COMPUTERS
and AUTOMATION

DATA PROCESSING • CYBERNETICS • ROBOTS

A Small Electronic Computer Applied in a Retail Department Store

A Line Printer Memory Utilizing Magnetic Cores

The Application of Digital Control Systems in the Process Industries

AUGUST
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