used in the mathematical and physical sectors. Recently other sectors have also been showing great interest. The medical, legal and linguistic faculties for example are becoming more and more interested. The development of information retrieval techniques too is an important reason in this connection.

—It is probable that certain other educational institution such as technical, nautical and electrotechnical colleges will also start using small computers as educational aids. The development in Great Britain points in that direction. In that country more than 15 such colleges already use machines such as FERRANTO SIRIUS, NATIONAL 803, IBM 1620 and STANTEC ZEBRA. The 67 universities in the EEC mentioned above also include some technical schools such as the Bergakademie in Clausthal, Germany (ZUSE 22), the École Nationale Supérieure d'Aeronautique in Paris, France (CAB 500) and the École Supérieure d'Electricité in Paris, France (CAB 500).

B. Insurance companies

This is the second group which had an early start in the field of automation. This early start is probably partly the result of the successes of automation with some big American insurance firms. The purely administrative character of this type of organization is doubtless an important reason for this early development. Also important is the large amount of mathematical and statistical work which is mostly done by highly qualified personnel. A third reason is the fact that nearly all the accounting tasks are based on a set of data already known from the start (the policy data). The result is that there are but few types of businesses so well suited for a really integrated application of automation as the insurance companies.

The development of automation in this branch is, moreover, highly supported and stimulated by an international organization called CAPA (Comité d'Action pour la Productivité dans l'Assurance) which is seated in Paris. This organization has already twice organized a special congress on automation in the insurance branch (June, 1960 and October, 1962). Another incentive has without doubt been given by the international actuarial congresses which are held regularly and where more than once the subject of automation has been on the agenda.

The number of private insurance companies having computers installed or on order is, as far as is known, 60 with a total of 85 machines. If we include the social insurance organizations which are often wholly or partly governmental institutes, this figure rises to 80 and 109, or 13 per cent of the total of 689 known companies and 10 per cent of the total of 1,080 known machines (see table V and chart F). In reality these percentages are probably lower because the information available concerning this branch is better and more complete than that on most other branches. Nevertheless the figures clearly demonstrate that the insurance branch is far ahead of any other. Another proof of this is the cooperative use of computers which in Europe started first in this branch. Examples of such co-

Table V

Computers in the European Economic Community Countries (Installed and on Order) - as Far as Known, as of the Middle of 1962

The first figure indicates the number of users, the second the number of computers. The classification per type of user is the same as that used in the article.

	Belg./Lux.	Germany	France	Italy	Netherlands	Total
A. Universities, etc.	8 - 13	49 - 74	32 - 43	15 - 22	19 - 30	123 - 182
B. Insurance companies	7 - 9	32 - 46	25 - 32	5 - 8	11 - 14	80 - 109
C. Transport	3 - 5	5 - 10	2 - 3	1 - 2	3 - 6	14 - 26
D. Service centers	4 - 6	21 - 38	10 - 22	5 - 17	13 - 22	53 - 105
E. Industrial companies	15 - 17	79 -132	46 - 66	47 - 58	25 - 42	212 - 315
F. Trading concerns	7 - 9	24 - 44	6 - 10	5 - 5	8 - 11	50 - 79
G. Banks, etc.	2 - 4	9 - 15	14 - 30	24 - 37	13 - 21	62 - 107
H. Public utilities		5 - 5	2 - 28	7 - 9	4 - 4	18 - 46
I. Governmental inst.	5 - 6	11 - 14	16 - 32	10 - 16	2 - 4	44 - 72
J. Local government		29 - 33	1 - 1	1 - 2		31 - 36
K. Miscellaneous					2 - 3	2 - 3
Total European Economic Community	51 - 69	264 -411	154 -267	120 -176	100 -157	689 -1080

Table VI

Computers in the Remaining European Countries (Installed and on Order) - as Far as Known, as of the Middle of 1962

	Great Britain	Scandinavia	Switzerland	Austria	Other Countries	Total
A. Universities, etc.	59 - 77	19 - 25	9 - 14	1 - 3	4 - 4	92 - 123
B. Insurance companies	19 - 22	23 - 34	15 - 16	9 - 11		66 - 83
C. Transport	9 - 15	6 - 10	2 - 5	2 - 3	1 - 1	20 - 34
D. Service centers	31 - 71	15 - 22	6 - 11	2 - 2	1 - 1	55 - 107
E. Industrial companies	192 - 257	28 - 36	45 - 60	10 - 13	5 - 5	280 - 371
F. Trading concerns	15 - 21	9 - 9	12 - 12	1 - 1		37 - 43
G. Banks, etc.	24 - 29	9 - 13	13 - 22	3 - 3	6 - 6	55 - 73
H. Public utilities	14 - 24	4 - 4	1 - 1	3 - 3	3 - 5	25 - 37
I. Governmental inst.	32 - 60	10 - 20	3 - 6	1 - 1	3 - 3	49 - 90
J. Local government	30 - 37	7 - 7	2 - 2	6 - 8		45 - 54
K. Miscellaneous	2 - 2	1 - 1	1 - 1		1 - 1	5 - 5
Total Non-EEC European Countries	427 - 615	131 - 181	109 - 150	38 - 48	24 - 26	729 - 1020

The "Other Countries" in this table include Ireland, Spain and Portugal. The Scandinavian figures include Denmark, Finland, Norway and Sweden.

operative use by insurance companies are known in Great Britain, Norway and the Netherlands. This concerns companies which are wholly independent of each other and do not even belong to the same ownership.

It may be stated that in spite of this lead the number of computer users in this branch will increase considerably. Not only by reason of the fact that a large number of companies still do not have a computer, but also because many firms have just made a start with automation. There are known cases where a rather high degree of integration has been reached already. But these are still a small majority.

It may be of interest that the types of machines used in this area differ considerably from those in the group mentioned before. Only two of the 109 machines may be classified as small scientific ones and nine as big ones. The large majority consists of middle class machines. There are also fewer different types, not more than 24 among the 109 machines. Of 14 of these 24 there is only one machine per firm. The machines mostly used are IBM 1401 (34), IBM 650 (17) and UNIVAC SOLID STATE (14). The number of the other types does not exceed five.

The more advanced companies show a marked tendency towards expansion of the installation. In several cases old machines have been replaced by bigger ones; sometimes, however, a second machine of the same type as the first is taken.

C. Transport companies

This group should really be divided into three subgroups, viz., air, railway and other transport. The former two belong with the insurance companies as early starters. All big airlines in the EEC have computers installed. Air France, Alitalia, Royal Dutch Airlines (KLM), Lufthansa and Sabena have installed or on order 14 machines together. In addition to these there is the machine of the Deutsche Flugversicherung at Frankfurt, which brings the known number of machines to 15, the machines for seat reservation not included. Four of these fifteen can be classified as large ones. A considerable increase in the number of machines in this group cannot, therefore, be expected.

The same goes but to a lesser extent for the railway group. Here 14 machines are known to be installed or on order. Users are the national railways of Belgium, France, Germany and the Netherlands, and in addition to these 14, a reservation system for the ferries from Germany to Scandinavia should be mentioned.

Of the fifteen machines only two may be classified as large ones. The European railway companies keep in close contact with each other and there is a lively exchange of data. This naturally furnishes a stimulus for automation. Increase in the total number of machines may be expected because of the big projects to which automation has not yet been applied and the development in countries outside the EEC. British Railways now have 10 machines installed or on order. It is to be expected that the Italian Railways too will start using computers.

The third group of transport companies has not got so far yet. The only known user is the Hamburger Hochbahn. Outside the EEC a private transport company in Austria also using a computer, is known. In exceptional cases the work of a municipal tramway- or bus-organization is done on the computer of the municipality concerned. It may however be expected that this group will start using computers in the future, either having their own machines or in combination with other municipal services. Considering the little headway made so far, it will certainly take several years before automation is of any importance in the group of tramway-, bus- and forwarding companies.

Among the 31 computers mentioned (15 air, 15 railway and 1 other) there are 14 different types, of which 10 machines are IBM 1401; none of the others occurring more than three times.

A fourth category of transport companies has not yet been mentioned in this section. The reason why the shipping companies, however important they are, have not been discussed, lies in the fact that automation has hardly started here. There are hardly any shipping companies that have even ordered a computer. This does not alter the fact that without doubt shipping companies will start studying computer possibilities in the coming 10 years.

(To be Continued in the Next Issue)

THE CURRENT STATE OF THE COMPUTER FIELD IN BRITAIN

R. H. Williams
Computer Consultants Limited
Enfield, Middlesex, England

Wishful Thinking and Reporting

A report on the state of any industry is usually colored by a certain amount of wishful thinking and the particular position of the individual who is preparing the report.

Too often in the past, usually intelligent individuals from American universities and other places have visited Europe and in particular Great Britain, and have then returned to the United States with very distorted views on the state of the British computer industry. There is more activity in the development and production of computers in Britain than anywhere else in the world apart from the United States, and how these individuals can ever hope to produce a true report after collecting opinions from a small number of people in a very short space of time has always puzzled us in Britain.

Nevertheless, very important decisions are taken and developments are planned on the basis of these reports, often with disastrous results.

Hardening American Computer Market

Now that the American computer market is getting into an advanced state of competition and is hardening, more and more American companies are turning their attention to Europe where the number of computers installed is very much fewer than in the United States. It is obvious that many more computers will be installed in Britain and Europe, and at first sight the market seems to be an attractive and easy one.

Table 1. Details of Numbers and Values of British-Built Computers, and Company Family Trees (Part 1)

Elliott Bros. (London) Ltd. — National Cash Register Co. Ltd. → National-Elliott

Computer	Average Price £	British Installed No.	British Installed Value £1000	British On Order No.	British On Order Value £1000	Exported Installed No.	Exported Installed Value £1000	Exported On Order No.	Exported On Order Value £1000
Elliott Bros.									
Arch	25,000	-	-	2	50	-	-	1	25
401	15,000	1	15	-	-	-	-	-	-
402	22,000	6	132	-	-	1	22	-	-
402E	25,000	1	25	-	-	-	-	-	-
402F	25,000	1	25	-	-	1	25	-	-
403	100,000	-	-	-	-	1	100	-	-
502	135,000	1	135	1	135	-	-	-	-
503	80,000	-	-	2	160	-	-	3	240
802	17,000	3	51	-	-	4	68	-	-
803	35,000	74	2590	7	245	58	2030	8	280
	Total	87	2973	12	590	65	2245	12	545
NCR 315	Total	5	300	12	720	-	-	-	-
Nat.-Elliott									
405	120,000	28	3360	-	-	4	480	-	-
405M	130,000	1	130	-	-	-	-	-	-
	Total	29	3490	-	-	4	480	-	-

Table 1 (Part 2)

E.M.I. Limited; Hollerith Limited — Powers-Samas Limited → International Computers & Tabulators Ltd.; Ferranti Limited → I. C. T. - Ferranti Limited ?

Computer	Average Price £	British Installed No.	British Installed Value £1000	British On Order No.	British On Order Value £1000	Exported Installed No.	Exported Installed Value £1000	Exported On Order No.	Exported On Order Value £1000
EMI (Now part of ICT)									
BMC Special	100,000	1	100	-	-	-	-	-	-
1100	180,000	14	2520	-	-	-	-	-	-
1101	180,000	2	360	2	360	-	-	-	-
2400	500,000	2	1000	1	500	-	-	-	-
	Total	19	3980	3	860	-	-	-	-
Hollerith HEC (1200)	Total	6	99	-	-	-	-	-	-
Powers-Samas, Ltd. PCC - calculator		-	-	-	-	-	-	-	-

Table 1 (Part 3)

Computer	Average Price £	British Installed No.	British Installed Value £1000	British On Order No.	British On Order Value £1000	Exported Installed No.	Exported Installed Value £1000	Exported On Order No.	Exported On Order Value £1000
I. C. T.									
1201	33,000	23	858	1	33	9	297	-	-
1202	45,000	25	1125	2	90	18	810	-	-
1300	45,000	-	-	25	1125	-	-	-	-
1301	120,000	16	1920	65	7800	10	1200	33	3960
1500 (RCA 301)	100,000	9	900	26	2600	7	re-export	25	re-export
	Total	73	4803	121	11648	44	2307	58	3960
MAIN TOTAL		98	8882	124	12508	44	2307	58	3960
Ferranti									
Apollo	35,000	1	35	-	-	-	-	-	-
Argus	20,000	4	80	2	40	-	-	2	40
Atlas	2000,000	1	2000	2	4000	-	-	-	-
Madam Mk I	40,000	1	40	-	-	1	40	-	-
Madam Mk II	45,000	5	225	-	-	2	45	-	-
Mercury	120,000	13	1560	-	-	6	720	-	-
Orion	300,000	1	300	10	3000	1	300	2	600
Pegasus	50,000	23	1150	-	-	3	150	-	-
Pegasus 2	120,000	13	1560	1	120	-	-	-	-
Perseus	250,000	-	-	-	-	2	500	-	-
Sirius	17,000	12	204	1	17	6	102	-	-
	Total	74	7154	16	7177	21	1857	4	640
GRAND TOTAL		172	16036	140	19685	65	4164	62	4600

Table 1 (Part 4)

Leo Computers Limited — English Electric Limited

↓

English Electric-Leo Ltd.

Computer	Average Price £	British Installed No.	British Installed Value £1000	British On Order No.	British On Order Value £1000	Exported Installed No.	Exported Installed Value £1000	Exported On Order No.	Exported On Order Value £1000
Leo									
Leo I	95,000	1	95	-	-	-	-	-	-
Leo II	95,000	11	1045	-	-	-	-	-	-
Leo III	200,000	6	1200	16	3200	2	400	-	-
	Total	18	2340	16	3200	2	400	-	-
English Electric									
Deuce I	45,000	21	945	-	-	1	45	-	-
Deuce II	50,000	5	250	-	-	1	50	-	-
Deuce IIA	55,000	6	330	-	-	-	-	-	-
KDF 6	60,000	-	-	2	120	-	-	-	-
KDF 9	120,000	1	120	16	1920	-	-	1	120
KDN 2	20,000	2	40	5	100	-	-	-	-
KDP 10 (RCA 501)	400,000	5	2000	1	400	-	-	-	-
	Total	40	3685	24	2540	2	95	1	120
	Summary	58	6025	40	5740	4	495	1	120

We say advisedly at first sight, because the behavior in both Britain and Europe of the people who decide to buy computers or sometimes decide not to buy computers, can to our American friends appear totally irrational and contrary to what any reasonable American might expect. Again, this has led to many mistakes being made and wrong decisions of principle being taken.

Conservatism

By nature the Britisher is far more conservative than his American cousin, and also the pattern of the usage of office equipment is totally different. For example, whereas in America there is a tendency to rent rather than purchase, in Britain the accent is very much on purchase rather than on rent. The Britisher is far less likely to buy this year's model for the sake of prestige or what have you, if his existing equipment is giving satisfactory service however antique this may appear on the face of it. Let's face

Table 1 (Part 5)

Standard Telephones Limited | Solartron Electronics Group Limited

Computer Engineering Limited | Metropolitan Vickers Limited

↓

Associated Electrical Industries Limited

Computer	Average Price £	British Installed No.	British Installed Value £1000	British On Order No.	British On Order Value £1000	Exported Installed No.	Exported Installed Value £1000	Exported On Order No.	Exported On Order Value £1000
Standard Tel.									
Zebra	27,000	20	540	-	-	26	702	-	-
Solartron El. Grp.									
Solartron Special Digital Computer	100,000	1	100	-	-	-	-	-	-
Computer Eng.									
CE 55	2,000	1	2	-	-	-	-	-	-
CE 102	10,000	1	10	-	-	-	-	-	-
Met. Vickers									
Metrovick 950	20,000	3	60	-	-	-	-	-	-
Assoc. El. Ind.									
AEI 1010	360,000	3	1080	5	1800	-	-	-	-

it also, that if one can do a job fast enough and accurately enough, then fast enough is fast enough, and there is no purpose whatever in doing it in one tenth of the time.

Patterns of Industries

The pattern of certain industries and organizations is also different in Europe. For example, there are very few banks in Britain, but they do have very many branches. The same thing applies to insurance companies. The pattern of Government behavior is also traditionally different from that in America and certainly the educational pattern as it relates to the use of computers in universities is vastly different.

In an article of this type, therefore, it would be as well at the outset to get our facts right and with this in mind, the article contains four tables.

Table 2. Summary of British-Built Computers

	British Installed No.	British Installed Value £1000	British On Order No.	British On Order Value £1000	Exported Installed No.	Exported Installed Value £1000	Exported On Order No.	Exported On Order Value £1000
Elliott Bros.	87	2973	12	590	65	2245	12	545
NCR	5	300	12	720	-	-	-	-
National-Elliott	29	3490	-	-	4	480	-	-
ICT	98	8882	124	12508	44	2307	58	3960
Ferranti	74	7154	16	7177	21	1857	4	640
English Electric-Leo	58	6025	40	5740	4	495	1	120
Standard Telephones	20	540	-	-	26	702	-	-
Solartron	1	100	-	-	-	-	-	-
Computer Engineering	2	12	-	-	-	-	-	-
A. E. I.	6	1140	5	1800	-	-	-	-
	380	30616	209	28535	164	8086	75	5265

Tables

Table 1—"Details of Numbers of and Values of British-built Computers and their Company Family Trees"—gives just the information which the heading implies. Included in this table is the position in the event of ICT and Ferranti signing the now long-talked-about computer merger agreements.

If this merger does come into being, and there is considerable doubt that it will, any virtue that it might originally have had has now long since disappeared. The type of personnel employed throughout both companies is very different, and one cannot really imagine at this stage there being any useful purpose in the new arrangement at this time.

Even from the point of view of the quality of equipment, which from Ferranti's standpoint was at one time undoubted, it is now open to question in the light of their experience in developing their Orion computer which is many months behind schedule.

In passing, one should also mention, to get the record straight, that the much discussed Atlas computer has yet to be proved and at the time of writing this article, is not yet fully complete. While there is no reason at the moment to suppose that it will not function as expected, we all remember the sad experience of STRETCH!

Table 2 seeks to summarize the tables given in Table 1.

From this table, it will be seen that there are at the moment 589 British-built computers either on order or installed in Britain, and 239 British-built computers either installed or on order for installation in countries outside Britain.

Table 3 shows the number of foreign computers on order or installed in Britain. From this it will be seen that apart from American computers, there are in fact only nine other foreign computers in Britain. Eight of these are from France and one from Germany.

On order there are two French computers.

Installations

Taking into account all computers installed, American, French, German and British, there are at present in Britain, 575 computers and Table 4 shows the rate and years in which these computers were installed.

Table 4. Rate of Installation of British Computers

Year	Category (in thousand pounds) 10 to 49	50 to 199	200 to 499	500 to 699	700 to over 2000	All:
1953		1				1
1954	1					1
1955	12	1				13
1956	6	6				12
1957	17	20	1	1		39
1958	39	23				62
1959	17	26				43
1960	31	29			3	63
1961	33	47	5	2	2	89
1962	75	92	12		3	182
1963 Jan. to June	29	35	3	2	1	70
					Total:	575

Table 3. Foreign Computers Installed and On Order in Britain

Computer	Average Price £	Installed No.	Installed Value £1000	On Order No.	On Order Value £1000
U. S. A.					
Burroughs					
E101	17, 000	3	51	-	-
E102	10, 000	1	10	-	-
B270	130, 000	1	130	1	130
B280	140, 000	-	-	1	140
Clary					
D. E. 60	8, 000	1	8	-	-
Honeywell					
400	120, 000	2	240	7	840
800	395, 000	1	395	1	395
IBM					
1400	250, 000	-	-	1	250
305	70, 000	6	420	3	210
650	125, 000	9	1125	-	-
704	650, 000	1	650	-	-
705	700, 000	2	1400	-	-
709	1, 000, 000	1	1000	-	-
1401	120, 000	126	15120	83	9960
1410	200, 000	3	600	15	3000
1440	30, 000	-	-	50	1500
1620	20, 000	9	180	20	400
7030	1, 500, 000	2	3000	-	-
7070	450, 000	1	450	5	2250
7074	500, 000	2	1000	3	1500
7090	1, 000, 000	3	3000	1	1000
Monroe					
Mk. XI	12, 000	4	48	-	-
NCR					
390	25, 000	-	-	1	25
Packard Bell					
250	20, 000	2	40	-	-
Royal Precision					
LGP30	18, 000	1	18	-	-
Thompson Ramo Woold.					
330	60, 000	-	-	2	120
Remington					
SS80	100, 000	5	500	-	-
1107	850, 000	-	-	2	1700
Total		186	29385	196	23420
France					
Bull					
G. 30 (RCA 301)	120, 000	1	120	-	-
150	50, 000	3	150	-	-
300	22, 000	4	88	2	44
Total		8	358	2	44
Germany					
Standard Electrik					
DB40	50, 000	1	50	-	-
GRAND TOTAL		195	29793	198	23464

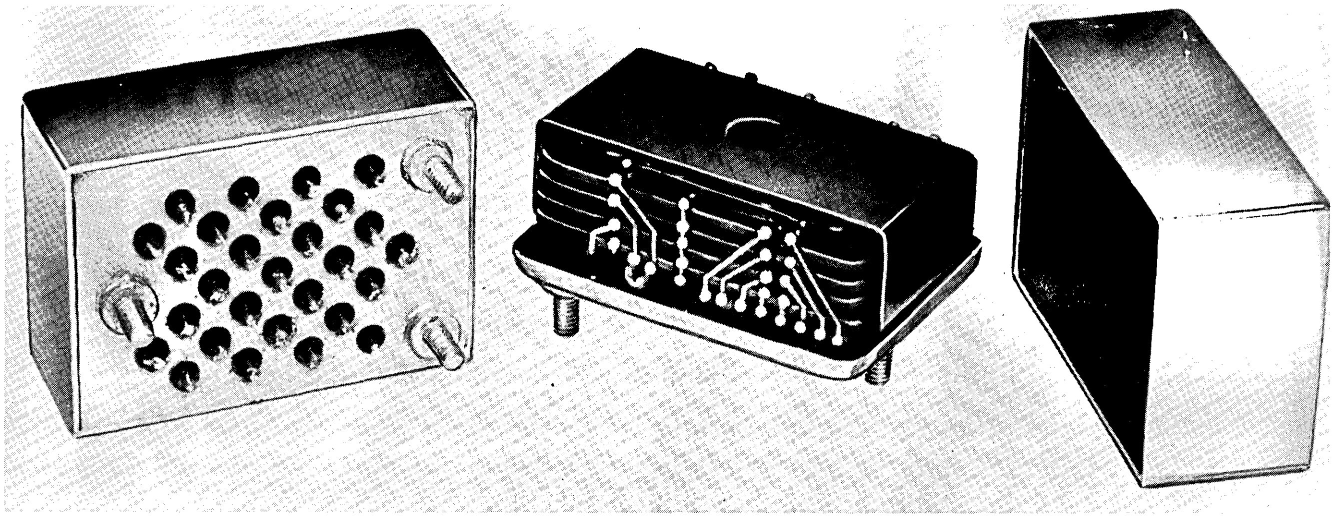
182 installations were made during 1962 and it looks from current trends as if slightly less will be made in 1963.

Computer Consultants Limited has, however, carried out an extensive survey and they are of the opinion that 5,000 computers will be installed in Britain by 1970. The pattern in other European countries is very similar and the figures will probably be of the same order of magnitude for France and Germany as for Britain; slightly less for Italy and correspondingly less according to size for the other European countries.

Suppliers

Who will supply the majority of these computers is, of course, the $64,000 question. Running it very closely is the question of what types of computers will they be.

Britain and America, computer-wise, started off abreast but the initiative and drive in America has unquestionably



— A microminiature module containing four substrates each 3 cm by 2 cm. Approximately 30 semiconductors and 70 other components are contained in this unit; it would normally be hermetically sealed.

put that country in the lead. America was helped to a large extent by the larger volumes involved but had Europe operated as a whole with the Commonwealth, the size of population and industries would have been somewhat similar.

Britain is very concerned at its position. If matters continue as they are at present, and they are likely to do so for the next year or so, then there will be a considerable drain on British foreign currency resources. Some American computers, for example the IBM 1401 and the IBM 7070, are built in Europe, but at present no American-designed computers are built in Britain.

Drop in Selling Price

Computer Consultants Limited are of the opinion that the selling price of computers which at the moment bears little relation to what should be their true production cost, will decrease suddenly and probably by the factor of 10 to 1, and it might possibly be as much as 20 to 1. These cheaper machines, admittedly slower, but at the same time fast enough to be functional for business data processing, will not be scaled down versions of existing computers but computers deliberately built down to a price.

Thin Films and Lasers

Manufacturers such as Mullard, are actively working to this end now, and have in production thin film circuits which, as well as having the benefit of miniaturization, will be considerably cheaper both to produce and to use in complete systems.

Specialization techniques of this type are being developed by several British manufacturers with the philosophy of no production of "specials" but only of standard type components. Quite rightly, they consider that the profit and return on the production of "specials" does not warrant the tying up of labor and capital in very short runs to suit some designer's unique ideas.

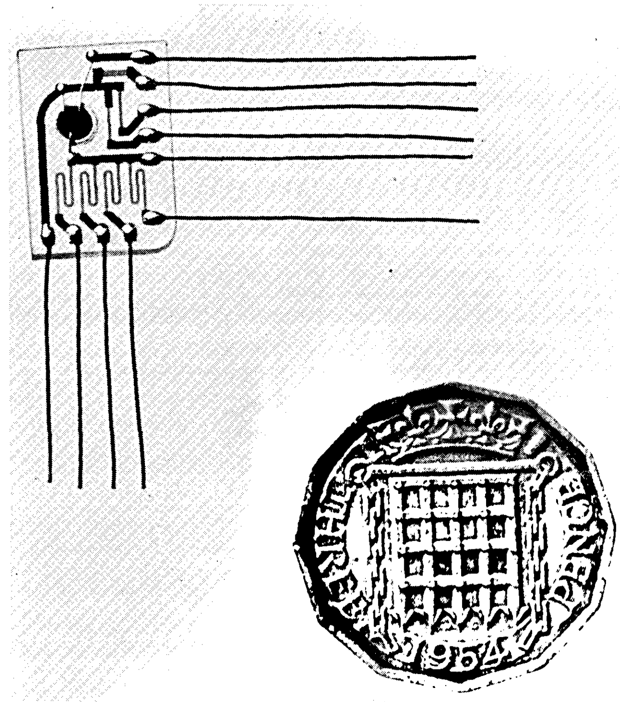
Much work has also been done on new concepts of memory, using laser techniques. Here again the cost can be drastically cut and indeed the whole processing of data dealt with on a revolutionary rather than traditional basis, as a result of the influence of these new types of equipment.

To Jump Ahead

Some British manufacturers are now accepting the fact that it will be extremely difficult for them to catch up with the state of development which has been reached by American computer manufacturers. They therefore intend, as a matter of policy, not to try and chase them but to jump ahead to the newer techniques and develop these to such a stage that they can then be ready and waiting for the market with this equipment in about five years' time.

They also feel that they should carry the initiative into the American market by producing their products primarily for America on a volume basis and selling the remainder in their own home market.

Paradoxically the success at present enjoyed by a company like IBM, geared to an existing rental policy, can a few years from now be its greatest disadvantage. A company having no heavy existing rental agreements can most easily accept a new price policy.



— A logical-"NOR" gate on a glass substrate just over half an inch long, compared in size with an English threepence. Made by Mullard Ltd., London, England.

A SURVEY OF NEW WEST-EUROPEAN DIGITAL COMPUTERS (Part 1)

Joseph L. F. De Kerf
Research Laboratories
Gevaert Photo-Producten N.V.
Mortsel, Belgium

Introduction

In two previous papers, "A Survey of British Digital Computers" (Computers and Automation, Vol. 8, Nos. 3/4/5) and "A Survey of European Digital Computers" (Computers and Automation, Vol. 9, Nos. 2/3/4), most European experimental and commercial digital computers known by the end of 1959 were described. About forty new commercial digital computers have been marketed or announced in West-Europe since that time. Descriptions of three of them may be found in "A Census of West-European Digital Computers" (Computers and Automation, Vol. 9, No. 12).

It is the purpose of this paper to make the previous surveys more up-to-date. A lot of the information given has been assembled by the author in the course of 1961. The final summary was postponed however till after the IFIP Congress 62 (Munich, August, 1962). Descriptions of most computers announced in the meantime have been added and the numbers of installations or orders were supplemented. Some of the announced computers have not yet been marketed and their descriptions must be considered to be provisional.

As in previous papers, the survey is restricted to pure European constructions. Seven of the described computers are copies of United States machines, manufactured in Europe under license. United States machines marketed by companies like IBM and Remington Rand are not included, even if they are constructed by their European branches or affiliations. An exception has been made for the RCA 301, which is marketed by the Compagnie des Machines BULL (GAMMA 30) and by International Computers and Tabulators Ltd. (ICT 1500). It may be probable that they will manufacture this computer themselves in the near future.

When available, approximate prices are given. For convenience, they have been converted into United States dollars, but in most cases they are only valid for the country where the computer is constructed.

The author is indebted to the management of the Gevaert Photo-Producten N.V., Mortsel, Belgium, who made this study possible. Thanks are due to the institutes and companies who checked the information given. Finally, he wishes to thank Miss Louisa Van Dessel for her collaboration with the production of the text and other assistance.

DENMARK

A computer called DASK, based on BESK (cf. Comp. & Aut., Vol. 9, No. 4, p. 25), has been in operation since 1958 at the REGNECENTRALEN, Danish Institute of Computing Machinery, Academy of Technical Sciences (Copenhagen). A transistorized computer called GIER, has been developed by the REGNECENTRALEN in close cooperation with the Geodetic Institute of Denmark. Besides the prototype, the REGNECENTRALEN has built 8 copies of this machine, to be placed at Danish universities and at several institutes of higher education. The manufacturing has been delegated to the DISA (Herlev Hovedgade 15-17, Copenhagen Herlev), who are marketing it under the name of DISADEC. Several improvements have been added and a series of seven is under construction (August, 1962).

DISADEC

Control: stored program (readily exchangeable microprogram unit). Operation mode: parallel. Number base: binary. Word length: 40 bits (sign bit included) + 2 marking bits. Point working: fixed and floating. Floating point representation: 30 bit mantissa + 10 bit exponent. Instruction type: 0 and 1 address (relative and indirect addressing are possible). Instruction length: ½ and 1 word. Number of basic operations: 57 (maximum 64). Number of registers: 17 (12 index registers).

Store: magnetic cores. Capacity: 1,024 words. Cycle time: 9 microsec. Auxiliary store: magnetic drum. Capacity: 12,800 words (320 channels of 40 words). Speed: 3,000 rpm. Average access time: 10 ms. External store: up to 12 Facit ECM 64 carousel type magnetic tape units. Number of reels: 64 per unit. Tape width: ⅝ inch. Tape length: about 30 feet. Density: 200 characters per inch. Read/write speed: 40,000 char. per sec. Minimum access time: 1 sec. Maximum access time: 3 sec.

Input/output: Flexowriter (10 char. per sec.), punched tape reader (Facit ETR 500: 500 char. per sec.), and tape punch (Facit PE 1500: 150 char. per sec.). A punched card reader (Bull: 700 cards per min.) and line printers (Anelex: 1,000 numeric or 750 alphanumeric lines of 120 char. per min.) may be connected.

Fixed point operation speeds: 22 microsec for addition and subtraction, 155 microsec for multiplication, and 240 microsec for division. Floating point operation speeds: 66 + 2.2 × (exp. + norm.) microsec for addition and subtraction, 140 microsec for multiplication, and 190 microsec for division.

Power consumption: 1 kVA. Pulse rate frequency: 450 kc/s. Components: about 7,000 diodes and 5,000 transistors. Price (basic machine): about $120,000. Not leased.

A new journal in the computer field, called BIT (Nordisk Tidsskrift for Informationsbehandling), has been published quarterly since 1961 by the Societies for Information Processing in Denmark, Finland, Iceland, Norway, and Sweden. It contains articles on computer-technical problems, numerical analysis, programming, operations research, and data processing including office automation. Most of the articles are written in English. The subscription price for the USA amounts to $3.00. Subscriptions should be sent to the REGNECENTRALEN, Danish Institute of Computing Machinery, Gamle Carlsbergvej 2, Copenhagen Valby.

FRANCE

AFCALTI (Association Française de Calcul et de Traitement de l' Information, Boulevard Arago 98bis, Paris 14), founded on 31 May 1957, held its first congress in September, 1960 at the University of Grenoble. The proceedings were published by Gauthier-Villars et Cie (Quai des Grands-Augustins 55, Paris 6). The second congress, partly organized in collaboration with SOFRO (Société Française de Recherche Opérationnelle), was held in October, 1961 at Paris. The third congress was held in May, 1963 at Toulouse. Further activities of the association are: the edition of a bulletin (bulletin de l'AFCALTI), the quarterly edition of the journal Chiffres (Editor: J. Kuntzmann, Institut Fourier, place Doyen-Gosse, Grenoble), the organization of lectures and seminaries, etc. The membership exceeds 500 (August, 1962). AFCALTI represents France in the IFIP (International Federation for Information Processing).

The Compagnie des Machines BULL is still the largest manufacturer of data processing equipment in Europe. The concern comprises eleven factories and the staff exceeds 14,000 now. Sixty per cent of its production is exported. About 2,000 punched card equipments, 600 Gamma 3's, 80 Gamma MD's, and 13 Gamma 60 large scale computers have been installed by BULL (September, 1962). A new punched card calculator, the Gamma 300, was announced by BULL in 1960. It may be expanded by connection of additional equipment to a versatile data processing system, known as the 300 DP SERIES. The first was installed in January, 1961 at the Etablissements Masurel, Roubaix. About a hundred 300 DP SERIES have been delivered and more than thirty-eight are on order (September, 1962). In October, 1961 BULL concluded an agreement with the Radio Corporation of America for the exchange of technical information and patents in the field of data processing. As a result of this agreement, BULL marketed the same year the RCA 301 medium scale computer under the name of GAMMA 30. It may be probable that BULL will manufacture this computer itself in the near future. Five GAMMA 30 computers have been delivered and more than 65 are on order (September, 1962). BULL is represented in the Commonwealth by De La Rue Bull Machines Ltd. (Southampton Row 114/118, London WC1), formed in July, 1958, and owned equally by the French company and De La Rue Co. Ltd. A subsidiary company was formed recently in the USA (Bull Corporation of America, 521 Fifth Avenue, New York).

300 DP Series

Control: plugboards and stored program. Operation mode: serial. Number base: binary decimal (4 bits per digit). Alphanumeric representation: 2 digits per character. Word length: 12 decimal digits. Point working: fixed and floating. Instructions: 1 or 2 address type (½ or 1 word). Number of operations: 15.

Quick access store: electromagnetic delay lines. Capacity: 7 to 15 words. Cycle time: 173 microsec. Transit store: magnetostriction delay lines. Capacity: 90 words. Cycle time: 173 microsec. Auxiliary store: magnetic drum. Capacity: 7,424 or 14,848 words. Speed: 2,750 rpm. Average access time: 11 ms. External store: up to 8 magnetic tape units. Tape width: ½ inch. Tape length: 2,400 feet. Capacity: 320,000 words per reel. Read/write speed (simultaneous): 31,500 digits per sec. A connecting unit, with magnetic core store, permits independent processing of the tapes.

Input/output: punched card readers (Bull: 300 cards per min.), card reader/punches (Bull: 300 cards per min.), and line printers (Bull: 300 lines of 80 or 120 char. per min.). Maximum number of units: 6.

Operation speeds: 1 ms for addition and subtraction, 6 ms for multiplication and division.

Power consumption: from 31 to 51 kVA. Pulse rate frequency: 280 kc/s. Components (complete installation): 1,830 tubes, 45,215 diodes, and 3,000 transistors. Price: $60,000 and up. Rent: $1,200 per month and up.

GAMMA 30

Control: stored program (simultaneous input/output and processing). Operation mode: serial. Number base: alphanumeric (7 bits per character, parity bit included). Word length: variable. Point working: fixed. Instruction type: 2 address. Instruction length: 10 characters. Number of operations: 48. Index registers: 1.

Store: magnetic cores. Capacity: 10,000, 20,000 or 40,000 characters. Access time: 7 microsec. Auxiliary store I: 1 or 2 Data Disc Files. Capacity: more than 88 million characters per unit (supplied in modules of about 22 million characters on six discs). Speed: 1,200 rpm. Average access time: 0.1 sec. Transfer rate: 32,000 char. per sec. Auxiliary store II: up to 6 Data Record Files (128 interchangeable records per unit). Capacity: about 4.6 million characters per unit (maximum capacity: more than 27 million characters). Average access time: 4.25 sec. Transfer rate: 2,500 char. per sec. External store I: 1 or 2 groups of 6 magnetic tape units. Tape width: ½ inch. Tape length: 1,200 feet. Density: 333⅓ char. per inch.

Capacity: more than 3 million characters per reel. Read/write speed: 10,000 char, per sec. External store II/III: up to 14 high-speed magnetic tape units. Tape width: ¾ inch. Tape length: 2,400 feet. Density: 333⅓ or 666⅔ char. per inch. Capacity: about 8.5 or 14 million characters per reel. Read/write speed: 33,333 or 66,666 char. per sec. Any combination of the three types of magnetic tape units may be included in the same system, provided the total number of decks does not exceed 14.

Input/output: 1 console typewriter (10 char. per sec.), 1 enquiry station (10 char. per sec.), 1 punched tape reader (1,000 char. per seç.), 1 tape punch (100 char. per sec.), 1 tape reader/punch (100 char. per sec.), 1 or 2 punched card readers (600 cards per min.), 1 card punch (100 or 200 cards per min.), and 1 or 2 line printers (800 or 1,000 lines per min., 120 or 160 char. per line).

Operation speeds: 189 microsec for addition and subtraction (5 digit terms), 4.2 ms for multiplication (5 digit factors), and 4.2 ms for division (5 digit quotient). Mode of operation of the arithmetic unit: table look-up system. Multiplication and division by program.

Power consumption: 19 kVA. Pulse rate frequency: 200 kc/s. Components: all-transistorized. Price: about $200,000 and up. May be leased.

The SEA (Société d'Electronique et d'Automatisme) is manufacturing its scientific and medium size data processing CAB 500 at a rate of four per month. About 50 have been delivered and about 35 are on order (September, 1962). First deliveries of the CAB 600, an improved version of the CAB 500 connected to closed loop magnetic tape units, are expected by the end of 1962. A new business and data processing system, the SEA 3900, has been announced in 1960. Five have been installed and about 10 are on order (September, 1962). More details are now available about the scientific SEA 5000 computer, announced several years ago. The computer is still in development and the description given below must be considered as provisional. The SEA computers are marketed by SEPSEA (Société pour l'Exploitation des Procédés S.E.A., Quai National 36, Puteaux-Seine).

SEA 3900

Control: stored program. Operation mode: serial parallel. Number base: alphanumeric (6 bits plus parity bit per character). Word length: variable. Point working: fixed. Instructions: 3 address type (8 characters). Number of operations: 47. Number of index registers: 3 (one for each address).

Store: magnetic cores. Capacity: up to 4 units of 4,096 characters (maximum capacity: 16,384 characters). Access time: 6 microsec. Auxiliary store: magnetic drum. Capacity: 40,960 or 81,920 characters. Speed: 3,000 rpm. Average access time: 10 ms. Block length: 160 characters. External store: up to 9 magnetic tape units (SEA 3700). Additional groups of up to 9 magnetic tape handlers per central unit may be connected. Tape width: ½ inch. Tape length: 750 m. Capacity: 4.5 million characters per reel. Read/write speed: 9,000 char. per sec. Block length: variable. Time-sharing provides simultaneous input/output and internal processing. Each character is written twice.

Input/output (on-line or off-line with optional coordination unit): electric typewriters (10 char. per sec.), punched tape readers (80 or 450 char. per sec.), tape punches (50 char. per sec.), punched card readers (600 cards per min.), card punches (100 cards per min.), and line printers (Shepard: 1,400 numeric or 900 alphanumeric lines of 120 char. per min.). Number of units according to requirements.

Operation speeds (5 digit factors): 216 microsec for addition and subtraction, about 5.6 ms for multiplication (average). Store access included. Division by microprogram.

Power consumption: 20 to 40 kVA. Pulse rate frequency: 2,000 kc/s. Components: printed circuits, all-transistorized. Price (basic computer with 4,096 character store, plus 1 Flexowriter, 1 punched tape reader, 1 line printer, and 4 magnetic tape units): about $280,000 (France). Rent (the same installation): about $6,400 per month (France).

SEA 5000

Control: stored program. Operation mode: serial. Number base: binary. Word length: 42 bits (1 sign plus 2 parity bits). Point working: fixed and floating. Floating point representation: 32 bit mantissa + 10 bit exponent. Instructions: 2 address type (1 word). Number of operations: 34 (automatic square root extraction). Number of index registers: 3.

Store: magnetic cores. Capacity: up to 8 units of 4,096 words (maximum capacity: 32,768 words). Access time: 6 microsec. Auxiliary store: up to 8 magnetic drums. Capacity: 16,384 words per drum. Speed: 3,000 rpm. Average access time: 10 ms. Block length: up to 128 words. External store: up to 64 magnetic tape units (SEA 3700). Tape width: ½ inch. Tape length: 750 m. Capacity: 4.5 million characters per reel. Read/write speed: 9,000 char. per sec. Block length: variable. Dual recording.

Input/output: 1 or 2 punched tape readers (450 char. per sec.), 1 or 2 tape punches (45 char. per sec.), and 1 line printer (Shepard: 1,400 numeric or 900 alphanumeric lines of 120 char. per min.).

Fixed point operation speeds: 24 microsec for addition and subtraction, 48 microsec for multiplication, and 1 ms for division. Floating point operation speeds: 48 microsec for addition and subtraction, 48 microsec for multiplication, and 55 ms for division. Store access included.

Pulse rate frequency: 2,000 kc/s. Components: printed circuits, all-transistorized. Price: not yet made available.

The Thompson Ramo Wooldridge Corporation, the Société Intertechnique, and the Compagnie Générale de Télégraphie sans Fil (CSF), formed in 1960 the Compagnie Européenne d'Automatisme Electronique (CAE, Rue de Marignan 27, Paris 8). The new company manufactures and sells the TRW digital control computers as well as its own equipments in the European Common Market. The TRW corporation furnishes its designs, patents, and its experience in process control technology. The Intertechnique, formerly licensee of TRW, has made available its equipment, personnel and contracts. The CSF contributes its large manufacturing facilities and technical experience. Fifteen CAE industrial control systems have been installed and about fourteen are on order (August, 1962). An improved version of the RW-300, the RW-330, and a data processing system with stored logic, the RW-530, have been announced recently. Six RW-330 systems and six RW-530 systems are in construction (September, 1962). A data logger, known as the 3030 Processor, has been developed by CAE and the first models have been installed. CAE has also recently added to its product line a military computer system, the TRW-130, derived from the well-known American TRW Navy computer, the AN/UYK-1, as well as two numerical machine-tool control systems for positioning (DCS-2000) and contouring control (DCS-3000). The TRW computers are marketed in the United Kingdom and the Commonwealth by an associated company: International Systems Control Limited (East Lane, Wembley, Middlesex, England).

RW-330

Control: stored program (with automatic interrupt facility to priority program). Operation mode: serial. Number base: binary. Word length: 28 bits (sign bit included, plus parity bit in the arithmetic unit and in the store). Point working: fixed. Instructions: 1 address type (1 word). Number of basic operations: 32 (more than 200 orders, automatic square root extraction). Number of index registers: 1.

Store: magnetic drum. Capacity: 8,192 words (64 tracks of 128 words). Speed: 3,600 rpm. Average access time: 8 ms. One track is used as quick access circulating store. Capacity: 128 words. Average access time: 2 ms. The capacity of the store may be expanded in groups of 64 tracks up to a maximum of 512 or 1,024 (65,536 or 131,072 words).

Input/output: Flexowriter (10 char. per sec.), punched tape readers (10 or 50 char. per sec.), tape punches (10 or 50 char. per sec.), printers (10 or 100 char. per sec.), digital signals (up to 64 groups of 28 signals in and out), and analog signals (up to 1,024 or 2,048 signals in and up to 128 signals out). Conversion accuracy: 0.1%.

Operation speeds (optimum storage location): 312 microsec for addition and subtraction, from 1.56 to 4.68 ms for multiplication, from 1.72 to 4.84 ms for division, and 2.49 ms for square root extraction.

Power consumption: 2 kVA. Pulse rate frequency: 246 kc/s. Components: 5,832 diodes and 1,042 transistors. Price (basic computer with 8,192 words store and Flexowriter): about $72,000. May be leased.

RW-530

Control: stored program (microprogrammed). Operation mode: parallel. Number base: binary. Alphanumeric representation: 6 bits per character. Word length: 18 bits (plus parity bit in the store). Point working: fixed and floating. Floating point representation: 36 bit mantissa + 18 bit exponent. Instructions: 1 address type (1 word). Number of basic operations: up to 64 (automatic multiple precision and square root extraction). Number of index registers: unlimited.

Store: magnetic cores. Capacity: up to 4 units of 8,192 words (maximum capacity: 32,768 words). Read/write cycle: 6 microsec. Auxiliary store I: magnetic drums (RW-571). Capacity: from 12,188 to 196,608 words per drum. Speed: 3,000 rpm. Average access time: 10 ms. Transfer time: 10,000 words per sec. Auxiliary store II: magnetic disc units (RW-572). Capacity: from 1 to 24 million words per unit. Average access time: 150 ms. Maximum number of auxiliary units (I + II): 8. External store: up to 16 magnetic tape units (RW-570). Read/write speed: 15,000 or 42,500 char. per sec. Block length: 128 words or variable. The tape is compatible with IBM systems. Auxiliary store units and magnetic tape handlers are linked to the central processor through an exchange unit (RW-541). A special decentralization unit (RW-573) may be used to connect the magnetic tape handlers, providing simultaneous input/output and operation of the central processor.

Input/output (minimum): Flexowriter (RW-585: 10 char. per sec.), punched tape reader (RW-551: 600 char. per sec.), tape punch (RW-561: 100 char. per sec.). Optional standard equipment (up to 32 units): printers (RW-562: 100 char. per sec.), teletype writers (10 char. per sec.), punched tape readers (10 or 600 char. per sec.), tape punches (10 or 100 char. per sec.), card reader/punch units (column by column), inquiry stations (10 char. per sec.), and visual displays (cathode ray tubes). Optional high-speed equipment (up to 15 units): punched card readers (RW-550: 650 cards per min.), card punches (RW-563: 100 cards per min.), and line printers (RW-560: 750 lines of 132 char. per min.). Digital signals: up to 64 groups of 18 signals in and out. Analog signals: up to 1,024 signals in and up to 128 signals out. Conversion accuracy: 0.1%. The standard equipment is linked to the central processor through the exchange unit (RW-541). The high-speed equipment is connected to the system through the additional decentralization unit (RW-573).

Single precision operation speeds: 54 microsec for addition and subtraction, 216 microsec for multiplication, 230 microsec for division, and 631 microsec for square root extraction. Double precision operation speeds: 114 microsec for addition and subtraction, 684 microsec for multiplication, 875 microsec for division, and 2,109 microsec for square root extraction.

Power consumption: from 500 to 1,000 VA per cabinet. Pulse rate frequency: 333 kc/s. Components: 7,057 diodes and 1,574 transistors. Price (basic computer with 8,192 words store and Flexowriter): about $150,000. May be leased.

A newcomer in the computer field is the Société d'Exploitation et de Recherches Electroniques (SEREL, Boulevard de Nantes, Aubergenville, Seine et Oise). Early in 1961 the company introduced a process control computer, called SEREL-1001. The first was installed in November, 1961. Four have been delivered and another three are on order (September, 1962). A small process control computer, the SEREL-505, and a medium scale computer designed for scientific applications, the SEREL-1010, have been announced. First deliveries are expected by the end of 1963.

SEREL-1001

Control: stored program. Operation mode: parallel. Number base: binary. Word length: 17 bits (plus sign bit and two store protection and classification bits). Point working: 1 address type (1 word). Number of operations: 64. Number of index registers: 2.

Store: Magnetic cores. Capacity: 4,096 or 8,192 words. Cycle time: 6 microsec. Auxiliary store I: magnetic drum. Capacity: up to 3 million bits. Speed: 3,000 rpm. Average access time: 10 ms. Auxiliary store II: magnetic disc unit. Capacity: up to 700 million bits. Average access time: 100 ms. External store: any number of magnetic tape units. SEREL units may be used. Tape width: ¼ inch. Tape length: 1,200 feet. Capacity: 1,800 words per reel. Read/write speed: 80 words per sec.

Input/output: electric typewriters, punched tape readers, tape punches, punched card readers, card punches, line printers, digital and analog signals (including SEREL converters: 12 bits, 800 microsec per conversion). No standard devices: system to meet each application. Number of input and output channels: unlimited.

Operation speeds: 49 microsec for addition, 58 microsec for subtraction, 300 microsec for multiplication, and 460 microsec for division. Access time included.

Power consumption: 0.6 kVA. Pulse rate frequency: 300 kc/s. Components: 2,750 diodes and 3,000 transistors. Price (basic machine): about $70,000. Not leased.

Another newcomer in the field is the Compagnie Industrielle des Téléphones (CIT, Rue Emeriau 33, Paris 15). In 1961 the firm announced the completion of the prototype of a process control computer, called CITAC 210 B. The first was installed in early 1962 at the Centrale Nucléaire de Chinon. A total of four are to be installed at this power station by the end of 1962. About ten are on order (September, 1962).

CITAC 210 B

Control: stored program. Operation mode: serial parallel (character by character). Number base: binary. Alphanumeric representation: 6 bits per character (plus parity bit). Word length: 21 bits or 3 characters. Point working: fixed. Instruction type: 1 address. Instruction length: 2 words (6 characters). Number of operations: 47. Number of index registers: 8.

Store: magnetic cores. Capacity: up to 8 units of 4,096 words (maximum capacity: 32,768 words). Access time: less than 20 microsec. Auxiliary store: up to 24 magnetic discs. Capacity: 8,192 blocks of 128 words per disc (maximum capacity: more than 25 million words).

Input/output: electric typewriter (IBM: 4 to 10 char. per sec./Creed: 100 char. per sec.), punched tape reader (Creed: up to 20 char. per sec./Elliott: 1,000 char. per sec.), tape punch (Creed: up to 25 char. per sec.), digital and analog signals (CIT multiplexers and converters). Number of input channels: 4 (2 alphanumeric and 2 binary channels with automatic priority interrupt). Number of output channels: 12 (8 alphanumeric simultaneous and 4 binary channels). Magnetic tape units may be connected.

Operation speeds (execution times): 50 microsec for addition and subtraction, 400 microsec for multiplication, and 800 microsec for division. Interpretation time: 100 microsec. Indexing time: 50 microsec.

Power consumption: 2 kVA. Pulse rate frequency: 100 kc/s. Components: printed circuits and semiconductors. Price (basic computer, punched tape reader and typewriter included): from $80,000 to $150,000.

Finally, the Société Européenne pour le Traitement de l'Information (SETI, Place des Etats-Unis 12, Montrouge), licensed by the Packard Bell Computer Corporation, is manufacturing and marketing a copy of the well-known PB 250 general purpose computer. The magnetic tape handlers are manufactured by the Compagnie des Compteurs (CdC). A process control system, called SETI 2000, may be connected. Four PB 250 computers have been delivered by SETI and about twelve are on order (September, 1962).

PB 250

Control: stored program. Operation mode: serial. Number base: binary. Word length: 22 bits (sign bit included). Point working: fixed. Instructions: 1 address type (1 word). Number of operations: up to 64 (including double precision arithmetic and automatic square root extraction). Number of index registers: 1.

Store: magnetostrictive delay lines. Capacity: from 2,320 to 15,888 words. Access time (256 words): from 12 to 3,072 microsec. Short lines are used as quick access store. Capacity: 16 words. Access time: from 12 to 192 microsec. External store: up to six CdC closed loop (UBM 200) or normal spool (UBM 300) magnetic tape units. Read/write speed: 2,500 char. per sec. Up to 4 magnetic tape control units (CB 400), with a capacity of up to 6 fast magnetic tape handlers (UBM 400) each, may be connected. Read/write speed: 15,000 char. per sec. Computation may proceed during the input/output or searching operation of the fast tape handlers. The fast tape is compatible with IBM systems.

Input/output: Flexowriter (10 char. per sec.), electric typewriters (UME 1: 10 char. per sec.), punched tape reader (LR1: 300 char. per sec.), tape punch (PR1: 110 char. per sec.), punched card reader (LC1: 600 cards per min.), card punch (PC1: 150 cards per min.), numeric line printer (IR24: 1,200 lines per min.), alphanumeric line printer (IR 72: 600 lines per min.), curve display oscilloscope (TCC1), curve plotter (TT1), digital signals (standard: 30 input and 32 output channels), analog-to-digital converters (up to 18,000 conversions per sec.) and digital-to-analog converters (up to 20,000 conversions per sec.).

Operation speeds: 12 microsec (single precision) or 24 microsec (double precision) for addition and subtraction, up to 276 microsec for multiplication, up to 252 microsec for division and square root extraction. Access time not included (optimal access time: 12 microsec).

Power consumption (electronic circuits): 30 VA. Pulse rate frequency: 2,000 kc/s. Components (central computer): 115 printed circuits, 375 transistors. Price (basic computer, Flexowriter included): about $40,000. May be leased.

GERMANY

About 40 Z 11 punched tape controlled calculators and about 50 Z 22 stored program magnetic drum computers have been installed by ZUSE KG. The Z 11 calculator is no longer manufactured. An improved and all-transistorized version of the Z 22 computer, known as the Z 23, was marketed in 1961. Thirty-one Z 23 computers have been installed (August, 1962). A magnetic core store computer with large facilities on optional auxiliary store and input/output equipment, known as the Z 31, has been announced by ZUSE KG.

A reconstruction of the Z 3 punched-tape-controlled relay calculator was shown by ZUSE KG at the INTERDATA Exhibition of the IFIP Congress 62. The original machine is said to be the first program-controlled calculator. Indeed, Konrad Zuse succeeded in accomplishing and demonstrating the Z 3 in 1941. The machine was completed by request of the Deutsche Versuchsanstalt für Luftfahrt. After three years of continuous operation, it was destroyed by the war in 1944.

ZUSE Z 23

Control: stored program. Operation mode: serial. Number base: binary. Word length: 40 bits (sign bit included). Point working: fixed and floating. Floating point representation: 30 bit mantissa + 8 bit exponent (both with sign bit). Instructions: 1 address type (1 word). Microprogrammed: 18 operation bits.

Quick access store: magnetic cores. Capacity: 240 words. Each cell may be used as index register and accumulator. Main store: magnetic drum. Capacity: 8,192 words (1,024 words are used for microprograms and input/output routines). Speed: 6,000 rpm. Average access time: 5 ms. External store: up to 4 Ampex magnetic tape units. Tape width: ½ or 1 inch. Tape length: up to 3,600 feet. Capacity: about 1 million words per reel. Block length: 128 words. Average access time per block: about 300 sec.

Input/output: 1 teleprinter (Siemens: 10 char. per sec.), 1 or 2 punched tape readers (Ferranti: 300 char. per sec.), 1 tape punch (SEL: 50 char. per sec.), 1 punched card reproducer (Bull: 120 cards per min. in and out), 1 printer (Creed: 100 char. per sec.), 1 line printer (Anelex: 300 lines of 120 char. per min.), analog-to-digital and digital-to-analog converters, and off-line curve plotters (Z 64).

Fixed point operation speeds (40 bits): 0.3 ms for addition and subtraction, 13 ms for multiplication and division. Floating point operation speeds (30 bits): 10.6 ms for addition and subtraction, 20 ms for multiplication and division. Access time to the main store not included.

Power consumption: 4 kVA. Pulse rate frequency: 150 kc/s. Components: 6,800 diodes and 2,700 transistors. Price: about $85,000 and up. May be leased.

ZUSE Z 31

Control: stored program. Operation mode: serial. Number base: binary decimal. Code: excess three: Alphanumeric representation: 2 digits per character. Word length: 10 digits (plus sign digit). Point working: fixed and floating. Floating point representation: 8 digit mantissa + 2 digit exponent (plus mantissa sign). Instructions: 1 address type (1 word). Microprogrammed: 4 operation digits. Number of index registers: 10.

Fixed program store (microprograms and subroutines): magnetic cores. Capacity: up to 2,600 words. Working store: magnetic cores. Capacity: independent partial units of 200 words. Maximum capacity: 9,000 words. Auxiliary store: blocks of up to 10 magnetic drums. Capacity: 6,000 words per drum. Speed: 3,000 rpm. Average access time: 10 ms. External store: blocks of up to 8 Ampex magnetic tape units. Tape width: ½ or 1 inch. Tape length: up to 3,600 feet. Capacity: about 750,000 words per reel. Read/write speed: 15,000 characters per sec. Average access time per block: 300 sec.

Input/output: electric typewriters (IBM: 10 char. per sec.), teleprinters (Siemens: 10 char. per sec.), punched tape readers (Siemens: 15 char. per sec. / Ferranti: 300 char. per sec.), tape punches (Reichert: 15 char. per sec. / SEL: 50 char. per sec.), punched card readers (Elliott: 333 cards per min. / IBM: 500 cards per min.), card punches (Bull: 150 cards per min. / IBM: 250 cards per min.), punched card reproducers (Bull: 120 cards per min. in and out), combined card reader/punches (IBM: 800 cards per min. in and 250 cards per min. out), line printers (Maul: 60 lines of 80 char. per min. / Olympia: 180 lines of 120 char. per min. / IBM: 600 lines of 132 char. per min. / Anelex: 600 lines of 72 char. and 960 lines of 160 char. per min.), analog-to-digital and digital-to-analog converters, and off-line curve plotters (Z 64).

Fixed point operation speeds (10 digits): 0.42 ms for addition and subtraction, 28 ms for multiplication, and 38 ms for division. Floating point operation speeds (8 digits): 15 ms for addition, 19 ms for subtraction, 31 ms for multiplication, and 42 ms for division.

Power consumption: 5.1 kVA. Pulse rate frequency: 150 kc/s. Components: 12,000 diodes and 4,000 transistors (and up). Price (basic machine, 1 typewriter and 1 slow punched tape reader included): about $45,000. May be leased.

Some essential characteristics of the SIEMENS 2002 data processing system, manufactured and marketed by SIEMENS & HALSKE AG, have been changed and several improvements have been added. A revision of the original description has been published in the Readers' and Editor's Forum of this journal (cf. Comp. & Aut., Vol. 10, No. 3, p. 21). Twenty-five SIEMENS 2002 computers have been installed and seventeen are on order (July, 1962). A high-speed line printer, with a speed of 1,500 numeric or 750 alphanumeric lines of 132 characters per minute, was demonstrated by SIEMENS & HALSKE AG at the INTERDATA Exhibition of the IFIP Congress 62.

Ten SEL-ER 56 computers have been installed by STANDARD ELEKTRIK LORENZ AG and another is on order. Several special purpose computers have been built by the company. SEL-ES 92, a permanent control and bookkeeping system, was installed in 1956 at a large mail order house (Quelle, Nürnberg). SEL-DB 10, a system for car transport reservation on a ferry boat service, has been in operation since June, 1958 at the Deutsche Bundesbahn (Frankfurt am Main). SEL-DB 40, a flight availability system, was delivered to the Scandinavian Airlines Systems in November, 1958 (SAS, Copenhagen). Another SEL-DB 40 was delivered through the Standard Telephones & Cables Ltd. to the British Overseas Airways Corporation at the end of 1961 (BOAC, London). An aircraft weight and baggages control system, known as SEL-KA 21 and developed in co-operation with Standard Telephones & Cables Ltd., was brought into operation at SAS in the course of 1961 (Kastrup Airport, Copenhagen). The ssytem consists of a STANTEC ZEBRA computer connected to push-button keysets, located at passenger check-in points. SEL is no longer interested in the manufacturing of computers. The company is concentrating its activities especially in the design and development of data transmission equipment for the moment. A data transmission system with automatic error correction, known as the SEL-DT 12, was shown by SEL at the INTERDATA Exhibition of the IFIP Congress 62.

More details are available now bout the large scale computer TR 4, manufactured and marketed by TELEFUNKEN GmbH. A more up-to-date description is given below. Two TR 4 computers have been installed and another seven are on order (September, 1962). Units for the automation of cheque handling in the German Post Office Banks were shown by TELEFUNKEN for the first time at the INTERDATA Exhibition associated with the IFIP Congress 62. The central processor consists of an accounts computer, originally introduced as the TR 5 but now called the TRP, and a magnetic tape control unit. The control unit is used to connect the magnetic tape units and a high-speed line printer for preparing statements to the TRP; this ensures that several tape units may be operated simultaneously. The peripheral equipment includes: letter opening machines, voucher facing units, voucher preparation desks for the manual printing of data in magnetic ink, electro-optical registers for checking signatures, voucher sorting machines, voucher input machines for the input of magnetic ink data into the computer, and packing desks for packing statements and voucher stubs together. Deliveries of the first systems are expected in the course of 1963.

TR 4

Control: stored program (microprogrammed). Operation mode: parallel. Number base: binary and binary decimal (4 bits per decimal digit). Alphanumeric representation: 6 bits per character. Word length: 48 bits, sign and tag bit included, plus 4 check and identification bits in the store (11 decimal digits or 8 alphanumeric characters). Point working: fixed and floating. Floating point representation: 38 bit mantissa + 7 bit exponent (both plus sign bit). Instructions: up to 256 (automatic double precision and square root extraction). Number of index registers: 256 (16 bits).

Store: magnetic cores. Working store capacity: from 2 to 7 units of 4,096 words (maximum capacity: 28,672 words). Cycle time: 6 microsec. Access time: 2 microsec. A passive store is used for standard routines and fixed subroutines. Capacity: 1,024 words (expandable to 4,096 words). Cycle time: 2.5 microsec. Access time: 1 microsec. External store: up to 64 magnetic tape units (Telefunken: MDS 251 A). Tape width: ½ inch. Tape length: 2,500 or 3,600 feet. Density: 550 char. per inch. Read/write speed: 55,000 char. per sec. Block length: variable.

Input/output: electric typewriters (10 char. per sec.), punched tape readers (500 or 1,000 char. per sec.), tape punches (150 char. per sec.), punched card readers (800 cards per min.), card punches (250 cards per min.), document sorters (750 documents per min.), and line printers (1,920 numeric or 960 alphanumeric lines of up to 160 char. per min.). Punched tape equipment: Facit. Punched card equipment: IBM or Bull. Line printers: Anelex. Maximum number of units: 64 (magnetic tape units included). Up to eight units may be handled in parallel and computing may proceed in the meantime.

Binary working fixed point operation speeds: 5 microsec for addition and subtraction, 30 microsec for multiplication, and 105 microsec for division. Binary working floating point operation speeds: 15 microsec for addition and subtraction, 30 microsec for multiplication, and 90 microsec for division. Decimal working fixed point operation speeds: 10 microsec for addition and subtraction, 250 microsec for multiplication, and 375 microsec for division. Average times, access not included.

Power consumption: about 3 kVA. Pulse rate frequency: 2,000 kc/s. Components: 70,000 diodes and 12,000 transistors. Price (basic machine): about $700,000. May be leased.

TRP

Control: stored program (microprogrammed). Operation mode: serial parallel. Number base: binary and binary decimal (excess three code). Alphanumeric representation: 6 bits + parity bit. Word length: variable. Point working: fixed. Instructions: 1 address type (8 characters). Number of operations: 127. Index registers: 252 characters of the working store.

Store: magnetic cores. Capacity: up to 8 units of up to 32,768 characters (maximum capacity: 262,144 characters). Cycle time: 20 microsec. A passive store may be used for fixed programs. Capacity: up to 32,768 characters (4,096 instructions). Cycle time: 20 microsec. External store I: up to 7 Telefunken MDS 249 magnetic tapes used as account store. Tape width: ½ inch. Tape length: up to 660 feet. Capacity: about 10,000 accounts. External store II: up to 7 Telefunken MDS 251 magnetic tape units used as journal store. Tape width: ½ inch. Tape length: 2,500 or 3,600 feet. Density: 330 char. per inch. Read/write speed: 33,000 char. per sec. Block length: variable. Two magnetic tape units may be operated simultaneously, while computing proceeds.

Input/output: electric typewriters (10 char. per sec.), punched tape readers (500 char. per sec.), tape punches (50 char. per sec.), magnetic ink document readers (750 documents per min.), and high-speed line printers (600/720 lines per min.). Maximum number of input and output units: 16.

Binary working operation speeds: 560 microsec for addition and 800 microsec for subtraction. Decimal working operation speeds: 800 microsec for addition, 1,020 microsec for subtraction, and 8.4 ms for multiplication (average). Access time included.

Power consumption: 0.8 kVA. Pulse rate frequency: 100 kc/s. Components: 11,200 diodes and 3,600 transistors. Price: not made available.

SCHOPPE & FAESER GmbH, manufacturers of LGP-30 for the European market, announced in 1960 the construction of another Librascope computer. This computer, a copy of the well-known LIBRATROL 500, is designed for data logging and process control. The process instrumentation is manufactured in co-operation with Hartmann & Braun AG. Both computers are marketed by EURECOMP GmbH (Schillerstrasse 72, Minden/Westf.). Thirty-six LGP-30's and 1 LIBRATROL 500 have been installed or are on order in Europe (August, 1962). The manufacturing and marketing of the Royal Precision RPC-4000 System was announced by EURECOMP GmbH at the INTERDATA Exhibition of the IFIP Congress 62. The basic system consists of the RPC-4010 Computer and the RPC-4500 Tape Typewriter System. The construction will be started in Germany in the course of 1963.

LIBRATROL 500

Control: stored program. Operation mode: serial. Number base: binary. Alphanumeric representation: 4 or 6 bits per character. Word length: 30 bits (plus sign bit). Point working: fixed. Instructions: 1 address type (1 word). Number of operations: 17.

Store: magnetic drum. Capacity: 4,096 words (plus 64 words as input/output buffer). Speed: 4,000 rpm. Average access time: 7.5 ms.

Input/output: Flexowriter (10 char. per sec.), pulse counters, digital transducers and voltages from control instruments (128 channels and up, 75 samples per sec.), alarms, contact closures and voltages to actuate control elements (75 outputs per sec.).

Operation speeds (access time excluded): 0.25 ms for addition and subtraction, 15 ms for multiplication and division.

Power consumption: about 2.5 kVA. Pulse rate frequency: 140 kc/s. Components: 160 tubes, 1,600 germanium diodes and 100 transistors. Price: from $78,500 to $95,000 (depending on number of input and output channels). May be leased.

RPC-4000

Control: stored program. Operation mode: serial. Number base: binary. Word length: 32 bits (sign bit included). Point working: fixed. Instructions: 1 + 1 address type (1 word). Number of basic operations: 32. Number of index registers: 1.

Store: magnetic drum. Capacity: 7,872 words (123 tracks of 64 words). Speed: 3,600 rpm. Average access time: 8.5 ms. Two additional tracks are dual access. Capacity: 128 words. Second access time: 4 or 6 ms after the first access. One additional track is used as quick access circulating store. Capacity: 8 words. Average access time: 1 ms. A magnetic tape unit will be available in the near future.

Input/output (RPC-4500 System): electric typewriter (10 char. per sec.), punched tape reader (60 char. per sec.), and tape punch (30 char. per sec.). Optional equipment: photoelectric punched tape readers (RPC-4410: 500 char. per sec.) and high-speed tape punches (RPC-4440: 300 char. per sec. / Facit: 150 char. per sec.). A line printer will be available in the near future. Maximum number of input/output units: 45.

Operation speeds (minimum access included): 1 ms for addition and subtraction (0.25 ms when repeated), 18 ms for multiplication and division.

Power consumption: 0.85 kVA. Pulse rate frequency: 140 kc/s. Components: 2,400 diodes and 680 transistors. Price (basic equipment): about $75,000. May be leased.

OLYMPIA WERKE AG (Wilhelmshaven), manufacturers of typewriters and office machines, are newcomers in the field. In 1960 they introduced a punched-tape-controlled business calculator, called OMEGA. The central calculator is rather small, but up to 20 magnetic drums with a capacity of 595,000 characters each may be linked. Electric adders, electric typewriters, punched tape equipment, punched card equipment and line printers may be used as input/output equipment. For the present, the calculator is only marketed in Germany. No data is available about the number of OMEGAs installed or on order.

OMEGA

Control: punched tape. Operation mode: serial. Number base: alphanumeric. Code: 27 excess (6 bits per character). Word length: variable (up to 119 characters). Point working: fixed. Instruction type: 1 address. Instruction length: 2 punched tape rows (16 bits). Number of basic operations: 32.

Store: magnetic drum. Capacity: 100 blocks of 119 characters (plus registers). Speed: 3,000 rpm. Average access time: 10 ms. Two magnetic core stores are used as internal buffer and as buffer for input/output. Capacity: 20 and 119 characters. Auxiliary store: up to 20 magnetic drums. Capacity: 5,000 blocks of 119 characters per drum. Speed: 180 rpm. Average access time: 150 ms. The possibility to connect Ampex FR 400 magnetic tape units is under development.

Input/output: electric adders and typewriters (10 char. per sec.), punched tape readers (20 or 1,200 char. per sec.), tape punches (36 char. per sec.), punched card readers (400 cards per min.), and line printers (600 decimal or 230 alphanumeric lines of 120 char. per min.). Maximum number of units: 4 for input and 4 for output.

Operation speeds: 20 ms for addition and subtraction (18 digit terms), 260 ms for multiplication (9 digit factors), and 260 ms for division (9 digit quotient).

Power consumption (central unit): 1 kVA. Pulse rate frequency: 36 kc/s. Components (central unit): about 4,000 diodes, 1,800 transistors and 900 magnetic cores. Price (central unit): about $42,500. Rent: about $900 per month.

Many details about the analog and digital computer activity in Germany, including exhaustive computer descriptions and lists of installations, may be found in "Stand des elektronischen Rechnens und der elektronischen Datenverarbeitung in Deutschland." This survey was compiled at the Institut für Praktische Mathematik of the Technical University at Darmstadt (IPM) and published in 1961 by the Deutsche Arbeitsgemeinschaft für Rechenanlagen (DARA). The list of journals and periodicals published in German language, given below, has been taken from this second volume.

A "Current Bibliography on Analogue and Digital Computers and Their Applications" (Titel von Veröffentlichungen über Analog-und Ziffernrechner und ihre Anwendungen), is edited by the Deutsche Forschungsgemeinschaft (Bad Godesberg) and the Provisional International Computation Centre (Rome). The Bibliography has been published continually since 1954, and since 1957 four times a year, by the Franz Steiner Verlag GmbH (Wiesbaden). The subscription price is 96 DM.

Periodicals and Journals:

ADL-Nachrichten.
Arbeitsgemeinschaft für elektronische Datenverarbeitung und Lochkartentechnik, e. V., Kiel-Elmschenhagen.
Quarterly. DM 4.50 per number.
BTA, Bürotechnik und Automation.
Robert Göller Verlag, Baden-Baden.
Monthly. DM 4.00 per number.
Elektronische Datenverarbeitung.
Verlag Friedrich Vieweg & Sohn, Braunschweig.
Bimonthly. DM 8.50 per number.
Zeitschrift für moderne Rechentechnik und Automation.
Stiasny Verlag, Graz/Oesterr.
Quarterly. DM 8.00 per number.
Automatik.
R. v. Decker's Verlag, Hamburg.
Monthly. DM 4.00 per number.
Elektronische Rundschau.
Verlag für Radio-Foto-Kinotechnik, Berlin-Borsigwalde.
Monthly. DM 3.75 per number.
Kybernetik.
Springer-Verlag, Berlin.
Irregularly. DM 10.80 per number.

(To be Continued in the Next Issue)

DESIGN OF A REAL-TIME PROGRAMMING SYSTEM

R. J. Coyle and
J. K. Stewart
Datatrol Corporation
Silver Spring, Maryland

How would you develop a comprehensive program which controls a general-purpose computer so that it could perform data processing as fast as needed in actual time? The authors say how, with due attention to removing the debugging bells and whistles.

I. INTRODUCTION

This paper concerns the design of a real time system, by which we mean a comprehensive program which controls a general-purpose computer of data processing in real time. It is not meant to be a tutorial or state-of-the-art presentation but is instead a set of notes which will hopefully point up problem areas which should be considered in real time design. The paper was written by programmers to be read by programmers and we hope the reader will find it useful and informative.

II. WHAT IS REAL TIME COMPUTING?

One of the difficulties in defining real time computing is the fact that a discussion along those lines can easily wander off into semantic argument. A question often asked is: 'Well now, if I don't need the results of a machine run until a month from now, and I get them in three weeks, is that real time?" We would prefer to say that this is timely processing but not necessarily real time. We would like to define real time operation more from the computer's (and hence, the programmer's) point of view.

Let's try a couple of analogies. Consider a programmer at his desk going over the results and dump of a bad machine run. On his desk he has an In basket and an Out basket and, while he is working, the In basket is beginning to accumulate various pieces of paper. He discovers the bug in his program and makes the necessary corrections and then turns to his In basket, winnowing through the different items there, dropping them into his Out basket as he finishes whatever is necessary to be done to them.

This is pretty much the way batch processing works. Runs accumulate at a staging area and, when the computer is finished with its current processing, are then batched through the machine to accumulate at another staging area waiting for pickup or delivery.

Now let us consider the same programmer, again at his desk, only this time he is reading a technical journal. The telephone rings. He marks his place and answers the phone and, say, answers a question from an operator in the machine room. The conversation finished, he hangs up the telephone and goes back to the point he left in his reading.

This example has all of the attributes of a real time situation. An *external* signal (the telephone ringing) *interrupts* what he was doing. He *marks his place* and *services* (takes care of) the interruption. He then resumes what he was doing. Describing this in computer terms, we have:

(Based on a talk by the authors before the Washington, D. C., chapter of the Association for Computing Machinery, January, 1963)

An external signal comes into the computer from an external source and interrupts[1] the program causing the next instruction to be taken from a specified location[2] in memory, rather than from the location which would normally have been referenced if the interrupt had not occurred.

The address of the instruction which would have been next executed under normal conditions (the point of interrupt) is saved, either by hardware or programming means.

At the point in memory to which the interrupt causes a transfer of control there must be either the appropriate routine to perform the required processing to service the interrupt or a transfer instruction to such a routine.

This routine must save the condition of the machine (contents of addressable registers) before the computer begins processing. When processing is completed the routine can then restore the machine's condition and, using the address of the point of interrupt which was saved when the external signal was received, can then transfer back into the interrupted program which proceeds as if it had never been disturbed.

III. THE INTERRUPT MECHANISM

Somewhere within most computers is a register called the location counter or program address register. This register contains the address of the next instruction in memory to be executed. Sometime during the execution of each instruction the location counter is incremented by one and this causes the computer to interpret sequentially the instructions of a program. A transfer instruction operates simply by gimmicking this register: Instead of updating the location counter by one, the address field of the transfer instruction[3] is stored in the location counter thereby causing the computer to take its next instruction from that location.

With this procedure already built into a computer's hardware, the modifications necessary to handle real time interrupts are quite straightforward. All that the computer must do when an external signal is received is to wait until the current instruction has been executed and then simply store the contents of the location counter (which now contains the address of the next instruction to be executed) into a fixed location in memory and replace the counter's contents with the address of the location to which control is to be transferred. For example, if the rule for a particular computer is that an interrupt causes the address of the instruction that would normally have been executed to be stored in location 0 and the computer to transfer to location 1, the mechanism effecting this would store the contents of the location counter into location 0, place 1 in the location counter (with the appropriate number of leading zeros), and then allow the normal transfer operation to take place.[4]

IV. MANDATORY COMPUTER FEATURES

Let's assume that you do not have a computer inhouse and you wish to pick one for a real time application. What factors, in addition to the usual ones of cost and computing power, need be considered?

The purpose of the previous discussion of the interrupt mechanism is to point up the fact that there is nothing unique about a real time computer. In fact, a survey of the available computers on the market will reveal that the overwhelming majority

[1] Due to the fact that each computer manufacturer seems to make a concerted effort to use terminology which is different from that of the competition, there is the usual proliferation of synonymous terms. We shall describe the interrupt as saying that the program in process is interrupted at the "point of interrupt" and a transfer (jump, branch) to a specified memory location called the "interrupt location" is made. Alternate ways of saying this, depending on whose hardware you're using, are: a "trap" occurs and the computer "traps to" a specific "location, or the program is "derailed" and a "subsequence call" is made. There are probably others.

[2] It is slightly easier to discuss the interrupt process in terms of a fixed word length computer. No slighting of character machine programmers is intended and we ask them to bear with us and to substitute field or starting position, in place of location, as appropriate.

[3] Or one of the address fields if not a single-address machine.

[4] It should be noted that not all computers effect their interrupts in precisely this way. An alternate method is to cause the transfer to the interrupt location by a hardware override of the normal sequencing procedure without changing the contents of the location counter. In the interrupt location, instead of using a straight transfer to the routine servicing the interrupt, a return jump (mark place and branch) instruction is used. This type of instruction is normally employed to transfer to a closed subroutine. The usual definition of a Return Jump to Y instruction is that it stores the address of its location in location Y + 1. What actually happens, however, is that the contents of the location counter are stored in Y and, since the location counter in this case still contains the address of the instruction next to be executed in the interrupted program, it is the point of interrupt which is saved, the net effect being the same as above.

of them have (usually optional) external interrupt capabilities. Therefore, to a certain extent, your choice of a computer must be tailored to the processing you wish to accomplish, much as is the case with batch processing applications. Computers do differ however, and while it is true that a clever programmer can teach even the veriest dog of a machine a few new tricks, there are certain features which we feel are mandatory in a computer which is to be used for real time processing:

1. It should have sufficient memory and a process rate fast enough for the particular application. This more or less goes without saying but the timing problem is intensified by the fact that the machine cannot be allowed to glut; it must be able to accept data as fast as it comes in. If there is more than one data source with data inputs arriving relatively asynchronously to each other, the computer must be able to handle the worst case. This is also the case if there are peak load conditions during the processing period. In general, real time system design is conducted on a very pessimistic worst case basis. It is something like a hunter who must use a deer rifle to hunt rabbits, since a deer just might come along and he is not allowed to let it get away.

2. Input/Output must be asynchronous[5] and should interrupt on termination. While it is not necessarily true that if there are real time interrupts everything must interrupt, it *is* true that the computer cannot be allowed to stop, hang up in an I/O select, or lock up the main frame waiting for an I/O termination. All of these conditions may be the cause of "lost" interrupts, depending on the particular computer, and this cannot be tolerated. From the programmer's point of view, having I/O devices interrupt the computer on termination provides the capability of a much more efficient input/output scheme than does the case where a prior test must be made to determine if the I/O devices are busy.

3. There should be a periodic time interrupt. This is an interrupt driven by an external clock or time generator and occurs as often as needed to allow the computer to keep time to a desired precision: every second if the computer is keeping time to the nearest second, every minute if the computer is keeping time to the nearest minute, etc. With a periodic time interrupt, the date/time need only be entered into the computer during the initialization phase of a real time run and it can then be maintained by the system. The advantages of having the computer know what time it is are several: All messages received can be logged on magnetic tape with time of receipt. Periodic status outputs can be provided and all outputs can be time tagged for post run analysis. The system can be requested to transmit a message at a prespecified time of day: for instance, a control signal to a satellite. In addition, in an "active" real time system, in which transactions are initiated by the computer's sending a message to a remote site then waiting for a reply, the ability to determine elapsed time is mandatory. In this latter case, if the remote site does not respond in a specified amount of time, the computer can output a trouble message to the operator and clear the transaction; otherwise, it would patiently wait forever.

4. The computer must have a Disable instruction and an Enable instruction. When a Disable instruction is executed, the computer is placed in a condition in which the program in control may not be interrupted. The Enable instruction resets the computer from the disabled mode to the enabled (normal) mode. An interrupt which would have occurred is not lost when the machine is disabled; instead, it "waits" and occurs when the machine has been re-enabled. (Malfunctions will occur if a situation arises when a second interrupt is called for on a channel which already has an interrupt waiting; therefore, the computer must not be disabled too long.) The purpose of these instructions is to protect short sequences of instructions which must be executed consecutively without interruption. For example, consider a computer which requires two instructions to effect an input or an output: A "ready" instruction which identifies the I/O device and whether the transmission is to be input or output, and a "specifi-

[5] Asynchronous in the accepted computer sense of the term, in which an I/O device operates on a time sharing basis with the main frame, snatching cycles for memory references as needed.

cation" instruction which references a location containing the starting location and the length of the buffer to be used. Normally, this two-instruction sequence would be preceded by a Disable and followed by an Enable, but if it were not the following *could* happen: After the "ready" instruction is executed, the sequence is interrupted. The scheduling requirements of the system require that considerable processing be done on the data related to the interrupt and that the last thing the appropriate routine does is to execute an input or output using an I/O device on another I/O channel. Control is then returned to the interrupted sequence but, due to the delay, the I/O device which was originally selected has "dropped out of ready". The device selected in the interrupt routine has not, however, and the result is that execution of the "specificacation" instruction not only causes data to be moved relative to the wrong I/O device but also possibly in the wrong direction. This example not only serves to demonstrate the need for disabling and enabling under program control but also the conservative "worst case" thinking which must be used in real time programming.

V. DESIRABLE HARDWARE FEATURES

Since we are discussing hardware, we shall mention a few features that real time programmers don't need but will make life considerably easier.

1. At least one index register, with address modification, is desirable. Also, indirect addressing, particularly unlimited levels of indirect addressing, is extremely useful. Unlimited indirect addressing allows the programmer to set up control schemes which are quite sophisticated but are economical in execution time, since each indirect address only costs one machine cycle.

2. Preferably, there should be two types of real time interrupts: One for "end of block" and the other for "end of message". The former is the usual I/O type of interrupt in which the computer is interrupted when an input buffer is filled or an output buffer is depleted. The latter pertains to real time input only and allows for an interrupt to be initiated by a special character or a special signal which indicates the end of a discrete stream of data (usually called a "message"), completely analogous to an end-of-record interrupt in asynchronous input. The availability of both types of interrupts allows the programmer to efficiently arrange his buffer storage by adopting a standard buffer length and linking together buffers currently not in use in the usual list processing manner. He can still accept variable length input since the end-of-message interrupt allows streams of data shorter than the standard block length to be input, while the end of block interrupt allows longer messages to be placed in several blocks. More important, the availability of both types of interrupts allows the programmer to protect the system from errors in the input data, since the end-of-block interrupt will catch messages in which the end-of-message character or signal has been lost or garbled, or which is longer than a specified maximum. The end-of-message interrupt will catch messages which are shorter than a specified minimum.

3. The use of index words for real time I/O is preferable. Most computers with real time capabilities have more than one real time I/O channel and this, necessarily, requires a separate fixed interrupt location in memory (usually lower memory) for each channel to which an interrupt on that channel causes a transfer. Each channel must also have a buffer area associated with it. One approach to this is to have a fixed buffer area (with a fixed length) associated with each channel. However, this has a disadvantage in that data must be moved into or out of these fixed buffers which slows down the total system. In particular, a real time input message must be moved out of its buffer before it gets clobbered by the next message coming in. The other approach is to use an index word. This is a second fixed memory location for each real time channel which contains either the first and last locations of the buffer area or the first location and a count of the buffer length. The computer modifies a word each time a word comes into or goes out of memory in the same manner as similar specification words are used in conventional asynchronous

I/O, either counting the first location up until it exceeds the last location, or counting the count down to zero. The advantages to the programmer are that he can control the length of the buffers and, given an interrupt, his program need only provide a new index word (to the appropriate location in lower memory) to provide a new buffer to the channel involved.

4. If mass storage devices (drums or discs) are required for data storage, they should be as associative as possible, i.e., they should have a "search" mode. The search mode works as follows: Instead of the program, in effect, saying to the storage device, "Get me the block of data starting at your location number so-and-so", it says, "Here is a pattern word; get me the block of data following it". The storage device then makes a brute force search, comparing each word it has stored against the pattern word given it by the computer until a match is found. At this point, the storage device transfers the data block to the computer's memory and interrupts the computer on completion. Note that this provision is truly asynchronous during the search since no computer memory references need be made until data actually begins to move into memory. The advantages to the programmer are prodigious. The mass storage file need be kept in no particular order, since, for a *random access* request, latency time averages one-half a revolution (for a drum, timing for discs is analogous), whether you know where the data is and ask for it or don't know where it is and search for it. Also, extensive location reference tables need not be kept in the computer which the program must search.

The reader will have noted that recommendations have not been made as to the relative real time merits of fixed word length or variable word length computers. This is because both types are being used quite successfully on real time applications. Once again, we suggest you select your machine not only for its real time I/O capabilities but also for its capabilities to handle the processing of the data once it has been received in the machine.

VI. PROGRAMMING

A real time programming system is usually a team effort and, the programming business being what it is, some of the personnel on the team will probably change during the time the system is being implemented. This means that good programming practices and good documentation are especially important. This should not be taken as the usual pious advice to young programmers, but as a literal statement of fact. A real time system is usually written and checked out in pieces and then put together. Then the system either runs, capable of handling every condition that may occur, or it blows up. Sloppy programming on the part of any member of the team guarantees that latter, and bad documentation just sweeps the dirt under the rug.

We define good programming practices to mean: Use straightforward coding and forget all the tricks of adding instructions together and masking bits in and out of instructions to build programmed switches and branch points. Always assume that somebody else will have to go through your coding and figure out *exactly* how it works. The right hand side of the listing should be black with comments.

Design the system so that it is easy to change. It is inevitable that you will have to change it *somewhere* along the line and you might as well make it as painless as possible. Such things as referring to all block lengths in symbolic terms and using computed addresses (as: LDA BLOCK +L, 1 rather than LDA BLOCK + 100, 1) can save you a great deal of grief in the long run. If the necessity arises to change the length of BLOCK, all that must be done is to change the statement defining L and reassemble. The alternative would be to go through the program and change every reference to BLOCK, which is not only tedious but subject to error.

In a similar manner, if specific locations in a block are referenced this should be done symbolically, i.e., set up a defining sequence of the type: LZERO EQU 0, LONE EQU 1, LTWO EQU 2, etc. and make references with the starting location of the block in an index register (for an incrementing machine). Thus, LDA LONE, 1 would pick up word one of the block and should it ever be necessary to rearrange the contents of a block, it can be done automatically again by rearranging the EQU specifications and reassembling. Pseudo-ops like EQU are very attractive in that they do not cost anything in terms of memory or execution time, but give great flexibility to the programmer.

Since the system will probably be written in pieces and then assembled all together, there will arise multiply-defined and undefined reference problems. These problems can be avoided by setting up a rigid system of rules for naming key locations. Also, each routine in the system can have all of its symbolic location names start with the same arbitrary two characters, such as AA for one routine, AB for another, etc. This is a fairly good guarantee against multiple definition and also pinpoints to whom specific errors can be attributed.

Program documentation should be extremely detailed. The whole emphasis should be on a complete description of how the system is composed and how it works. Special quirks that have been built into the system should be noted with an explanation as to why they are there. In particular, information should be included on how to expand or modify the system. Once again, this is for the person who will be required to make changes in the event you leave. If the system is not well documented, what may seem like a simple change to your replacement may turn out to be the equivalent of adjusting a wristwatch with a crowbar.

VII. TOOLS FOR THE PROGRAMMER

Programming of the real time system will probably be done in a symbolic machine-oriented language. To this end, the programmer should be provided with a good, powerful assembler, including pseudo-ops and the capability of programmer macros. The programmer will need both snapshot and postmortem dumping facilities and a straightforward method of making corrections. The correction facilities need not be as elaborate as some of the Symbolic Alter/Load and Go schemes now available; the ability to update a symbolic input tape will do. It should be remembered that a great deal of reassembling is done when working with large systems and continuously reloading thousands of lines of symbolic coding either onto magnetic tape off-line or into a computer on-line can greatly extend the total time required to debug the system.

It is advisable for an installation which is shopping for a computer for a real time application to take a good, hard look at the software that comes with it before making a final decision. Also to be considered are the advantages of off-line I/O capabilities in cutting down the elapsed time required for debugging.

VIII. DEBUGGING PROBLEMS — SIMULATION

Simulation means different things to different persons. To some, it can mean using a computer to simulate an external environment, such as driving displays in a mocked-up control room to give a military trainee experience in tactical situations. Another interpretation of simulation is programming a computer to act like another device, such as simulating one computer on another computer. A third meaning is to have a program in a computer's memory which simulates real time I/O interrupts to a real time system, also in memory, giving it the illusion of operating in real time for the purpose of debugging. It is the latter form of simulation that we will discuss.

In order to simulate real time, three programs are required. The first one generates a tape containing simulated input data. The second is the simulator itself, which acts as a super monitor, reading these messages into the appropriate buffer areas and providing the transfers to the real time system's interrupt locations. The real time system, of course, must be gimmicked to return control to the simulator, for it also simulates real time output. The simulator generates a history tape, consisting of snapshot dumps and other useful information, and the third simulation program is used to make post-run analyses on this tape.

This scheme actually runs in tape time, not simulated real time. However, if the computer's real time hardware contains an "alarm clock" provision, a more sophisticated approach can be used. The "alarm clock" is a device called an interval timer, which can be set with a count under program control. The interval timer then proceeds to count down by one at periodic intervals, say every millisecond. When it has counted down to zero, it produces a real time interrupt. This provision being available, the first program, the one which generates simulated input data, can include a count on the tape with each input message generated. This count may be either the same number each time or may be pseudo-randomly generated within appropriate bounds. The simulator is initiated by the interval timer interrupt and then uses the count received within the last message to reset the interval timer and is thus able to function under much more realistic conditions, simulating the arrival of regularly or randomly arriving data, as the case may be.

One of the problems involved in real time work is the fact that there will probably be special-purpose real time I/O devices and other hardware that must be "married" to the computer and this gives rise to interface problems. Once the real time system appears to be running on the computer proper, it will be desirable to make test runs including the special-purpose devices. This can often be done by using tape recordings of actual data of the type to be received and attaching tape recorders to the special-purpose I/O devices so that data flows into and out of the entire hardware complex under conditions as realistic as possible. The simulator program will now no longer be used but, for a while, it will probably be desirable to leave in some of the snapshot dumps, etc. This, of course, will cause unrealistic timing interrelationships which can be offset to some extent by running the input tapes at a speed slower than the initial recording speed and adjusting the computer's periodic time interrupt suitably. Thus, if the computer normally gets a half-second time interrupt, it could be given a two-second interrupt and the tapes run at quarter speed. In effect, the computer thinks[6] it is running in real time, but actually it is running in "slow time".

Eventually, the system will reach a point where all of the debugging bells and whistles will have been removed from the real time system and simulation under realistic conditions can be attempted. This is where the fun begins, since all the programmer has available to him when the program blows up is a post-mortem dump. This type of test run with recorded input data, including all hardware short of the communications links to remote sites, is commonly called an "in-house" run.

After the in-house tests are going smoothly, you are ready to fire up your entire network and make runs using recorded or other test data patched in at the remote sites. After that, you are ready for the real thing. This "live run" is often called, with reason, the "moment of truth".

There are several noteworthy points in this problem of simulation. One is that time will be spent writing and checking out programs whose only purpose is to debug your real time system of programs. After the real time system is checked out and running, these simulation programs are no longer needed. Such simulation programs can be as elaborate as desired but a nice balance must be struck between the effort required to produce these debugging programs and providing realistic check-out for the real time system.

Another point is that simulation is extremely expensive in machine time and elapsed time. For scheduling purposes, you would be well-advised to allow at least an equal amount of time for system testing (from the start of simulation to full operation) as it took to bring the entire effort up to that point.

Another problem is that you may be designing a real time system for a computer which has not yet been delivered. If at all possible, you should avoid simulation in one of the other meanings of the term. You are going to have timing problems enough without simulating real time on a computer which you are simulating on yet another computer. It is advisable to wait until you can gain access to a computer of the type you will be using and then go into crash debugging.

IX. SYSTEM RELIABILITY

It is the responsibility of the programmer, of course, to build reliability into his work so that his real time system can cope with any eventuality, including hardware malfunctions. There are three general methods of reinforcing hardware reliability in real time work: duplexing, backup, and load sharing. All are based on the general premise: If one computer is reliable, then two must be more reliable, and three even more reliable. There is an unfortunate corollary to this: If one computer costs n dollars, then two computers . . .

Duplexing is the most absolute (and most expensive) method of ensuring reliability. In a duplexed system, two computers are both receiving the same data and are performing the identical processing on it, and both are trying to send data back to remote sites. However, there is a switch which blocks one of the outputs at the transmission terminal so that only one computer is actually sending data and the other is "spilling it onto the floor". Should the computer which is "on-line"

[6] Discussions among real time programmers get quite anthropomorphic as to what the computer "thinks" and "knows".

begin to malfunction, throwing this switch will allow the other machine to take over. This principle can, of course, be extended to one computer on-line and (n-1) computers off-line, if the requirement for reliability justifies the expense.

Backup involves having one computer on-line and the other "standing by". The stand-by computer can be doing useful batch processing during this time and can thus represent a definite saving if the real time operation can tolerate the delay required to pull off the batch job and switch the real time system to the stand-by computer when the on-line computer begins to malfunction.

Load sharing is the technique of using several identical smaller computers, each of which handles a fraction of the inputs, instead of using a large computer to handle all of the real time problem. The advantages here are several: If a backup machine is used, its cost is reduced. If the operational requirements can tolerate it, a backup machine may not even be necessary. The total hardware system never goes down; if one computer does, the rest of them split its load among them and the system runs "slow". For systems running 24 hours a day there is an added attraction, due to the way computers are rented (i.e., once you have paid for the first n hours a month, you only pay for what you use). In such cases, sufficient hardware can be provided to handle the desired service at peak load conditions. Consequently, some of the computers can be shut down during slack periods; they are then essentially "free".

In considering programming system reliability, if you conduct timing studies on your real time system you will find that, in many cases, a surprisingly small fraction of a run hour is spent in useful processing. If you have room in memory for a batch processing program to do time sharing, or have enough tolerance in your operational requirements so that you can do memory sharing by overlaying, you can effect a definite saving. One point you should consider is the inclusion of computer diagnostic routines in your real time system to do machine checking in the intervals when it is not actually processing data. When designing such diagnostics, however, you must be careful to avoid the paradoxical situation of relying completely on a potentially sick machine to tell you that it is sick.

To guard against this, there is an extremely useful diagnostic device available to the programmer. This device is known as the computer operator. Operators, living with the computer eight hours or more a day, can usually sense when the machine is misbehaving very early in the game. Therefore, it is to your advantage to indoctrinate your operators on your system, fill them in on what it does, why it operates the way it does, what it should do, what it shouldn't do, rescue procedures, etc. Every hour you spend with your operators indoctrinating them on the real time system will pay off in pure gold.

Along with this, of course, the part of your documentation covering operating procedures should be as complete as possible. Trouble lies ahead in write-ups of the form:

1. Clear
2. Press Load
3. If anything goes wrong, give me a call

For some reason, things always seem to go wrong with real time systems around three o'clock in the morning.

X. REAL TIME SYSTEM DESIGN

There are various theories of real time system design, the following reflecting our preferences. A real time system can be considered to consist of three parts:

1. The Monitor.[7] This is the heart of the system. It is responsible for all input and output and functions as a scheduler and referee. With the exception of the interrupt processors, described below, all other portions of the system are entered from the monitor. All other portions of the system (including the interrupt processors) return control to the monitor when their functions are completed. It is the function of the monitor at all times to decide which step is to be performed next.

2. The Interrupt Processors. These are short routines, each of which is entered as the result of a specific real time interrupt. Their function is to perform the essential bookkeeping of servicing interrupts and they may or may not "run disabled" (i.e., with the

[7] Monitor is another one of those unfortunate sponge words which means different things to different persons—ranging from a tape library routine to a trace program. Its synonym, Executive, is just as bad. We use the word Monitor as here defined.

computer disabled), depending on the particular computer.

3. The Ordinary Processors. "Ordinary" is a somewhat slighting descriptive adjective here, since these are the routines which actually perform the processing on the real time data. They receive data from the monitor and return data to the monitor and have no direct contact with the outside world.

The scheduling function of the monitor is based on the idea of priority. Since the computer can only do one thing at any one instant in time, all of the processors under monitor control must have a relative order of priority. The need for this is not immediately apparent but the following example will show the usefulness of this approach.

Suppose we have a system which is maintaining an inventory system of some type in real time. Three types of messages are received: Messages to buy items in the inventory, messages to add new items to the inventory, and messages which cancel previous "buy" messages. If the system is currently processing a "buy" message and is interrupted by the receipt of a new message, then clearly this new message should be processed in its entirety if it is an "add" or "cancel" message before processing on the "buy" message is resumed. Otherwise, if the messages were processed in strict order of receipt, it would be possible for a "buy" message to be declined due to a depleted inventory when there might be a message in the machine waiting to add the items desired.

XI. THE REAL TIME PROGRAMMING GROUP

There are certain advisable procedures which can both avoid system problems and reduce costs during the period of design and implementation of a real time system.

The design proper should be a accomplished by a small group (two or three) who also code and check out the monitor and interrupt processors. These persons are known as the "monitor group" and they are essentially the watchdogs of the system. They develop all system specifications and establish requirements on the other programmers. For this reason it is vital that they remain with the project from start to finish, right through final documentation. There is a great temptation to pull these persons off and send them on to bigger and better things. This can prove to be false economy.

When the monitor design approaches completion, additional programmers can be phased in to write the simulation programs and the ordinary processors. The monitor group will then start shifting over to supervising them. An advantage to real time work is the fact that you can often use relatively junior-level programmers to write the ordinary processors. Of course, you will get relatively junior-level programming out of them, but consider the position of an ordinary processor writer: He is told where to get his input; he is told where to put his output; and he is told where his processor should transfer when done. If there are limits on the memory or execution time available to him, this is specified by the monitor group. He can treat his processor as if it were all alone in memory. Having no design responsibility, he has no worries, and, more important, will have less opportunity to blow up the system. Breaking in a new programmer to write monitor processors requires close supervision, but it also gives him an invaluable introduction to systems work.

We mentioned previously that a good estimate of the time required to check out the system is an amount equal to the time required to write and check out all the pieces. This is because the system should be checked out starting with the smallest number of pieces that will run by themselves (usually the monitor, some of the interrupt processors, and a few dummy ordinary processors) and then add the other pieces one at a time. One of the problems with real time systems checkout is that one part of the system will cause an apparent malfunction to occur in another part which actually may be functioning perfectly. Putting the system together gradually helps pinpoint problem areas. Putting the entire system together at once, then checking to make sure it will run will require more time in the long run.

XII. CONCLUSION

We hope that in pointing up problem areas we have not implied that the real time programmer faces insuperable difficulties. Real time system design is simply an extension of conventional system design — the restraints are just tighter and the management and checkout problems more exacting. But, after all, it's the hard jobs that are the most challenging — and the most fun to program.

ELECTRONIC COMPUTERS AND SCIENTIFIC RESEARCH

(Part 2)

Stanislaw M. Ulam
Los Alamos Scientific Laboratory
Los Alamos, New Mexico

A mathematician who is noted for starting an experimental method (the Monte Carlo method) for statistically examining complex mathematical situations, reports on further steps in using an electronic computer for finding out and collecting remarkable situations, and checking conjectures about them.

(Continued from the August issue, p. 24)

. . . . For cubic transformations, still in the plane, one obtains in the limit weird curves as "cyclic" distributions. In some transformations, points seem to converge to a perfect, nowhere dense set S lying on a curve. In the present state of analysis, it is impossible to calculate this curve in any explicit way, or even, for that matter, to establish its existence a priori. Recently, Stein found a case of quadratic transformation of the above kind, in four variables, in which, starting with any interior points, the iterates converge to two skew curves on which they run infinitely, switching from one to the other.

mysterious — bewildering — strange

The ergodic properties of the iterates of a linear transformation, e.g., rotations of a circle, are well understood from the theorems of Kronecker and Weyl. For quadratic point transformations, asymptotic behavior remains mysterious; our heuristic work has shown a bewildering array of different cases with strange behavior. It is hoped that some hints toward understanding the properties of nonlinear transformations will eventually come from this experimental material.

In problems of this nature, it is very important to have some auxiliary equipment attached to the computer to display the results of the calculations. An examination of the coordinates of the points printed out or listed on a tape is impractical. If one can display visually the positions of points in a plane, or in three dimensions in projections, or better still, in axonometric view, one gets very quickly an impression of the morphology of the distributions. Such a display mechanism, constructed by J. Richardson in Los Alamos, has shown itself of great use. In the problem mentioned above, the visual display enables one to see readily the iterates of a point traveling on curves or pieces of curves. This display can be repeated often enough so that one has more than fleeting impressions. Furthermore, the collections of points can be photographed (Figures 3 to 5).

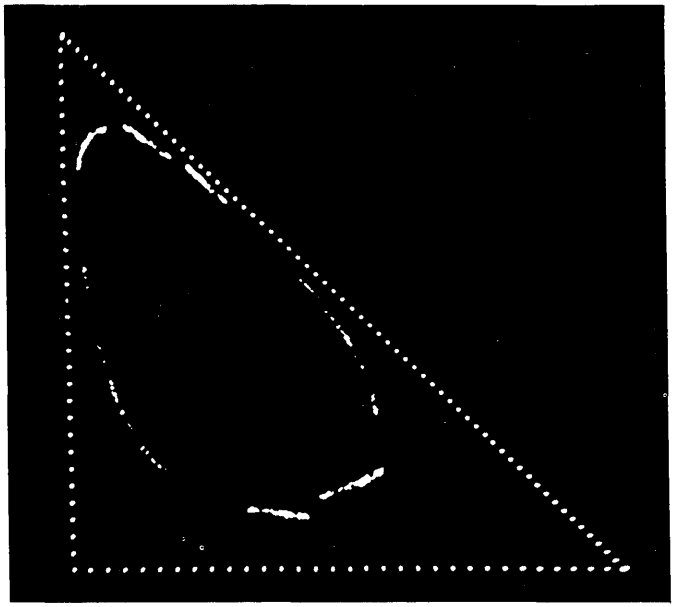


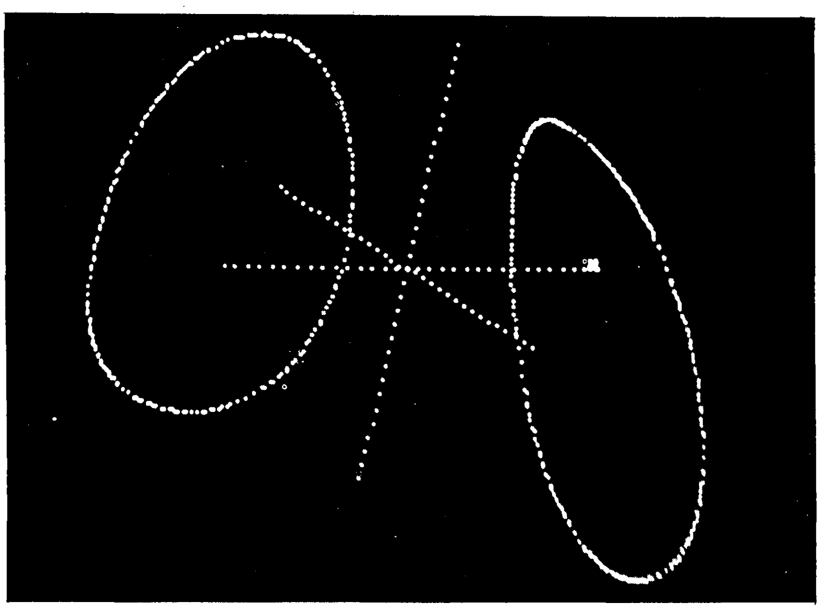
Figure 3. Several hundred iterates of an initial interior point under the transformation

$$x' = z^3 + 3xy^2 + 3yx^2 + 3yz^2 + 3zy^2 + 6xyz$$
$$y' = 3xz^2 + 3zx^2$$
$$z' = x^3 + y^3$$

where $x + y + z = 1$.

pictures of iterates

In 1953, the late Enrico Fermi and the writer started a small program of systematic investigations of the long-time, asymptotic behavior of nonlinear physical problems.[2] The first example chosen was a simple one. A string with fixed ends is displaced from equilibrium. It vibrates under the usual law of force, which is linear, but with an added nonlinear term for the force as a function of displacement. The nonlinear term (quadratic, for the first class of problems) is small compared with



another picture of iterates

Figure 4. Four hundred iterates of T, shown in two-dimensional projections, with the x, y, and z axes indicated, under the transformation

$$x' = x^2 + y^2 + 2yu$$
$$y' = u^2 + 2xu + 2zu$$
$$z' = z^2 + 2xy + 2xz$$
$$u = 2yz$$

where $x + y + z + u = 1$.

the predominant linear expression. The purpose of the calculations, which were performed on electronic computers, was to determine whether in the course of time the shape of the string, started initially at time $t = 0$ in a single sine mode, for example, would gradually become more and more complicated, and how the energy, initially all in the first mode, would flow to higher Fourier frequencies. Would there ultimately be a convergence to an equipartition of energy among all the possible frequencies?

One studies the problem on a computer by replacing the continuum of the string by a finite number of points (64 in our case); then the partial differential equation becomes a system of difference equations. The continuous time parameter is also replaced by a discrete number of time cycles. If x_i is the displacement of the ith particle of the string, the equations are of the type

$$\ddot{x}_i = (x_{i+1} + x_{i-1} - 2x_i) + \alpha[(x_{i+1} - x_i)^2 - (x_i - x_{i-1})^2]$$

or

$$\ddot{x}_i = (x_{i+1} + x_{i-1} - 2x_i) + \beta[(x_{i+1} - x_i)^3 - (x_i - x_{i-1})^3]$$

where $i = 1, 2, \ldots, N$, and α and β are coefficients so chosen that, at the maximum displacement which occurs, the nonlinear term amounts, at most, to one-tenth of the force. The problem was studied by following tens of thousands of time cycles or hundreds of the expected periods of the linear vibrations.

following tens of thousands of time cycles

The results of the computation were very surprising! Instead of a gradual flow of energy to higher harmonics and a tendency toward equipartition, something quite different was observed. Only the few low modes acquired any noticeable energy. There was an interplay among those until, after about thirty thousand cycles of computation, the string returned to its original form to within closer than 1 per cent of the total energy (Figure 6). It was suspected, at first, that this behavior might be due to the special, mathematical nature of the force. Similar phenomena were observed, however, when different expressions, e.g., a small cubic term, were substituted. Instead of a gradual sharing of

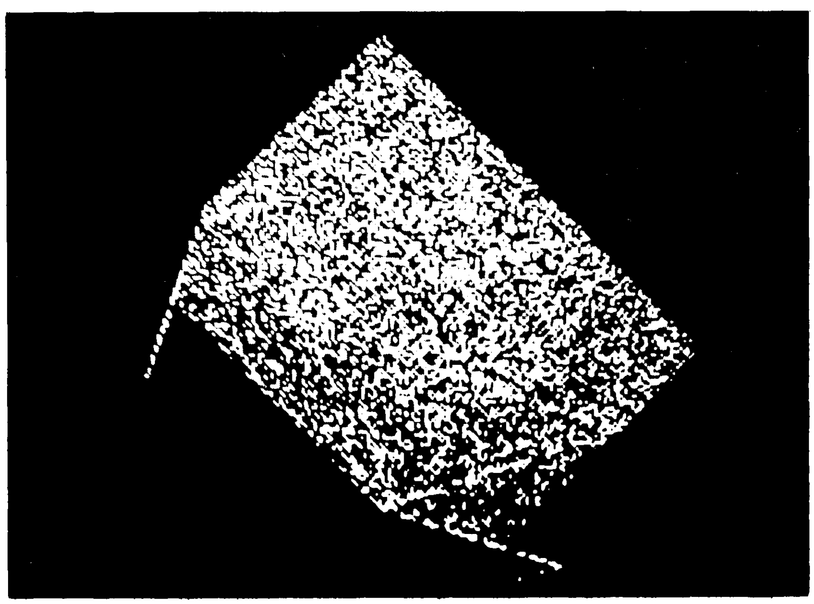


Figure 5. **Approximately 9,000 iterates of a point interior to the square, under** the transformation

$$x' = f(x, y) \qquad y' = g(x, y)$$

where f and g are functions which equal 0 on the circumference of the square and 1 at the points $(\frac{1}{4}, \frac{1}{4})$ and $(\frac{3}{4}, \frac{3}{4})$, respectively. They each increase linearly from 0 to 1 in the four triangles inside the square; that is, f and g form pyramidal surfaces.

energy among the various frequencies, there was a distribution of energy among a few low frequencies, which permuted among themselves.

In this first experiment, the string returned to within 1 per cent of its original condition. Starting with this configuration, J. Tuck and

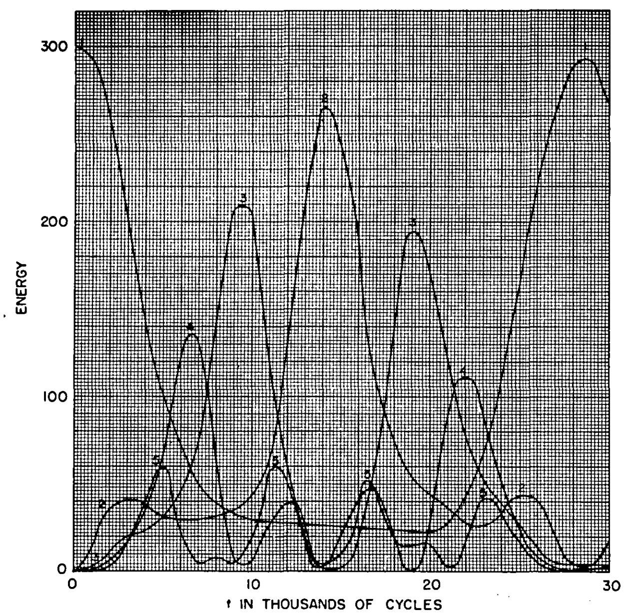


Figure 6. The quantity plotted is the energy (kinetic plus potential) in each of the first five modes; about 30,000 computation cycles are calculated. The units for energy are arbitrary.

Mary Menzel continued the computation for much longer time intervals. After another period of this sort (corresponding to several hundred of what would have been the linear operation period), the string returned to within 2 per cent of its original position. The "great periods" were repeated several times. After eight of these large periods, the discrepancy was as much as 6 per cent. But, from then on, the discrepancy began to diminish, and after 16 large periods the string was almost *exactly* in the initial position again; in fact, to within less than the 1 per cent of the original great cycle. This phenomenon reminds one of the cycles of cycles in Hindu mythology.

cycle of cycles in Hindu mythology

During the last few years, several mathematicians have examined these heuristic results with a view toward possible explanations through analytical work. Recently, Kruskal and Zabudsky obtained most interesting results on partial differential equations which correspond to the limits of our difference schemas. It appears that such nonlinear equations have solutions which tend to develop discontinuities in the higher derivatives, leading to phenomena of the kind described.

The increasing complexity of ideas in even the fundamental theories of physics, in addition to the constantly augmenting combinatorial and analytical complexity of recent technology, has made the computing machine not only welcome, but necessary, as an aid in scientific work. In Los Alamos, during the war, study of the phenomena determining the nature of nuclear explosions involved a treatment of simultaneous problems in neutronics, hydrodynamics, and the behavior of radiation. In order to obtain a quantitative answer, sometimes merely of the yes-

increasing complexity of ideas → computer necessary or-no kind, enormously elaborate calculations had to be performed. Concepts in basic physics, considered to be elementary or fundamental, have repeatedly turned out to be systems of many interrelated aspects. This tendency, characteristic of recent developments, has led to constantly increasing mathematical sophistication of the simple underlying picture developed during the nineteenth century.

But even in the somewhat older theory, for example, in the theory of general relativity and gravitation, the mathematical difficulty of obtaining particular solutions is very great. In fact, it is not now possible to check the predictions of the general theory without numerical work; to decide between alternative formulations, it is necessary to calculate their consequences. A similar situation prevails in the proposed field theories in nuclear physics.

onset of turbulence

In still older subjects, e.g., in the field of hydrodynamics, the situation is the same, and methods of the kind described offer a profitable approach. The problem of the onset of turbulence, for example, can be studied by calculating specific cases. These "experiments on paper," using computers, have already been started by many mathematicians and physicists, and will undoubtedly be continued. A number of problems in the mechanics of continua have recently been studied by brute force, so to speak. The fluid is replaced by hundreds or thousands of material points, and forces, such as the gradients of pressure, are simulated by repulsions chosen as a function of the distance between the points.[3] The results of this work give promise, during the next few years, of producing a much better understanding of the dynamics of compressible media. One application of the knowledge thus acquired will be the possibility of calculating more precisely than heretofore possible the phenomena of circulation in the atmosphere, and consequently of predicting the weather. Understanding of the fundamental problems of stability of atmospheric motions may lead, ultimately, to some control of air masses, perhaps even with moderate expenditures of energy. It should be noted again that, for problems of this kind, improved display mechanisms and easier access to the computer, for controlling the course of calculation, are of the utmost importance.

stellar models

Space does not permit a detailed description of the interesting applications of computing machines in problems of astronomy. Work on stellar models and on the evolution of stars has benefited greatly by the use of computers. The work of Henyey, Schwarzschild, Hoyle, and others has been of the greatest interest and value in cosmogonic theories. With the new high-speed computers now in operation, it is possible to tackle the problem of the equilibrium and development of rotating stars. These machines also make possible advances toward the solution of problems in statistical mechanics and quantum physical chemistry.

It may appear that the promise of the pragmatic approach has been emphasized largely in the more abstract parts of mathematics. It is well to remember that some branches of science originated as the study of isolated curiosities or "mathematical amusements." But these soon acquired importance, beyond mathematics, in physics or statistical mechanics, for example. The theory of probability and the field of combinatorial analysis (an ill-defined area of mathematics dealing with the properties of arrangements of objects) originated in problems of chance or mathematical games. Somehow, perhaps through biological instinct or the "wisdom of the race," these theoretical activities acquire a vital, practical significance for the species as a whole. An example that comes to mind is the recent application of combinatorial mathematics to the rapidly developing field of molecular biology. A most exciting and important work is now in progress on the understanding of the code in the DNA molecules. The study of the sequence of the molecules in a linear structure, which determines the geometric properties of protein molecules, is now possible because of the availability of electronic computers. By sophisticated mathematical analysis, Kendrew in England determined the relative positions of the atoms constituting the myoglobin molecule, work which could be done only because of the availability of mechanical means of performing the necessary calculations.

combinatorial analysis → genetic code

In the theory of specialization of cells and the structure and growth of their groupings, mathematical models, examined by the aid of computers, will no doubt be of great use. One class of problems will deal with the diffusion process of a great many particles of different types, among which short-range binary forces tend to organize diverse subsystems.

"palpable" experience in 4 dimensions

Going further, it is perhaps permissible to speculate on a still different role of the computing machines. It is conceivable that, through experimentation with computers, new types of intuition may be acquired by mathematicians; these may include "palpable" experience with objects in more than three dimensions and greater familiarity with new topological and kinematical situations. It is only too easy to underestimate the heuristic value of such approaches. But some anthropologists have seriously advanced the thesis that it was the development of the opposable thumb in the hand, and the ensuing use of the hand and tools, that helped to a considerable extent to mold and develop the human brain itself. It is foolhardy to prophesy where the development of such new tools will lead us in the future, but it seems quite clear that the progress of technology, rapid and alarming as it is, may be accelerated still further.

A great deal of preliminary speculation and some work have been devoted to what is called the analogy between the structure and connections in the computers, on the one hand, and the neural connections in the nervous system and in the brain, on the other. This is an enormous subject, about which nothing very definite can be said as yet. But even if we discover, by looking at the apparent analogies, what the brain is not, a great deal will be accomplished.

It is inevitable that the increasing availability and use of computers will bring about modifications in some of the curricula of instruction in mathematics and other sciences. This is already apparent on the undergraduate level and will lead to considerable changes in educational programs. In the near future, the young scientist will do his work and develop his ideas with the aid of novel and valuable tools, among the most important of which will be electronic computers.

REFERENCES

1. P. Stein and S. Ulam, Quadratic Transformations, Part I, *Los Alamos Sci. Lab. Rept.* LA-2305, Office of Technical Services, U.S. Department of Commerce.
2. See, for example, S. Ulam, "A Collection of Mathematical Problems," Interscience, New York, 1960.
3. F. Harlow et al., The Particle and Force Computing Method for Fluid Dynamics, *Los Alamos Sci. Lab. Rept.* LAMS-2567, 1961.

(Reprinted with permission from "The Age of Electronics" edited by Carl J. Overhage, published by McGraw Hill Book Co., New York, N. Y., 1962)

"ACROSS THE EDITOR'S DESK"

Computing and Data Processing Newsletter

TABLE OF CONTENTS

NEW APPLICATIONS

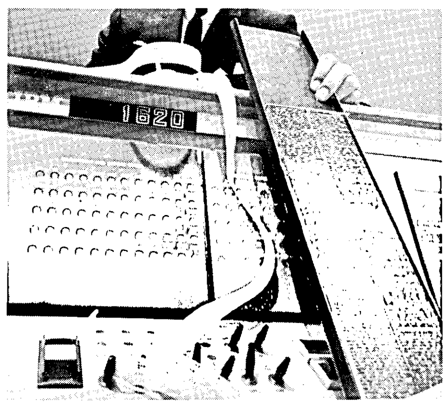
COMPUTER MAKES TYPESETTING FULLY AUTOMATIC

Fully automatic type composition by computer has been announced by IBM Corp., Data Processing Division, White Plains, N.Y. The process eliminates manual intervention from the time a punched paper tape is created to the time hot type is poured by an automatic linecasting machine. An IBM 1620 data processing system with a newly developed on-line allotting capability is used with a set of IBM 1620 type composition programs.

The 1620 with allotting capability can accept copy coming in the form of electrical impulses from as many as 20 manually-operated paper tape punches. It feeds the output through electrical connections to as many as 20 paper tape readers attached electrically to 20 automatic linecasting machines. Under control of the IBM program, the 1620 can hyphenate and justify as many as 12,000 11-pica lines of type an hour. It can control format factors such as column width, all types of indentation, and type fonts. Without significant modification, it can be used wherever an automatic linecasting machine is used to set type for a brochure, book, magazine or newspaper.

The basic 1620 system hyphenates and justifies 4000 lines an hour. Its output tape is torn off at the computer and placed manually into the linecaster's paper tape reader.

To use the IBM type composition program, edited copy is first punched into paper tape by a typist. The tape then is fed into the 1620, which stores the copy in its magnetic core memory. Guided by the new program, the 1620 adds spacing to fill out the lines evenly, hyphenates where necessary to break off a word at the end of a line, and produces a finished, fully-justified tape. This tape, in turn, is fed into an automatic linecasting machine which sets the type.
(For more information, circle 34 on the Readers Service Card.)



-- Punched paper tape and an IBM 1620 computer -- coupled to an automatic linecasting machine -- were used to set the galley of newspaper type shown here.

COMPUTER INFORMATION SYSTEM SERVES CHICAGO PUBLIC SCHOOLS

A computer information system, designed to serve the entire public school system in Chicago, has entered its initial stages. The system, called "Total Information Service (TIS)" is based on an IBM 7074, three IBM 1401's, and an optical page scanning device made by Recognition Equipment, Inc., Dallas, Texas. Over 100 million characters of random access memory will be in the system. All units of the system are being leased by Chicago public schools at a total cost of about $50,000 per month.

The system serves nearly 600,000 students and teachers at primary and secondary levels, 11 junior college branches, and two teachers colleges in Chicago. Not all of the schools in Chicago will fall under this service before four or five years. When completed, TIS is expected to serve a total of 500 schools and buildings. The relief of teachers from clerical duties, alone, will save an estimated $1½ million per year.

TIS will provide complete current and historical information on each student and teacher in Chicago. It will perform accounting, school supplies inventory, building maintenance schedules, student course scheduling, etc. In addition, it will enable advanced research in education through the careful interpretation and processing of students' achievements and backgrounds.

The optical reader device, a key element of TIS, is expected to read and convert up to 32 million documents per year into machine language. This device will accept simple typewritten information and, without further handling, transfer it to magnetic tape.

Responsibility for the design of the Total Information Service system, and for computer programming and operation has been delegated to a Bureau of Data Processing, headed by Stanley R. Patton. (For more information, circle 30 on the Readers Service Card.)

CRITICAL PATH METHOD (CPM) BEING USED BY CONSTRUCTION CORPORATION

The HRH Construction Corporation, New York, N.Y., one of the largest building construction firms in the United States, is using the GE-225 computer system Critical Path Method (CPM) in scheduling work on a 34-story apartment building in New York. This system of computer-assisted planning has previously been successfully used by the firm on projects near Washington, D.C.

The more accurate timing of construction steps accomplished by CPM and the GE-225, is particularly important in New York because of the acute demand in New York for labor and materials, as well as the shortage of delivery space in New York streets.
(For more information, circle 31 on the Readers Service Card.)

GUESTRON — REAL-TIME DATA PROCESSING FOR HOTELS

LFE Electronics, a division of Laboratory For Electronics, Inc., Boston, Mass., has developed a real-time data processing system for the Sheraton Corporation of America. The new system will keep track of guest charges on a minute-to-minute basis.

The system, called Guestron, consists of a central computing and information retrieval unit, inputs similar to cash register keyboards, and output printers. Keyboards and output printers can be located anywhere in a hotel. The computing and information retrieval unit requires only a normal office environment. Guestron will perform all guest accounting and billing functions and provide all information required for night audit, income summary, and balancing cashiers' accounts.

Each guest will be assigned an individual account number specifically identifying him and the room to which he is assigned. This information is keyed into Guestron's memory, along with room and tax rates, through an input keyboard at the registration desk. (Other transaction points throughout the hotel -- restaurants, room service, barber shops, etc. -- will have similar keyboards.) Once a guest's account has been established, all charges incurred at any keyboard station will be automatically and immediately filed in the Guestron memory. All types of sales may be entered into the system, including cash sales, guest charges and credit charges. At checkout time, the guest's account code is keyed into the system, which extracts all charges from memory and prints the information out on the hotel's bill form. The bill he receives will be "final" since all of the guest's expenses during his stay were stored in the system the instant they were made. In this way, late charges will be eliminated.

The first of these systems is scheduled for installation early in 1964, in the Sheraton Atlantic in New York City.
(For more information, circle 32 on the Readers Service Card.)

NEW CONTRACTS

EAI GETS $2 MILLION CONTRACT FOR 11 ANALOG COMPUTER SYSTEMS

Electronic Associates, Inc., Long Branch, N.J., has received a $1,964,829 contract for 11 large-scale analog computing systems from the Martin Co. Several of the systems will be made up of advanced design equipment, including analog memory and logic.

The 11 computer systems will be installed at various Martin Company divisions involved in missile and space vehicle research. They will be used in the Martin space and missile programs.

PACKARD BELL DIVISION TAKES PB440 ORDERS

Packard Bell Computer, Anaheim, Calif., has received 10 orders for the PB440 stored logic computer (Computers and Automation, January 1963) and letters of intent for three more.

Orders for the PB440 include two for Douglas Aircraft Co., Santa Monica, Calif., which will probably use them for biomedical data processing and static rocket engine checkout; two for the National Aeronautics and Space Administration, Huntsville, Ala. and Houston, Texas; and one for the Navy Weather Research Laboratory, Norfolk, Va. First deliveries are expected to be made in November.
(For more information, circle 35 on the Readers Service Card.)

DISCfILE® SYSTEMS ORDERED BY UNITED KINGDOM AND JAPAN

Data Products Corp., Culver City, Calif., has received orders for DISCfILE® systems totaling more than $500,000. English Electric Computers Ltd., London, England, has ordered a system for use with the Leo III general purpose computer. The Japanese orders were negotiated through Nissho, Ltd., of Tokyo and call for delivery of systems to the Nippon Electric Company, Ltd., and to Fujitsu, Ltd.

All of the systems will be produced in the St. Paul, Minn., facility. Deliveries are scheduled for the fall of this year.
(For more information, circle 36 on the Readers Service Card.)

BELL AWARDS CONTRACT TO SCIENTIFIC DATA SYSTEMS

Scientific Data Systems, Inc., Santa Monica, Calif., has been awarded a $34,995 contract by Bell Aerosystems Company, Buffalo, N.Y. The contract is for analog to digital electronic equipment to be used in a Bell research and development program.
(For more information, circle 37 on the Readers Service Card.)

NEW INSTALLATIONS

LEICESTER BUILDING SOCIETY TO USE NCR 315 SYSTEM

Leicester Permanent Building Society of Great Britain has installed a NCR 315 system at Oadby, near Leicester, England, where the firm's new head office building is under construction. Society officials said the system would make possible better service to borrowers and investors, and provide for future growth involving up to three times the present volume of work. Starting with maintenance of depositor accounts, the computer will eventually handle the society's investment and mortgage accounting. (For more information, circle 38 on the Readers Service Card.)

O.E. McINTYRE INSTALLS UNIVAC III COMPUTER

A new UNIVAC III computer has been installed at the plant of O. E. McIntyre Inc., Westbury, N.Y., to address direct mail advertising. O. E. McIntyre Inc. handles large-scale consumer mailings for leading publications, insurance companies and manufacturers. The mailing list is made up of the 40,000,000 U.S. families who own telephones. The UNIVAC III will permit faster selection of precisely defined consumer markets.

The equipment installed at McIntyre's Westbury plant consists of a central processor, 14 Uniservo III tape units, a 16,000-word core memory, 2 high-speed card readers, 2 high-speed printers, and a control console. It replaces two medium-scale computing systems installed several years ago. (For more information, circle 39 on the Readers Service Card.)

NAVY COMMUNICATION SYSTEM WILL USE TRW-130

The TRW Computer Division, Redondo Beach, Calif., has delivered a TRW-130 digital computer and peripheral equipment to DECO Electronics, Santa Monica, Calif. DECO Electronics will use the TRW-130 and its associated equipment as components of an engineering model of a Naval communication system being developed under a contract with the Bureau of Ships. (For more information, circle 40 on the Readers Service Card.)

DAYTON TIRE TO INSTALL CARD RANDOM-ACCESS COMPUTER

The Dayton Tire & Rubber Co., Dayton, Ohio, will install a computer system built around an NCR 315 computer and using a Card Random Access Memory. The system will automatically process orders, control production, maintain inventory records, and handle billing and payroll.
(For more information, circle 41 on the Readers Service Card.)

RCA 301 WILL UPDATE DAILY ONE MILLION SUBSCRIPTIONS

Dow Jones and Company, Inc., New York, N.Y., has announced a lease purchase agreement with RCA Electronic Data Processing, New York, N.Y., for the installation of an RCA 301 computer at its plant in Chicopee Falls, Mass. Dow Jones plans an electronic data processing center for same-day updating of one million subscription accounts involving the "Wall Street Journal", "The National Observer", and "Barron's National Business and Financial Weekly".

The computer will handle billing, file maintenance, and a variety of statistical reports. An average of 5000 bills are processed at Chicopee Falls daily. Holiday and seasonal peaks raise the figure to as high as 10,000 a day. Subscription files for the three publications currently are maintained manually.
(For more information, circle 42 on the Readers Service Card.)

NCR'S 500TH COMPUTER SYSTEM TO BE INSTALLED AT FIRST FEDERAL SAVINGS & LOAN OF MIAMI

The National Cash Register Company, Dayton, Ohio, is installing its 500th computer system at First Federal Savings & Loan Association of Miami. The system is an NCR 315 computer which will eventually permit savings and loan transactions to be processed on-line at any of the tellers' windows in the association's main office or seven branches. The "on-line" data network, one of the first installations of its kind in the savings and loan field, is scheduled to go into operation next year. NCR installed its first computer systems in 1960.
(For more information, circle 55 on the Readers Service Card.)

SAVINGS AND LOAN ASSOCIATION INSTALLS B251 WITH REMOTE-CONTROL TAPE-PUNCHING

Mid America Federal Savings and Loan Association, Chicago, Ill., has installed a Burroughs Corporation B251 computer with a remote-control tape-punching feature. The electronic computing system, especially adapted for savings and loan usage, receives new account information through punched paper tapes produced by window posting machines as a by-product of normal passbook-posting operations. Instead of being punched by an attachment fastened directly to the posting machines, however, the tapes are produced by remote control in the computer room on a lower floor.

The system will be used for automatic maintenance of ledger card records for the association's 60,000 customers.
(For more information, circle 54 on the Readers Service Card.)

TRW-340 TO BE INSTALLED AT TVA BULL RUN POWER STATION

The Tennessee Valley Authority has ordered a TRW-340 control computer system for installation at TVA's Bull Run Steam Plant Unit 1, Edgemoor, Tenn. The Bull Run plant will be one of the world's largest, with a capacity of 900 megawatts.

The TRW-340 system will include: a 75,000-word drum memory and 8000-word core memory; 1000 contact-closure inputs; and 450 fixed-duration momentary contact inputs. The analog input/output system will provide 1365 analog inputs and 26 analog outputs. A fully automatic priority-interrupt system will be provided.

The control-computer system will supervise the boiler-turbine-generator unit, and will be capable of expansion to supervise a possible future second unit of similar capacity. The computer will provide data logging, off-limit supervision and alarm, performance calculations, and monitoring and control functions. Startup of the steam plant is scheduled for July, 1965.
(For more information, circle 56 on the Readers Service Card.)

ORGANIZATION NEWS

SINGER CO. TO ACQUIRE FRIDEN, INC. FOR $175 MILLION

Friden, Inc., San Leandro, Calif., may be acquired by Singer Manufacturing Co., New York, through a $175 million stock transfer. Under terms of the proposed agreement, Friden shareholders would receive one share of Singer stock for each 1.75 shares of Friden stock. A total of some

2 million shares would be exchanged for about 4 million Friden shares; the Singer shares would be worth $175 million. The agreement is subject to approval of both companies' directors and of stockholders.

Friden would become a major Singer subsidiary under its own management.

No management changes are anticipated. No plans exist for either physical or corporate combination of the electronics activities of Friden with those of Singer's electronics subsidiary, HRB-Singer, Inc., State College, Pa. (For more information, circle 43 on the Readers Service Card.)

CYBETRONICS OFFERS A TAPE REHABILITATION SERVICE

Cybetronics, Inc., Waltham, Mass., has expanded its magnetic tape rehabilitation equipment to include complete preventive maintenance. The tape rehabilitation service consists of cleaning, recertification, editing, marking, and repairing of magnetic tape. New automatic equipment for rehabilitation of tape is of Cybetronics' own design and manufacture. The initial "tape laundry" facility is now operating at Cybetronics' factory in Waltham, Mass. Additional tape servicing facilities will be installed in other localities.
(For more information, circle 44 on the Readers Service Card.)

ICT WILL MARKET UNIVAC COMPUTERS IN AUSTRALIA

UNIVAC electronic computing systems will be marketed in Australia by International Computers and Tabulators Holdings Australia Pty. Ltd. This is a non-exclusive distributorship agreement making the full line of commercial UNIVAC electronic computing systems available to prospects and customers in Australia through ICT.

The UNIVAC 1004 Card Processor is already being marketed in the area by ICT, Ltd. under terms of a prior agreement.
(For more information, circle 45 on the Readers Service Card.)

MCDONNELL AIRCRAFT'S NEW ACQUISITION TO BE KNOWN AS DELCOS, INC.

The assets of the Denver Electronic Computing Service, Inc., Denver, Colo., have been purchased by McDonnell Aircraft, St. Louis, Mo. The new acquisition will be known as DELCOS, Inc., and will operate as a wholly-owned subsidiary of McDonnell Aircraft, responsible to the company's Automation Center.

DELCOS will offer a complete data-processing service throughout the Eastern Rocky Mountain area. The purchase of DELCOS is the first step in the planned expansion of the McDonnell Automation Center.
(For more information, circle 57 on the Readers Service Card.)

SDS MARKETS IN EUROPE THROUGH CGE

Scientific Data Systems, Santa Monica, Calif., has completed an agreement with Compagnie Générale d'Electricité in Paris for the marketing of its complete line of SDS digital computers, system components, and logic modules throughout Europe and Great Britain.

The agreement calls for CGE to purchase SDS equipment in excess of $2 million during the first 18 months and includes an option for CGE to manufacture as a licensee. CGE has received delivery of their first SDS 910 digital computer, and it is currently in operation at their Paris offices.
(For more information, circle 58 on the Readers Service Card.)

EDUCATION NEWS

COMPUTERS & TV COMBINE FOR WEST POINT INSTRUCTION

The U.S. Military Academy has brought together two fields of educational technology to solve the problem of teaching computer techniques to more than 700 cadets in seven days. West Point officials decided that every entering freshman should receive "hands-on" computer training, and should carry that training forward throughout his four undergraduate years. This required integrated use of digital computers and closed circuit television.

The class is divided into approximately 50 groups, each containing 10 to 15 cadets. A specially prepared film was recorded at West Point; this was done to maintain the same quality of instruction for each of the 50 groups. Each cadet is given an opportunity to operate the computer himself. A special programming technique enables cadets to prepare computer instructions and data by mark-sensing. Using this method, students prepare their problems for computer solution in advance, in their rooms, or elsewhere.

During the film the instructor runs cards through the computer and indicates any errors found. (The computer has 50 kinds of checking and error detecting features programmed into it, to simplify and speed up the running of analyzing student's errors.) Then the students correct their own errors and run their cards through the computer individually.
(For more information, circle 46 on the Readers Service Card.)

HIGH SCHOOL DROP OUTS TO RECEIVE ON THE JOB TRAINING IN DATA PROCESSING

A program of on-the-job training in electronic data processing, for high school drop-outs, has been announced by Altro Workshops and ADAPSO (Association of Data Processing Services Organization) in New York. The program has been approved by three government bodies, and is being supported by funds under the Manpower Development and Training Act.

The program gives training in machine operation, key punching, and related data processing techniques to youths in the community who represent school drop-outs.

ADAPSO provides an advisory committee, assists in developing a recommended course of study, and furnishes instructors from time to time. Altro, a non-profit rehabilitation agency, is conducting the workshops at its center in the Bronx, N.Y. ADAPSO also aids in locating actual data processing jobs which can be handled by the youths when trained.
(For more information, circle 47 on the Readers Service Card.)

NEW PRODUCTS

Digital

RCA 350 RANDOM ACCESS FILE PROCESSOR SYSTEM

The Radio Corporation of America, New York, N.Y., has announced the addition of a third member to its 301 line -- the RCA 350 Random Access File Processor System. The system uses a variety of on-line remote and local inquiry and printing devices to handle widely-dispersed transactions on an "as-come" basis, without prior batching.

The processor unit contains both high-speed magnetic core memory and a high-capacity random access disc memory which ranges in capacity from 5-million to 45-million characters. The program-controlled processor also includes an alphanumeric on-line printer and card punch, and a logic unit which provides direct access to the high-speed memory from up to 20 input-output stations simultaneously.

Peripheral input-output units can be connected to provide for send-receive, receive only, multi-copy printing, and varying card reading speeds. These devices are not restricted as to distance from the processor.
(For more information, circle 48 on the Readers Service Card.)

PDS ANNOUNCES TWO NEW COMPUTERS

Pacific Data Systems, Inc., Santa Ana, Calif., has developed a new small-scale computer which allows the engineer-scientist to have direct and instantaneous communication with the computer using familiar mathematical terms. A self-contained engineering-oriented keyboard enables the user to easily solve problems ranging from simple equations to more complex iterative problems.

The PDS 1020 contains a 50-character-per-second paper-tape punch and reader as well as an output typewriter. The basic memory is 1024 words and can be expanded to 4096 words.

The second computer, PDS 1068, is a small-scale general-purpose control computer for use in data logging, automatic checkout and control systems. It is a serial-decimal machine with an index register, 31 commands, and parallel input/output. The basic memory is 512 words, expandable to 4096 words. PDS 1068 is an automatic variable field computer of 4, 8, or 12 digits.
(For more information, circle 49 on the Reader Service Card.)

Information Retrieval

ALMOST INSTANT BANKING FOR SAVINGS INSTITUTIONS WITH TELLERTRON

The Tellertron Corp., a wholly-owned subsidiary of Stone Laboratories Inc., Boston, Mass., has put into operation a modular, instantaneous, information-retrieval unit that will allow banks to process the average savings transaction in less than 30 seconds. The machine is not an all-purpose computer but is a "real-time" system of hardware coupled to existing teller equipment, and capable of working alongside already-installed data processing equipment.

Tellertron is capable of memorizing, updating, and feeding back to window tellers, in less than 2/5 of a second, the complete particulars on any one of 250,000 possible active savings accounts. In processing over 3000 accounts per hour, the system can show each teller: the old balance at the time of transaction; the new balance after the transaction has been completed; all previous transactions unrecorded on the passbook; the amount of unposted interest; and any 'stop-payment' information that might be required to cover as-yet-uncleared checks. Tellertron's system can cover outlying branch offices through a simple connection, by telephone wire, of small satellite units to the main console at bank headquarters.
(For more information, circle 50 on the Readers Service Card.)

Input-Output

AUTOMATIC DRAFTING MACHINE

A digitally controlled plotter, the new 1000 Series "automatic drafting machine", has been developed by the Gerber Scientific Instrument Company, South Windsor, Conn. It provides high-accuracy graphic display of digital information on a broad 5 x 12 foot horizontal or vertical plotting surface.

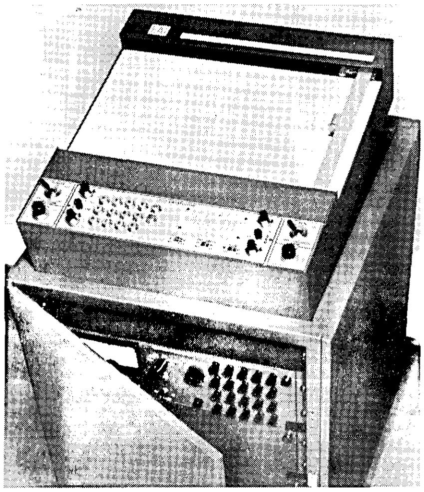
This plotter is able to control the acceleration and deceleration of the print head to provide optimum traversing speed between all data points without need for feed-rate input data. Reversal in both X and Y directions is almost instantaneous. Because the digital logic computes its own maximum feed rate and slow-down points, the only inputs required are: (a) the co-ordinates of the end points of the line, or incremental distance to be traveled; and (b) the pen or symbol commands.
(For more information, circle 51 on the Reader Service Card.)

DIGITAL PLOTTERS

A series of low cost, digital plotters for scientific, industrial and military uses was shown at the Western Electronic Show and Conference (WESCON) last month by Electronic Associates, Inc., Long Branch, N.J. The plotters, designated the 3110-3120-3130 DATA-PLOTTER Series, operate both on-line with a digital computer and from card or paper tape readers. They are capable of plotting points, symbols, or lines at speeds as high as 100 points or 70 lines a minute on a 10" x 15" plotting board.

Information is accepted in the form of three decimal digits plus sign in both X and Y for points and line end points. Input can be from serial or parallel punched-card readers, punched-tape readers, or, as a manual input, from a self-contained adding-machine type keyboard.

The basic Series 3110 DATA-PLOTTER provides a completely integrated system which automatically plots points or symbols from digital information on IBM cards or punched paper tape. The basic Series 3120 DATAPLOTTER also plots lines and it's system includes line

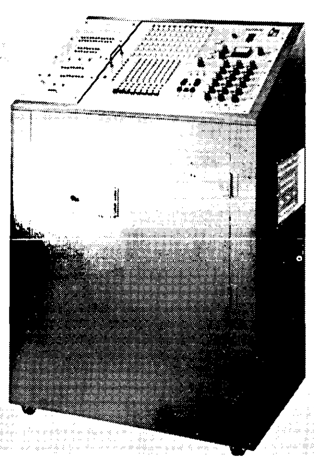


filters which enable the plotter to draw straight lines between two given end points. Series 3130 DATAPLOTTER includes circuitry for the operation of the 3120 on line with a digital computer. Through direct connection of computer and plotter, this series eliminates the need for card or tape preparation.
(For more information, circle 52 on the Readers Service Card.)

Components

DIGITAL MEMORY EXERCISER

Information Storage Systems, Inc., Pompton Lakes, N.J., has recently introduced a system to provide a fast, complete and accurate means of checking digital memory systems. The unit, called the ISS Type 200 Store Exerciser,



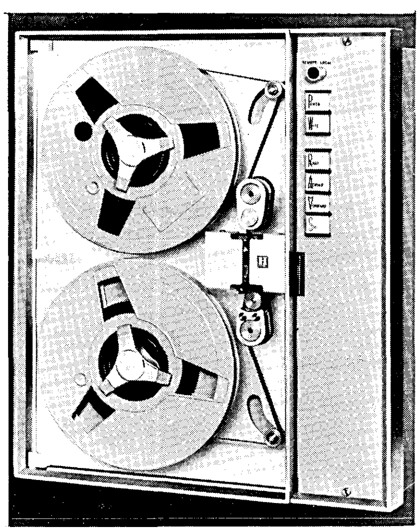
can be used to test random-access digital stores with read-write cycles ranging from 200 nanoseconds to 5 microseconds. 1024 words of 8 bits may be sequenced in various read-write modes and automatically checked. Provision is made for expansion to 4096 bits.

Information is written into the memory by programming an 8x8 switch matrix. Information read out from the store is verified; an error generates a pulse or stops the Exerciser. Error indication shows address, word and bit in error, and its type (early, late, gross). The unit may be programmed to continue after error or skip errors.
(For more information, circle 59 on the Readers Service Card.)

TAPE RECORDER INTRODUCED BY HONEYWELL

Honeywell's Denver Division has introduced a new incremental digital magnetic-tape recorder that can put asynchronous, random data into a form compatible with high-speed computers.

The Honeywell 6200 produces half-inch tapes that can be used directly on 7-track computer tape handlers. It has a packing density of 200 bits per inch, with a bit-spacing accuracy of ±20% non-cumulative, of about double the accuracy required by the computer's tape handler.



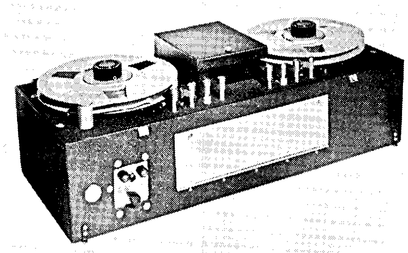
-- Small, compact Honeywell 6200 tape recorder weighs 90 pounds.

The 6200 transport, receiving an external stepping command, moves the tape in increments of 0.005 inch at a maximum speed of 100 steps per second. The stepping rate can be either synchronous or asynchronous up to this speed. A non-return-to-zero (NRZ) method of recording is used. The tape may be rewound or moved in fast-forward at the rate of a full 2400-foot reel in four minutes. Interlocks are used to prevent erasure of data during the fast-forward or rewind operation.

Two photo-sensing devices are mounted on the transport ahead of the recording head. One senses the load-point reflective marker, the other recognizes the end-of-tape marker on the tape. Both stop the transport when markers are recognized during active operation.
(For more information, circle 60 on the Readers Service Card.)

DIGITAL MAGNETIC TAPE TRANSPORT

A new precision digital magnetic tape transport has been developed by S-I Electronics, Inc., Nutley, N.J. It has been designed for airborne, shipboard and vehicular system applications. The device, Model DT-03B-2, is capable of recording and reproducing seven bits of digital information in any standard format on ½", 1", and other tape widths. An eighth track is used for transport control.



The device weighs under 95 pounds, and has high resistance to shock and vibration. Operating temperature ranges are -55° to +55°C at 50,000 feet, and -55° to +71°C at sea level.
(For more information, circle 61 on the Readers Service Card.)

NEW ALPHANUMERIC PRINTING TAPE PUNCH

The new Model 1010AN Alphanumeric Printing Tape Punch, developed by Navigation Computer Corp., Norristown, Pa., is in full production. This model is an expanded version of the 1010C Series Numeric Printing Tape Punches.

The new model Tapewriter has a full 1000-foot tape transport system, easily read bottom-margin printing, 8-hole punching at 10 characters per second, and a full 49-key alphanumeric keyboard with complete EIA Standard nomenclature and coding.

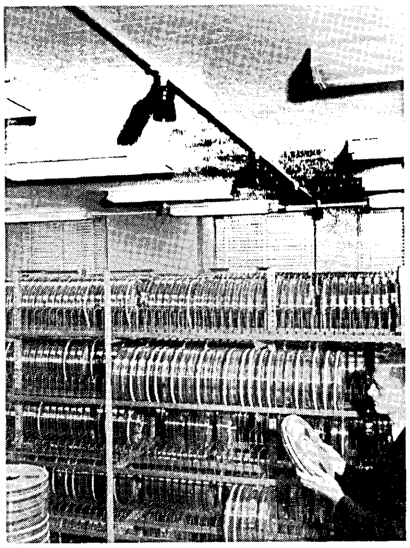
The unit, completely modular in construction, is 75% electronic. It has a printed circuit keyboard and coding matrix. Semiconductor circuitry generates all sequence timing.
(For more information, circle 62 on the Readers Service Card.)

AUTOMATION

AUTOMATIC CARBON DIOXIDE SYSTEM GUARDS COMPUTER TAPES AGAINST FIRE

The electronic data processing center in the New York City executive offices of the Royal-Globe Insurance Companies houses a huge quantity of data for the business of marketing, sales, underwriting and management. Some 7000 reels of magnetic tape are housed in an air-conditioned tape room approximately 31 feet square. Loss of these complex records through fire damage would involve months or even years of reorganization and reprocessing.

An automatic system using carbon dioxide was developed by Walter Kidde & Company, Inc., Belleville, N.J. to protect the computer tapes in the event of fire. Carbon dioxide for the system is stored in eighteen 75-pound cylinders located as a single bank in a nearby closeted space. A simple network of CO_2 piping has been installed in the tape storage room and in an adjacent paper storage room which also presented a hazard. In the event of fire, smoke detectors located in each protected room actuate electric control heads on the CO_2 cylinders. After a short time delay which allows personnel to clear the



-- Computer tape library room of the Royal-Globe Insurance Companies

area, pressure operated trips close dampers in the air-conditioning system and release a large self-closing access door. The carbon dioxide then enters the system piping under its own pressure and vents into the room reporting fire. Blanketing the complete area to its most inaccessible corner, the CO_2 snuffs any blaze in the earliest stages.

The clean, dry, odorless CO_2 leaves no residue after discharge from nozzles (see photograph) mounted on the ceiling pipeline and is carried off harmlessly by the normal ventilation system after the fire is out.
(For more information, circle 63 on the Readers Service Card.)

AIRMAIL EXTRACTING DEVICE

The U.S. Post Office, Washington, D.C. is testing a new technique for speeding up airmail service by the use of an electronic sorting device. This device was developed by the National Cash Register Co., Dayton, Ohio, for the Post Office Dept.'s Office of Research and Engineering in conjunction with the Post Office's R&D staff. The first trial of the system is in the Dayton, Ohio, Post Office.

The device identifies, and automatically sorts to a special bin, all envelopes carrying airmail stamps or stickers imprinted with new "tagging" inks. It will almost instantly separate airmail from a flow of 30,000 pieces of mixed mail an hour. The phosphorescent tagging inks are harmless and do not change either the appearance or the color of the stamps. The specially imprinted stamps and stickers are detected as they pass through the NCR sorting device, by an electronic sensor which responds only to the particular phosphorescent inks used. Tests so far have indicated that fluorescent inks and other materials commonly used in advertising, either on envelopes or inside the mail, do not affect the airmail extractor.

The new device operates with Post Office "facer-canceller" machines, which sort letters so that the stamped portion will face one way and then automatically cancel stamps. The extractor is attached to the front end of the facer-canceller unit. It "excites" the phosphorescent inks and makes a high-speed selection through logic circuitry. Electrical impulses generated by the sensing unit operate a mechanical switching gate to shift mail into the airmail bin or let it continue through the facer-canceller. The gate swings into position for each envelope in a few thousandths of a second.
(For more information, circle 33 on the Readers Service Card.)

MEETING NEWS

IFIP CONGRESS 65 SET FOR NEW YORK CITY

The United States will be host to the third triennial global conference of information processing scientists. IFIP Congress 65, sponsored by the International Federation for Information Processing, is scheduled at the New York Hilton Hotel, May 24-29, 1965. In association with IFIP Congress 65, the Interdata 65 exhibition is expected to display more than $15 million worth of advanced electronic information processing systems.

Detailed plans have been developed by all committees under the direction of the Conference Chairman, Dr. Werner Buchholz of IBM Development Laboratories, Poughkeepsie, N.Y. He is assisted by Vice Chairman, William R. Lonergan, of the Univac Division of Sperry Rand Corporation, New York City. Because of the global nature of the conference, these plans will be reviewed for final policy decision at an IFIP Council Meeting in Gola, Norway, this September.

IFIP Congress 65 will present a technical program designed as a comprehensive survey of the latest achievements in the information processing sciences. The Program Committee is headed by Borje Langefors of the Swedish Society for Information Processing. Vice Chairman is Dr. Alston S. Householder of Oak Ridge National Laboratory, USA.

While the technical program will present results of new research and development of new techniques in the handling of information by computers, the actual equipment, including digital and analog computers, information storage systems, input-output systems, data communications equipment, and advanced components, will be on operational display in Interdata 65, the IFIP Congress Exhibition. Exhibits Chairman is Dr. Don Thomsen of IBM Corporation, White Plains, New York. He expects displays to occupy more than 30,000 square feet of exhibition space at the New York Hilton. A special feature of IFIP Congress 65 will be an Information Sciences Cinema, showing an international selection of the best motion pictures about this field.
(For more information, circle 64 on the Readers Service Card.)

STANDARDS NEWS

INFORMATION INTERCHANGE CODE APPROVED AS AMERICAN STANDARD

A code for information interchange between business machines and computers has been approved as an American Standard. The new computer and communications code, formerly known as pASCII (proposed American Code for Information Interchange) was approved under the procedures of the American Standards Association, as the formally designated "American Standard Code for Information Interchange, X3.4-1963".

Charles A. Phillips, director of the Business Equipment Manufacturers Association's Data Processing Group, which sponsored the development of the code, estimates that the four-year effort to develop the new standard represents an investment of $3-million.

Work was started on the new standard when it became evident that the five-channel punched paper tape and other codes in common use did not offer a sufficient number of combinations of holes or characters to accommodate the increasingly complex needs of modern data processing and equipment.

A five channel tape, for example, can record only 32 different symbols per character position (by punching a combination of one or more holes) -- not even enough to record in single character positions a complete alphabet and ten numbers. The new code, on the other hand, with its combination of seven holes per position can provide 128 different combinations. This will enable the new code to handle a wide variety of special symbols in addition to the complete alphabet and numbers.

The new standard identifies each of the 128 possible character codes in binary number language and assigns to each code an alphabetic, numerical, or special symbol or equipment control function, such as carriage return, horizontal tab and delete. It also makes provision for expansion by leaving 28 codes unassigned.

Work is continuing, to develop further extensions of the standard by representation of the coded character set in the principal information interchange media (punched tape, magnetic tape and punched cards), and for error control considerations, collating conventions, relation of the standard set to other sets, and assignment of the unassigned codes as required.

The new standard is the second to receive official ASA approval under BEMA sponsorship. Two proposed standards on magnetic character recognition are being processed at ASA, and 25 others are in some stage of development. (see Computers and Automation, July, 1963, page 11)
(For more information, circle 65 on the Readers Service Card.)

ASA EXPECTS PROGRAMMING LANGUAGE STANDARDS BY 1965

A global standard spelling out the details of programming languages for data processing machines and computers may be a certainty by the summer of next year, according to an optimistic report from the American Standards Association. The ASA expects experts from 10 nations of the world to put the finishing touches on programming languages of ALGOL, COBOL and FORTRAN in time for a mid-May committee meeting mext year in New York. If all goes well at this point, a global standard may be a reality in 1965.

Steps indicating prompt committee action came this June in Berlin when delegates from eight nations surveyed the progress of programming languages standards. Meeting as subcommittee 5 (programming languages) of Technical Committee 97, Computers and Information Processing, of the International Organization for Standardization (ISO), experts paved the way for balloting in '64 on the language proposals.

Plans now call for the International Federation for Information Processing (IFIP) to coordinate committee documents and make proposals on an ALGOL subset (to allow for efficient implementation of the language), input-output facilities and graphics and media codes of ALGOL program symbols for punched cards and punched tapes in time for the '64 meeting. Delegates indicated that international recommendations expect to establish both ALGOL and FORTRAN for scientific use and COBOL for general business use.

In other action, delegates said a review of the COBOL 61 language would hopefully eliminate conflicts between the COBOL report and practices carried out by the member-nations of the full technical committee. U.S. representatives are continuing their study in this area, with some test problems expected for presentation at next year's plenary session in New York.

The subcommittee also approved formation of a sub-group to streamline operations and evaluate criteria for any programming language to be considered as a candidate for approval as an ISO Recommendation or global standard.

Delegations from France, Germany, Denmark, Italy, Netherlands, Sweden, United Kingdom and the U.S. were present at the three-day meeting chaired by R. F. Clippinger of Minneapolis-Honeywell Regulator Company, Wellesley Hills, Massachusetts.
(For more information, circle 66 on the Readers Service Card.)

BUSINESS NEWS

SPERRY RAND'S PROFITS IMPROVE; UNIVAC ORDERS UP 50%

First quarter profit of Sperry Rand Corp. rose to $4,843,000 from $3,467,169 a year earlier, H. F. Vickers, president and chief executive officer reported.

Sales rose to $298,325,000 from $280,816,331 in the period ended June 30.

Mr. Vickers said earnings for the fiscal year ending March 31, 1964, will be "at least twice those of last year". In fiscal 1963 Sperry Rand had net earnings of $13,834,794.

Mr. Vickers said that the company's Univac division is "increasing its production and deliveries very rapidly this year".

He said Univac's present backlog of commercial orders "exceeds last year's by 50%, and is sufficient to assure the success of all our programs". New orders are coming in faster than last year, he added.

Mr. Vickers said the company is producing 100 of the new Univac 1004 card processors a month, and expects production to reach 150 in September. The machine was put into production last year, and the first models were delivered in February.

George M. Bunker, president of Martin Marietta Corp. and a Sperry Rand director, said Martin Marietta holds "about one million shares," of Sperry Rand as an investment, and has no plans to acquire Sperry Rand's data processing business. He said Martin Marietta bought the shares because it "wants to have an interest in the data processing business," but not to acquire any data processing companies.

IBM INCOME UP 15.4%

For the six months ended June 30, 1963, IBM reports net earnings of $134,247,030. This is an increase of 15.4% over the $116,309,000 reported for the same period last year.

Gross income for the six months ended June 30, 1963, from sales, service and rentals in the

United States amounted to $996,-111, 391 compared with $931,705,051 in the corresponding 1962 period, an increase of 6.9%. Gross income from IBM regular products showed an increase of 11.4%. Military products gross income showed a 26.6% decrease compared with the first six months of 1962. This decrease reflects a reduction in supply or production type contracts and a greater emphasis toward research and development contracts, the company said.

NCR'S SIX-MONTH SALES UP

Sales of the National Cash Register Company for the first six months of 1963 totaled $270,494,818, up from $259,106,842 for the comparable period in 1962, according to Robert S. Oelman, chairman and president.

Net income was $7,722,755, compared with $8,580,750 reported for the first half of last year.

Mr. Oelman attributed the lower earnings to the fact that during the first half of 1963 the company delivered its greatest volume of electronic data processing equipment for any six-month period. "The heavy installation costs of these systems, most of which are rented and therefore result in a deferment of income, more than offset the positive effect of increased sales volume."

"This is characteristic of the computer industry during the early stages of a market penetration," Mr. Oelman said. "Although the favorable reception of NCR's electronic data processing equipment tends to adversely affect earnings initially, the longer-range implications are encouraging both in terms of income stability and improved profit margins."

NCR has now installed over 500 computer systems in banks, industrial and commercial companies, retail stores, and government agencies, Mr. Oelman said. This is double the number of EDP systems which the company had delivered a year ago.

Incoming orders for computer equipment during the first half of 1963 exceeded those for any other six-month period, Mr. Oelman said, and the backlog for such equipment is also substantially higher than at any previous time.

Mr. Oelman said that abroad, where the impact of computer deliveries is not yet as widespread as in the United States, earnings after foreign taxes rose 6% -- from $7,198,656 for the first six months of last year to $7,608,252 in the current period.

BENSON-LEHNER REPORTS PROFITS

Benson-Lehner Corp., makers of equipment for the conversion of data and graphic information, estimates it earned just over $270,000 in the year ended March 31, against a loss of nearly $1.3 million in fiscal 1962.

The fiscal 1963 improvement came on sales of approximately $3,650,000, down slightly from 1962's $3,859,277. In addition to volume from the present product line, Benson-Lehner expects to realize this coming year about $1 million in sales and at least $100,000 in earnings from two new products, a tape-operated typewriter and a high-speed printer-plotter.

DATA PRODUCTS SALES, EARNINGS, BACKLOG JUMP

Data Products Corporation, Culver City, Calif., reports results of operations for the first quarter ended June 29, 1963, showing sales of $1,282,758, earnings of $46,040, and an order backlog of $3,943,545.

In commenting on the performance gains, Erwin Tomash, President, pointed out that results showed improvement over the comparable period of a year ago when sales of $397,836, resulted in a loss of $498,488, and over the immediately preceding quarter when the company announced earnings of $6,569 vs. sales of $1,179,287.

Tomash also disclosed backlog increases in each of the company's product divisions and in the wholly owned subsidiary, Informatics Inc.

THOMPSON RAMO PROFITS SET 6-YEAR MARK

Sales of Thompson Ramo Wooldridge, Inc., set a record in the second quarter, and earnings were the highest since the second quarter of 1957.

Sales in the latest quarter edged up to $122,730,309 from $119,919,624 in the 1962 period. Profit rose to $3,976,207, from the year-earlier $3,536,500.

In the second quarter of 1957, profit was $4,600,000.

Sales in the first half rose to a record $240,081,345 from $231,589,854 a year earlier. Profit increased to $7,066,956, from $6,414,666, in the 1962 half.

J. D. Wright, chairman and chief executive officer, and H. A. Shepard, president, said, "At no time in recent years have all major segments of our business looked as favorable as they appear at midyear." They said the company, whose business is in computers as well as in aerospace technology, electronics and automative products, is expected to have record sales in 1963.

FARRINGTON MFG. REDUCES OPERATING LOSS

Farrington Manufacturing Co. had a substantial reduction in its operating loss in the first half from the like 1962 period. The maker of optical readers, business identification systems and printed circuits had a loss of $551,074 in the first half, compared with a loss of $1,599,121 a year earlier. Sales dropped to $6,093,762 from $7,324,717 in the 1962 half.

In all 1962, Farrington lost $2,997,040 on sales of $12,578,800.

Farrington reports it has a substantial order backlog, mostly for optical readers, but it didn't disclose the amount. There are 95 Farrington optical readers in operational use. Farrington Machines represent over 90% of total optical readers in operation.

CALENDAR OF COMING EVENTS

Sept. 9-11, 1963: 7th National Convention on Military Electronics (MIL-E-CON 7), Shoreham Hotel, Washington, D. C.; contact L. D. Whitelock, Exhibits Chairman, 5614 Greentree Road, Bethesda 14, Md.

Sept. 9-12, 1963: 18th Annual ISA Instrument-Automation Conference & Exhibit, McCormick Place, Chicago, Ill.

Sept. 9-12, 1963: International Symposium on Analog and Digital Techniques Applied to Aeronautics, Liege, Belgium; contact M. Jean Florine, 50, Avenue F. D. Roosevelt, Brussels 5, Belgium.

Sept. 16-20, 1963: 2nd Institute on Electronic Information Display Systems, The American University, SGPA, The Center for Technology and Administration, 1901 F St., N.W., Washington 6, D. C.; contact Dr. Lowell H. Hattery, The American University, Washington 6, D. C.

Sept. 18-20, 1963: Philco 2000 Computer Users Group Meeting, (TUG) Mayflower Hotel, Washington, D. C.; contact E. D. Reilly, Jr., TUG Secretary, General Electric Co., Box 1072, Schenectady, N. Y.

Sept. 23-27, 1963: International Telemetering Conference, London Hilton Hotel, London, England; contact F. G. McGavock Associates, 3820 E. Colorado Blvd., Pasadena, Calif.

Oct., 1963: 10th Annual Meeting, PGNS 2nd International Symposium on Aerospace Nuclear Prop. and Power

Oct. 1-3, 1963: 8th Annual National Space Electronics Symposium, Hotel Fontainebleau, Miami Beach, Fla.; contact Hugh E. Webber, Martin Co., Orlando, Fla.

Oct. 6-11, 1963: 26th Annual Meeting of the American Documentation Institute, Pick-Congress Hotel, Chicago, Ill.; contact Executive Secretariat, American Documentation Institute, 1728 N St., N.W., Washington 36, D. C.

Oct. 7-9, 1963: 9th National Communications Symposium, Hotel Utica, Utica, N. Y.

Oct. 8-11, 1963: Int'l on Electromagnetic Relays, Tohoku University, Sendai, Japan; contact C. F. Cameron, School of Eng., Oklahoma State University, Stillwater, Okla.

Oct. 14-15, 1963: Materials Handling Conference, Chamberlain Hotel, Newport News, Va.; contact R. C. Tench, C & O Rlwy Co., Rm. 803, C & O Bldg., Huntington 1, W. Va.

Oct. 14-16, 1963: Systems and Procedures Association, 16th International Systems Meeting, Hotel Schroeder, Milwaukee, Wis.; contact Systems & Procedures Association, 7890 Brookside Dr., Cleveland 38, Ohio

Oct. 17, 1963: 4th Annual Technical Symposium, University of Maryland, College Park, Md.; contact Hugh Nichols, Dunlap & Associates, Inc., 7220 Wisconsin Ave., Bethesda, Md.

Oct. 21-23, 1963: East Coast Conference on Aerospace & Navigational Electronics (ECCANE), Baltimore, Md.

Oct. 24-25, 1963: Symposium on Automatic Production in Electrical and Electronic Engineering, The Institution of Electrical Engineers, Savoy Place, London W. C. 2, England

Oct. 28-30, 1963: 19th Annual National Electronics Conference and Exhibition, McCormick Place, Chicago, Ill.; contact Prof. Hansford W. Farris, Electrical Engineering Dept., Univ. of Mich., Ann Arbor, Mich.

Oct. 28-Nov. 1, 1963: Business Equipment Manufacturers Assn. Exposition and Conference, New York Coliseum, New York, N. Y.; contact Richard L. Waddell, BEMA, 235 E. 42nd St., New York 17, N. Y.

Oct. 29-31, 1963: 10th Annual Mtg. PGNS 2nd Intn'l Symposium on Plasma Phenomena & Meas., El Cortez Hotel, San Diego, Calif.; contact H. A. Thomas, Gen. Atomics Div., Genl. Dynamics, San Diego, Calif.

Nov. 4-6, 1963: NEREM (Northeast Research and Eng. Meeting), Boston, Mass.; contact NEREM-IRE Boston Office, 313 Washington St., Newton, Mass.

Nov. 4-8, 1963: 10th Institute on Electronics in Management, The American University, 1901 F St., N.W., Washington 6, D. C.; contact Marvin M. Wofsey, Asst. Director, Center for Technology and Administration, The American University, Washington 6, D. C.

Nov. 10-15, 1963: 9th Annual Conference on Magnetism and Magnetic Materials, Chalfonte-Haddon Hall, Atlantic City, N. J.; contact Mr. C. J. Kriessman, Physics, Materials and Processes Sec., Box 500, Blue Bell, Pa.

Nov. 12-14, 1963: Fall Joint Computer Conference, Las Vegas Convention Center, Las Vegas, Nev.; contact Mr. J. D. Madden, System Development Corp., Santa Monica, Calif.

Nov. 18-20, 1963: 1963 Radio Fall Meeting, Manger Hotel, Rochester, N. Y.; contact EIA Engineering Dept., Room 2260, 11 W. 42 St., New York 36, N. Y.

Nov. 18-20, 1963: 16th Annual Conference on Engineering in Medicine and Biology, Lord Baltimore Hotel, Baltimore, Md.; contact Richard Rimbach Associates, 933 Ridge Ave., Pittsburgh 12, Pa.

Nov. 18-22, 1963: Institute on Patent Incentives, The American University, 1901 F St., N.W., Washington 6, D. C.; contact Marvin M. Wofsey, Asst. Director, Center for Technology and Administration, The American University, Washington 6, D. C.

Nov. 19-21, 1963: Fifth International Automation Congress and Exposition, Sheraton Hotel, Philadelphia, Pa.; contact International Automation Congress & Exposition, Richard Rimbach Associates, Management, 933 Ridge Ave., Pittsburgh 12, Pa.

Dec. 5-6, 1963: 14th Nat'l Conference on Vehicular Communications, Dallas, Tex.; contact A. C. Simmons, Comm. Industries, Inc., 511 N. Akard, Dallas, Tex.

Feb. 3-7, 1964: ASTM International Conference on Materials, Sheraton Hotel, Philadelphia, Pa.; contact H. H. Hamilton, American Society for Testing and Materials, 1916 Race St., Philadelphia 3, Pa.

Feb. 5-7, 1964: 5th Winter Conv. on Military Electronics (MILECON), Ambassador Hotel, Los Angeles, Calif.; contact IEEE L. A. Office, 3600 Wilshire Blvd., Los Angeles, Calif.

Feb. 10-14, 1964: 6th Institute on Information Storage and Retrieval, The American University, 1901 F St., N.W., Washington 6, D. C.; contact Marvin M. Wofsey, Asst. Director, Center for Technology and Administration, The American University, Washington 6, D. C.

Feb. 12-14, 1964: International Solid-States Circuits, Sheraton Hotel & Univ. of Pa.

Feb. 26-28, 1964: Scintillation and Semiconductor Counter Symposium, Washington, D. C.

Mar. 23-26, 1964: IRE International Convention, Coliseum and New York Hilton Hotel, New York, N. Y.; contact E. K. Gannett, IRE Hdqs., 1 E. 79 St., New York 21, N. Y.

Apr. 21-23, 1964: 1964 Spring Joint Computer Conference, Sheraton-Park Hotel, Washington, D. C.; contact Zeke Seligsohn, Pub. Rel. Chairman, 1964 SJCC, 326 E. Montgomery Ave., Rockville, Md.

Apr. 22-24, 1964: SWIRECO (SW IRE Conf. and Elec. Show), Dallas Memorial Auditorium, Dallas, Tex.

May 11-13, 1964: National Aerospace Electronics Conference (NAECON), Dayton, Ohio; contact IEEE Dayton Office, 1414 E. Third St., Dayton, Ohio

MONTHLY COMPUTER CENSUS

The number of electronic computers installed, or in production at any one time has been increasing at a bewildering pace in the past several years. New vendors have come into the computer market, and familiar machines have gone out of production. Some new machines have been received with open arms by users -- others have been given the cold shoulder.

To aid our readers in keeping up with this mushrooming activity, the editors of COMPUTERS AND AUTOMATION present this monthly report on the number of American-made general purpose computers installed or on order as of the preceding month. We update this computer census monthly, so that it will serve as a "box-score" of progress for readers interested in following the growth of the American computer industry.

Most of the figures are verified by the respective manufacturers. In cases where this is not so, estimates are made based upon information in the reference files of COMPUTERS AND AUTOMATION. The figures are then reviewed by a group of computer industry cognoscenti.

Any additions, or corrections, from informed readers will be welcomed.

AS OF AUGUST 20, 1963

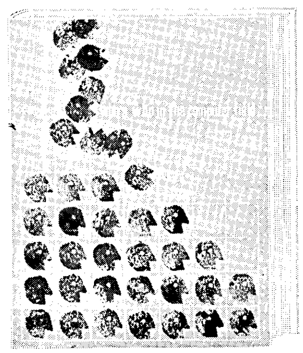
NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
Addressograph-Multigraph Corporation	EDP 900 system	Y	$7500	2/61	18	10
Advanced Scientific Instruments	ASI 210	Y	$2850	4/62	9	3
	ASI 420	Y	$12,500	2/63	1	X
Autonetics	RECOMP II	Y	$2495	11/58	115	X
	RECOMP III	Y	$1495	6/61	28	X
Burroughs	205	N	$4600	1/54	62	X
	220	N	$14,000	10/58	48	X
	E101-103	N	$875	1/56	154	X
	B250	Y	$4200	11/61	58	30
	B260	Y	$3750	11/62	43	42
	B270	Y	$7000	7/62	28	25
	B280	Y	$6500	7/62	27	23
	B5000	Y	$16,200	3/63	9	20
Clary	DE-60/DE-60M	Y	$525	2/60	131	4
Computer Control Co.	DDP-19	Y	$2800	6/61	3	X
	DDP-24	Y	$2750	5/63	1	10
	SPEC	Y	$800	5/60	10	0
Control Data Corporation	G-15	N	$1000	7/55	300	1
	G-20	Y	$15,500	4/61	23	2
	160/160A	Y	$1750/$3000	5/60 & 7/61	310	30
	924/924A	Y	$11,000	8/61	12	10
	1604/1604A	Y	$35,000	1/60	53	8
	3600	Y	$52,000	6/63	2	9
	6600	Y	$120,000	2/64	0	1
Digital Equipment Corp.	PDP-1	Y	Sold only about $120,000	11/60	42	9
	PDP-4	Y	Sold only about $60,000	8/62	16	10
	PDP-5	Y	Sold only about $25,000	11/63	0	2
El-tronics, Inc.	ALWAC IIIE	N	$1820	2/54	32	X
General Electric	210	Y	$16,000	7/59	75	5
	215	Y	$5500	-/63	0	22
	225	Y	$7000	1/61	140	60
	235	Y	$10,900	-/64	0	5
General Precision	LGP-21	Y	$725	12/62	42	38
	LGP-30	semi	$1300	9/56	405	5
	L-3000	Y	$45,000	1/60	1	0
	RPC-4000	Y	$1875	1/61	101	10
Honeywell Electronic Data Processing	H-290	Y	$3000	6/60	10	1
	H-400	Y	$5000	12/61	59	42
	H-800	Y	$22,000	12/60	52	9
	H-1400	Y	$14,000	5/64	0	5
	H-1800	Y	$30,000 up	11/63	0	2
	DATAmatic 1000	N	-	12/57	5	X

NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
H-W Electronics, Inc.	HW-15K	Y	$490	6/63	1	2
IBM	305	N	$3600	12/57	685	X
	650-card	N	$4000	11/54	590	X
	650-RAMAC	N	$9000	11/54	150	X
	1401	Y	$3500	9/60	5900	2700
	1410	Y	$12,000	11/61	220	300
	1440	Y	$1800	4/63	50	1050
	1460	Y	$9800	10/63	0	105
	1620	Y	$2000	9/60	1310	220
	701	N	$5000	4/53	2	X
	7010	Y	$19,175	2/64	0	36
	702	N	$6900	2/55	2	X
	7030	Y	$160,000	5/61	6	X
	704	N	$32,000	12/55	71	X
	7040	Y	$14,000	6/63	10	42
	7044	Y	$26,000	6/63	3	14
	705	N	$30,000	11/55	130	X
	7070, 2, 4	Y	$24,000	3/60	430	130
	7080	Y	$55,000	8/61	52	24
	709	N	$40,000	8/58	22	X
	7090	Y	$64,000	11/59	280	77
	7094	Y	$70,000	9/62	12	16
	7094 II	Y	$76,000	4/64	0	2
Information Systems, Inc.	ISI-609	Y	$4000	2/58	19	1
ITT	7300 ADX	Y	$35,000	7/62	6	3
Monroe Calculating Machine Co.	Monrobot IX	N	Sold only - $5800	3/58	175	2
	Monrobot XI	Y	$700	12/60	265	207
National Cash Register Co.	NCR - 102	N	-	-	24	X
	- 304	Y	$14,000	1/60	29	0
	- 310	Y	$2000	5/61	41	35
	- 315	Y	$8500	5/62	82	130
	- 390	Y	$1850	5/61	300	310
Packard Bell	PB 250	Y	$1200	12/60	145	15
	PB 440	Y	$3500	11/63	0	10
Philco	1000	Y	$7010	6/63	3	18
	2000-212	Y	$52,000	1/63	2	7
	-210, 211	Y	$40,000	10/58	21	8
Radio Corp. of America	Bizmac	N	-	-/56	4	X
	RCA 301	Y	$6000	2/61	295	200
	RCA 501	Y	$15,000	6/59	72	10
	RCA 601	Y	$35,000	11/62	2	3
Scientific Data Systems Inc.	SDS-910	Y	$1700	8/62	17	41
	SDS-920	Y	$2690	9/62	13	15
	SDS-9300	Y	$8000	1/64	0	1
Thompson Ramo Wooldridge, Inc.	TRW-230	Y	$2680	7/63	0	8
	RW-300	Y	$6000	3/59	37	2
	TRW-330	Y	$5000	12/60	11	18
	TRW-340	Y	$6000	12/63	0	4
	TRW-530	Y	$6000	8/61	18	6
UNIVAC	I & II	N	$25,000	3/51 & 11/57	51	X
	Solid-State II	Y	$8500	9/62	25	9
	III	Y	$20,000	8/62	27	24
	File Computers	N	$15,000	8/56	60	0
	60 & 120	N	$1200	-/53	860	8
	Solid-state 80, 90, & Step	Y	$8000	8/58	400	20
	490	Y	$26,000	12/61	14	27
	1004	Y	$1500	2/63	100	1475
	1050	Y	$7200	9/63	0	10
	1100 Series (except 1107)	N	$35,000	12/50	25	X
	1107	Y	$45,000	10/62	6	12
	LARC	Y	$135,000	5/60	2	X
X -- no longer in production				TOTALS	15,502	7810

here it is!

who's who in the computer field -'63/'64

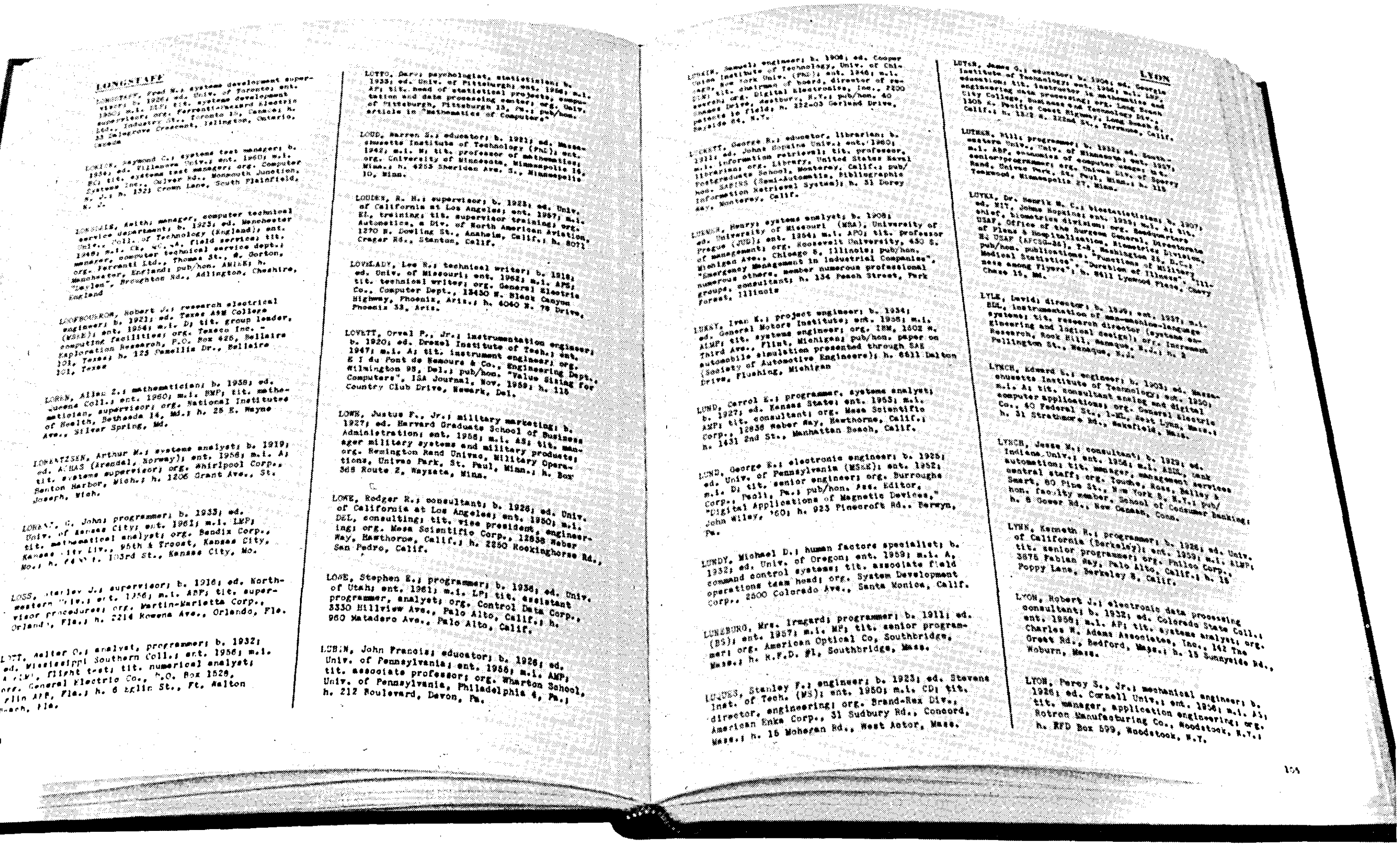
A new comprehensive edition of the **WHO'S WHO IN THE COMPUTER FIELD** is available. This is the first edition in over five years. All entries are complete and accurate as of January, 1963. This handsome, clothbound book is the standard biographical reference on over 5000 leaders in **computer applications/ design/ education/ logic/ mathematics/ marketing/ programming/ systems analysis**



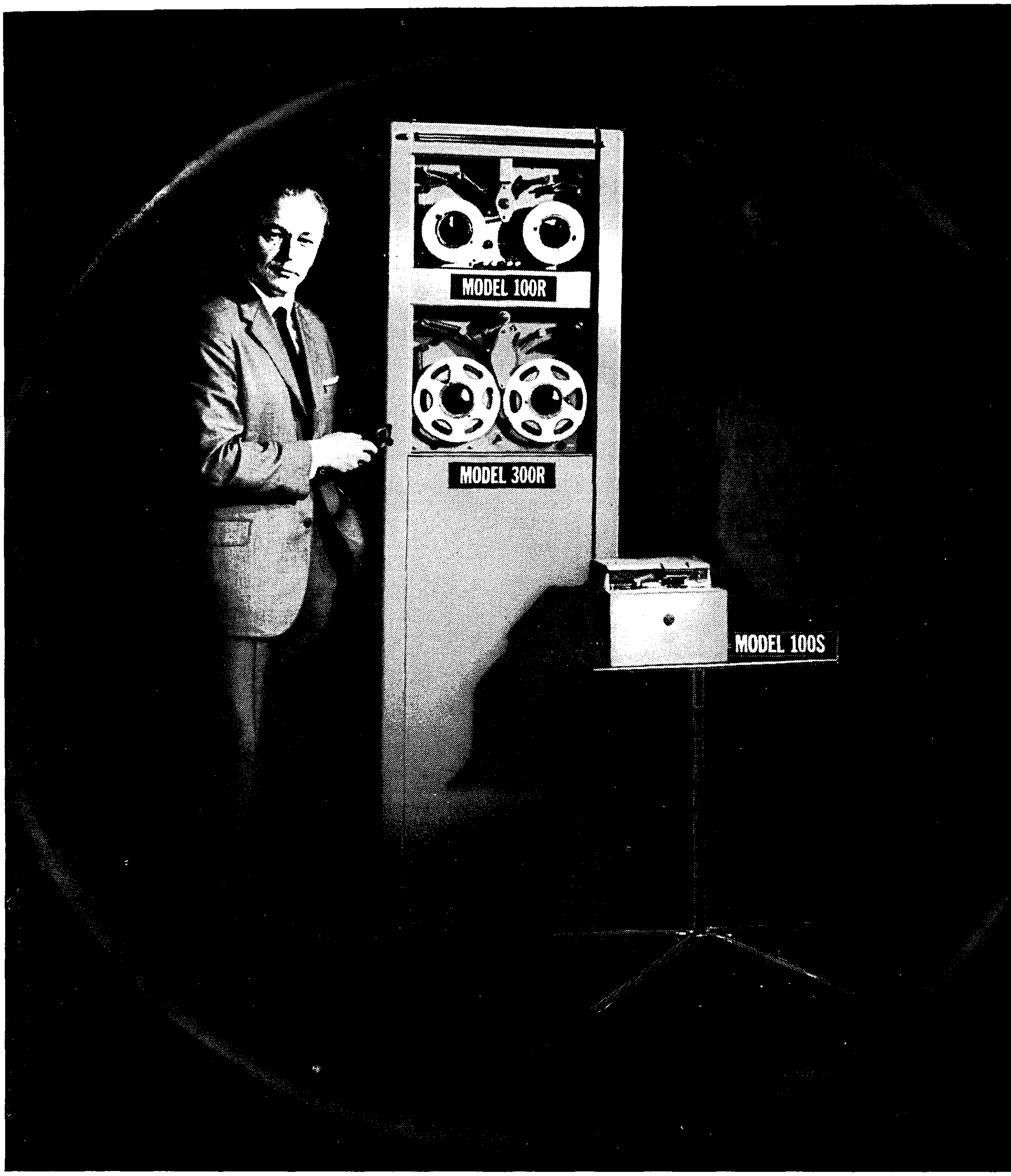
This is the answer book for such questions as:
Where did he get his degree?
How do you spell his name?
What is his home address?
Where is he working?
What is his job title?
What are his interests in the computer field?
What papers has he given?
What books has he written or edited?
To what societies does he belong?
In what year was he born?

Regular price: $24.95. Price to subscribers to Computers and Automation: $18.75. Full refund within ten days if not completely satisfied with the usefulness of this volume. To order your copy, send a check or purchase order to:

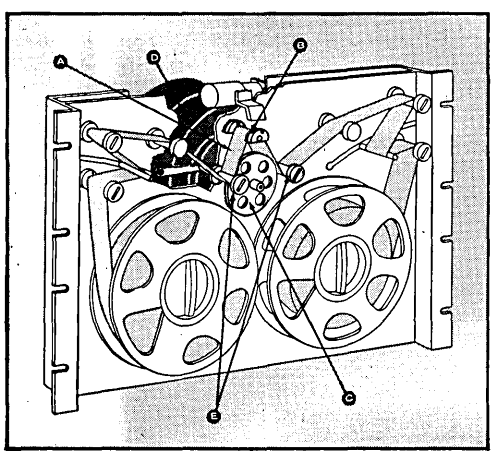
Who's Who in the Computer Field, Attn: Order Section
815 Washington Street, Newtonville 60, Mass.



Circle No. 7 on Readers Service Card →



WHAT MAKES THESE TAPE READERS THE BEST IN THE WORLD?



Mechanical simplicity . . . which yields a degree of reliability unattainable by any other paper tape reader! Simplicity made possible through the utilization of the revolutionary PMI printed motor direct drive servo. Movement of the tape through the read head is achieved by merely starting and stopping a printed motor. The brakes, clutches and pinch rollers that cause big trouble and down time in conventional tape transports are completely eliminated.

Line by line cycle: movement of tape (A) over read head (B) is controlled by drive capstan (C)—attached directly to shaft of PMI printed motor* (D); spring-loaded rollers (E) hold tape gently against capstan, keeping tape movement in exact accord with capstan rotation; advance command pulse accelerates motor, capstan, and tape; as read head detects next sprocket hole, a reverse pulse to motor halts capstan and tape with next character perfectly aligned in read head. **U.S. Patents of Printed Motors, Inc. Pending.*

PHONE, WIRE OR WRITE FOR COMPLETE INFORMATION

Photocircuits
CORPORATION
TAPE READER DIVISION
Glen Cove, N. Y.

BOOKS AND OTHER PUBLICATIONS

Moses M. Berlin

Allston, Mass.

We publish here citations and brief reviews of books and other publications which have a significant relation to computers, data processing, and automation, and which have come to our attention. We shall be glad to report other information in future lists if a review copy is sent to us. The plan of each entry is: author or editor / title / publisher or issuer / date, publication process, number of pages, price or its equivalent / comments. If you write to a publisher or issuer, we would appreciate your mentioning **Computers and Automation.**

Stires, David M., and Maurice M. Murphy / Program Evaluation Review Technique (PERT) and Critical Path Method (CPM) / Materials Management Institute, Cahners Bldg., 221 Columbus Ave., Boston 16, Mass. / 1962, photooffset, 286 pp, price?

This text elaborates upon material presented in a three-day formal PERT/CPM course, and although it is "not intended to serve as a primary source of instruction"; it is a useful book, whether as an adjunct to the lectures and practical problems presented during the course, or independently. The main purpose of this text is to describe the concept of PERT, and then suggest how management might turn this concept to practical use. Nine unnumbered sections are devoted to PERT, and six to CPM. Included among these are: "What is PERT," "Basic Network Terms," "Manual Calculations," and "Using PERT—A Simulated Problem." Re: CPM, the following sections are included: "History," "Basic Concept of CPM," and "Present Uses and Future Developments." There is a glossary of PERT terms. Five appendices, one of which lists selected references.

Simonton, Wesley, editor, and 13 contributors / Information Retrieval Today / Center for Continuation Study, University of Minnesota, Minneapolis, Minn. / 1963, photooffset, 176 pp, price?

This work contains the papers presented at the Institute conducted by the Library School and the Center for Continuation Study, Univ. of Minnesota, Sept. 19-22, 1962. In planning this institute, the editor states, the goal has been "to present a well-rounded picture of the present state of information retrieval, with attention given to the theory and practice both of traditional methods and of newer, 'non-conventional' methods . . ." Thirteen papers are presented and include: "The Propaedeutic of the New Librarianship," "Graphic Aids for Information Retrieval," "Machine Literature Searching at Western Reserve University," and "The Librarian and the Machine." Table of contents and list of figures, but no index.

Bukstein, Ed / Basic Servomechanisms / Holt, Rinehart and Winston, Inc., 383 Madison Ave., New York 17, N. Y. / 1963, printed, 190 pp, $5.25

Directed to the electronics technician, the emphasis in this book is on principles of operation rather than on design factors and procedures. Chapter 1, "Closed-Loop Control Systems," is introductory in nature and establishes the frame of reference for the rest of the book. Chapters 2, 3, and 4 are devoted to error-detecting devices: potentiometers, transducers, and synchros, respectively. Chapter 5 deals with error correctors. Chapters 6, 7, 8, and 9 are concerned with error amplifiers: vacuum tube, transistor, magnetic, and rotary, respectively. Stabilization techniques are covered in Chapter 10, and practical applications of servomechanisms are described in Chapter 11. A summary and a list of questions included at the end of each chapter. Index.

McCracken, Daniel D. / A Guide to ALGOL Programming / John Wiley & Sons, Inc., 440 Park Ave. S., New York 16, N. Y. / 1962, printed, 106 pp, $3.95

This paperback is written for people who wish to get a rapid grasp of the use of a computer; by the use of ALGOL, or a similar programming language, many of the details of computer operation do not need to be learned. The book also explains the fundamental idea of an algorithm. The book is organized so that the reader can select only the material he needs. Chapters 1 to 3 give a quick view of programming. Chapter 4, "The for-Statement," and chapter 5, "Subscripted Variables" develop the remaining information needed for the majority of applications. The eighth and final chapter, "Input and Output," suggests input and output methods for the person who has no actual system to study. Exercises at the end of each chapter. An appendix, "Answers to Selected Exercises," and an index are included.

Maynard, H. B., William M. Aiken, and J. F. Lewis / Practical Control of Office Costs / Management Publishing Corp., 22 West Putnam Ave., Greenwich, Conn. / 1960, printed, 160 pp, price?

This book is written for the manager who is trying to reduce his office costs without introducing expensive office automation equipment. The authors believe it is possible to do this because of work done in the field of work measurement. The essential procedure for attaining office cost control is known as Universal Office Controls, and the authors describe it fully in this work. Ten chapters include: "Eight Ways to Use Universal Office Controls," "Ten Questions that Test the Efficiency of Your Office," "How to Establish Effective Methods in the Office," and "Universal Office Controls Standard Data."

Kemp, Barron / Fundamentals of Magnetic Amplifiers / Howard W. Sams & Co., Inc., Indianapolis 6, Indiana / 1962, printed, 127 pp, $2.95

"Magnetic Amplifiers," "Reactor Cores," "Rectifiers," "Magnetic Amplifier Design," "Testing Magnetic Amplifiers" and "Applications"—are the six chapters of this paperback, published as an introductory and easily understandable text on saturable-core reactors and magnetic amplifier devices. Appendix 1 lists AIEE Standards for Presentation of Core-Material Data; Appendix 2, a glossary. Index.

NEW PATENTS

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

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

June 4, 1963

3,092,690 / Edmunds A. Rolley, Glenview, Ill. / Automatic Electric Labs., Inc., Northlake, Ill., a corp. of Delaware / High Speed Data Transmission System.

3,092,808 / Henry J. Wychorski, Hyattsville, and Perry M. Roberts, West Hyattsville, Md. / ACF Industries, Inc., New York, N. Y., a corp. of New Jersey / Continuously Variable Digital Delay Line.

3,092,809 / Phillip E. Merritt, Menlo Park, and Carroll M. Steele, Mountain View, Calif. / General Electric Co., a corp. of New York / Spurious Signal Suppression in Automatic Symbol Reader.

3,092,810 / Lothar M. Schmidt, Glendale, Calif. / General Precision, Inc., a corp. of Delaware / High Speed Tape Memory System.

3,092,811 / George J. Saxenmeyer, Vestal, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of New York / Data Input Device.

3,092,812 / Thomas D. Rossing, St. Paul, Arthur V. Pohm, White Bear Lake, and Sidney M. Rubens, St. Paul, Minn. / Sperry Rand Corp., New York, N. Y., a corp. of Delaware / Non-Destructive Sensing of Thin Film Magnetic Cores.

3,092,815 / Charles G. Hinze, San Jose, Calif. / I.B.M. Corp., New York, N. Y., a corp. of New York / Magnetic Core Sensing Device.

3,092,816 / Joseph P. Pawletko, Endicott, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of New York / Magnetic Drum Storage Apparatus.

3,092,817 / Henri B. Diamant, State College, Pa. / HRB-Singer, Inc., State College, Pa., a corp. of Pennsylvania / Magnetic Reading / Writing Circuit and Channel Selector Therefor.

June 11, 1963

3,093,745 / Andrew H. Bobeck, Chatham, N. J. / Bell Telephone Labs., Inc., New York, N. Y., a corp. of N. Y. / Magnetic Core Flip-Flop.

3,093,747 / John D. Goodell, Silver Spring, Md. / General Precision, Inc., a corp. of Delaware / Magnetic Signal Storage Logic Computing Element.

3,093,751 / Robert G. Williamson, Norwalk, Conn. / Sperry Rand Corp., New York, N. Y., a corp. of Delaware / Logical Circuits.

June 18, 1963

3,094,611 / Maurice Karnaugh, New Providence, N. J. / Bell Telephone Labs., Inc., New York, N. Y., a corp. of New York / Logic Circuit Employing Magnetic Cores.

3,094,613 / Solomon L. Miller, Poughkeepsie, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of New York / Binary Full Adder Utilizing Asymmetric P-N-P-N Transistors Operated at Different Saturation Current Levels.

3,094,614 / William W. Boyle, La Grangeville, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of N. Y. / Full Adder and Subtractor Using Nor Logic.

3,094,687 / Robert F. Archer, Clayton, Ohio / National Cash Register Co., Dayton, Ohio, a corp. of Maryland / Compound Cascade Transistor Memory Circuit Driver.

3,094,689 / Sven Erik Wahlström, Enskede, Sweden / Aktiebolaget Atvidabergs Industrier, Atvidaberg, Sweden, a joint-stock company of Sweden / Magnetic Core Memory Circuit.

June 25, 1963

3,095,559 / Albert Wolinsky, New Rochelle, N. Y. / General Precision, Inc., a corp. of Delaware / Binary Digital Single Brush Readout Device.

ADVERTISING INDEX

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

American Telephone & Telegraph Co., 195 Broadway, New York 7, N.Y. / Page 2 / N.W. Ayer & Son, Inc.

Audio Devices, Inc., 44 Madison Ave., New York 22, N.Y. / Page 4 / Charles W. Hoyt Co., Inc.

Bellcomm, Inc., 1100 17th-St., N.W., Washington 6, D. C. / Page 59 / N.W. Ayer & Son, Inc.

Ferroxcube Corp., Saugerties, N.Y. / Page 60 / Lescarboura Advertising, Inc.

International Business Machines Corp., Monterey & Cottle Rds., San Jose, Calif. / Page 56 / Benton & Bowles, Inc.

McGovern, Senter & Associates, Inc., 134 Main St., Stoneham, Mass. / Page 8 / Allied Advertising

National Cash Register Co., Main & K Sts., Dayton 9, Ohio / Page 9 / McCann-Erickson, Inc.

Photocircuits Corporation, Glen Cove, N.Y. / Page 55 / Duncan-Brooks, Inc.

Princeton University Press, Princeton, N. J. / Page 58 / Franklin Spier, Inc.

Technical Operations, Inc., 3600 M St., N.W., Washington 7, D. C. / Page 56 / Edwin F. Hall

United Research Services, 1811 Trousdale, Burlingame, Calif. / Page 57 / Hal Lawrence, Inc.

Univac, Div. of Sperry Rand Corp., Univac Park, St. Paul 16, Minn. / Page 49 / Pidgeon Savage Lewis, Inc.

Guidepost

The constellation Scorpio is one of the most familiar sights in space. When many problems of guidance are solved, it could well become an important guidepost for astronauts during their journey to the moon.

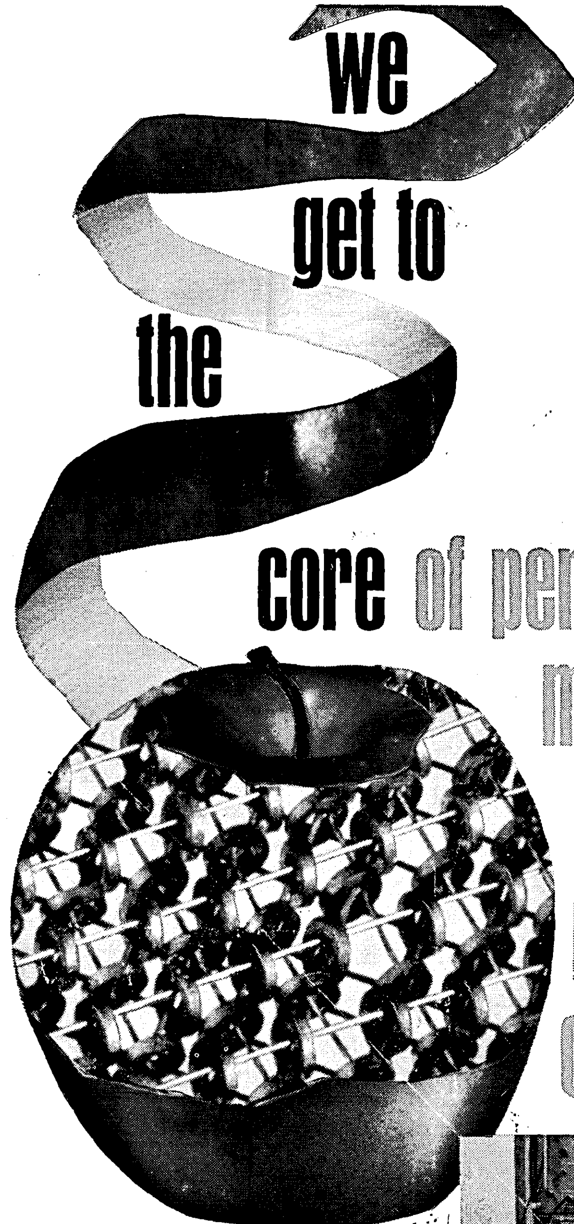
Guidance sensitivity is one of the most critical areas of America's manned space flight program. What precise point in space is best for mid-course maneuvering? What are the references, the guideposts for such maneuvers? How much energy should be expended for a correction at any given time?

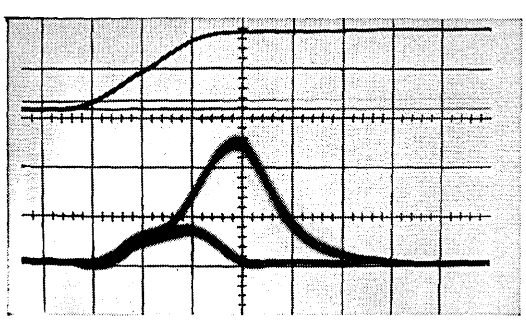
Bellcomm is now at work analyzing many of these problems, searching for unknowns that could affect guidance in the mysterious reaches of space. It is part of the total job Bellcomm is doing for NASA, planning and evaluating manned flight systems.

Such stimulating work offers rewarding opportunities for men well qualified in such fields as physics, chemistry, engineering, psychology, mathematics, flight mechanics, computing and programming, propulsion, aerodynamics and aeronautical engineering. If you are such a man, your résumé would be welcomed by Mr. W. W. Braunwarth, Personnel Director, Bellcomm, Inc., Room 1117U, 1100 17th St., N. W., Washington 6, D. C. Bellcomm is an equal opportunity employer.

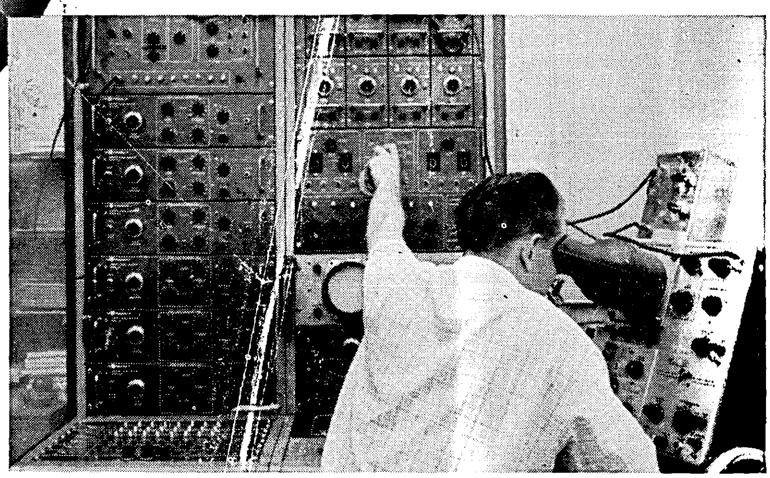
BELLCOMM, INC.
A Bell Telephone System Company

we get to the core of performance in memory planes and stacks to assure maximum system operating margins





Actual photo-recording (unretouched) of 4000 word memory plan utilizing 30FC01 cores. Worse case pattern.

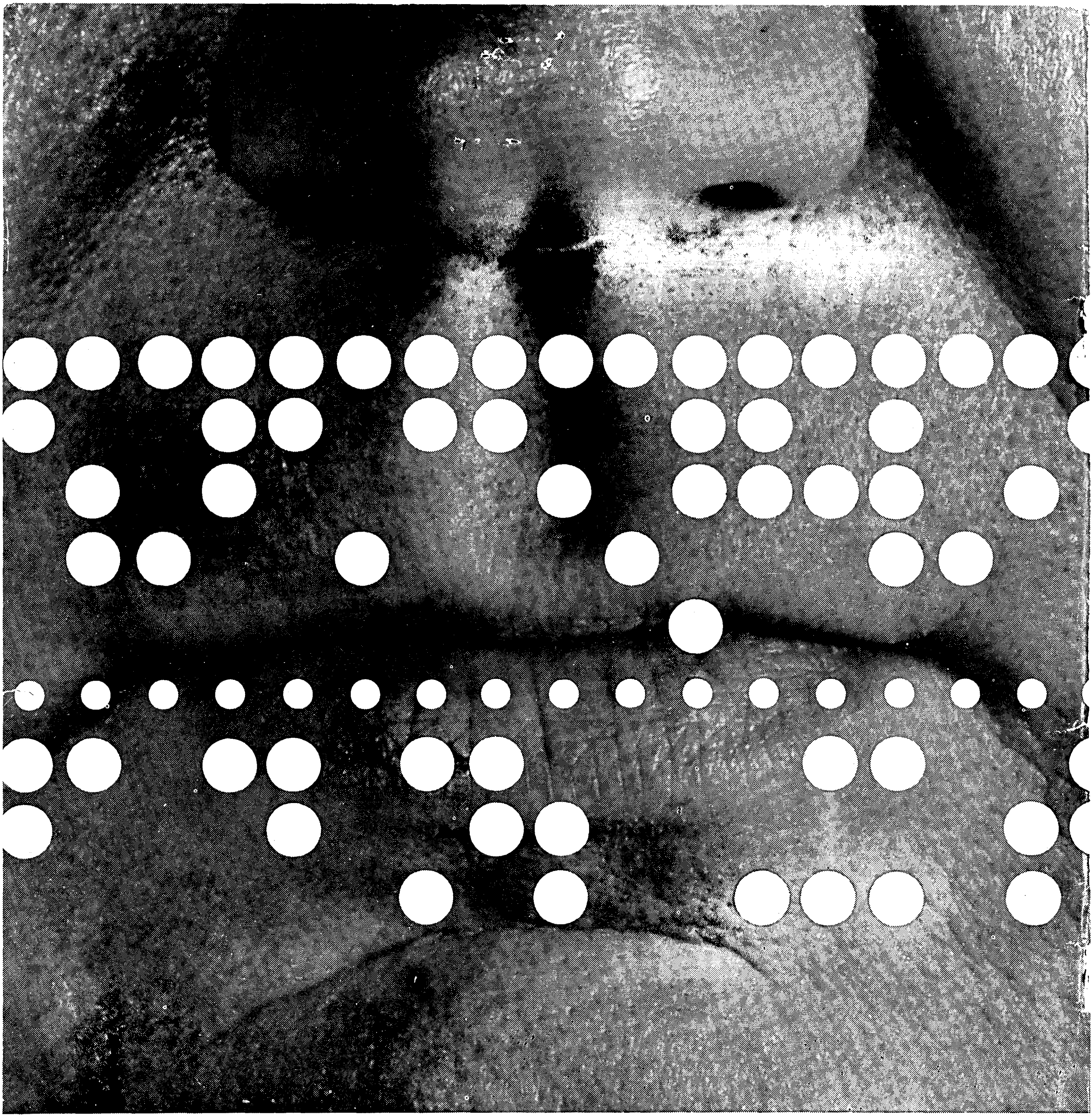


Some very good memory cores are thrown out at Ferroxcube simply because they do not meet the extra stringent requirements of performance in or out of the memory plane assembly. Only the best, closely matched to overall electrical requirements of the plane and stack, are delivered to our customers. Ferroxcube makes cores under precise batch kiln conditions and individually tests each core before assembly. After wiring in planes, cores are again submitted to advanced techniques of performance evaluation. Cores not up to Ferroxcube's specifications are replaced, until the entire assembly provides the **operating margins of performance** that means better overall memory characteristics, longer service life, and surprisingly, **you benefit by lower costs.**

WRITE FOR COMPLETE MEMORY COMPONENT TECHNICAL DATA...

FERROXCUBE
CORPORATION OF AMERICA
SAUGERTIES, NEW YORK

Circle No. 11 on Readers Service Card

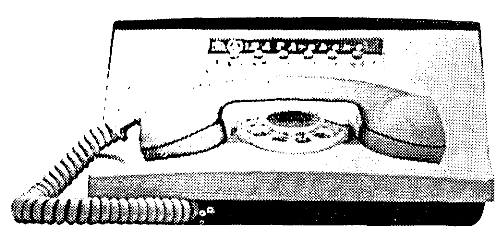


YOU DON'T HAVE TO SAY A WORD to send great masses of business data to any location by telephone. New Bell System DATA-PHONE service is the reason why.

Machines do the talking — 16 times faster than people can talk.

Almost any kind of word or figure data in any amount can be transmitted immediately any time you want—at regular telephone rates.

There's no faster, safer and more economical way to ship data than by DATA-PHONE service. Have a talk with one of our Communications Consultants about it. Just call your Bell Telephone Business Office and ask for him.



BELL TELEPHONE SYSTEM

Circle No. 1 on Readers Service Card

September, 1963

computers and automation

Western Europe and Computers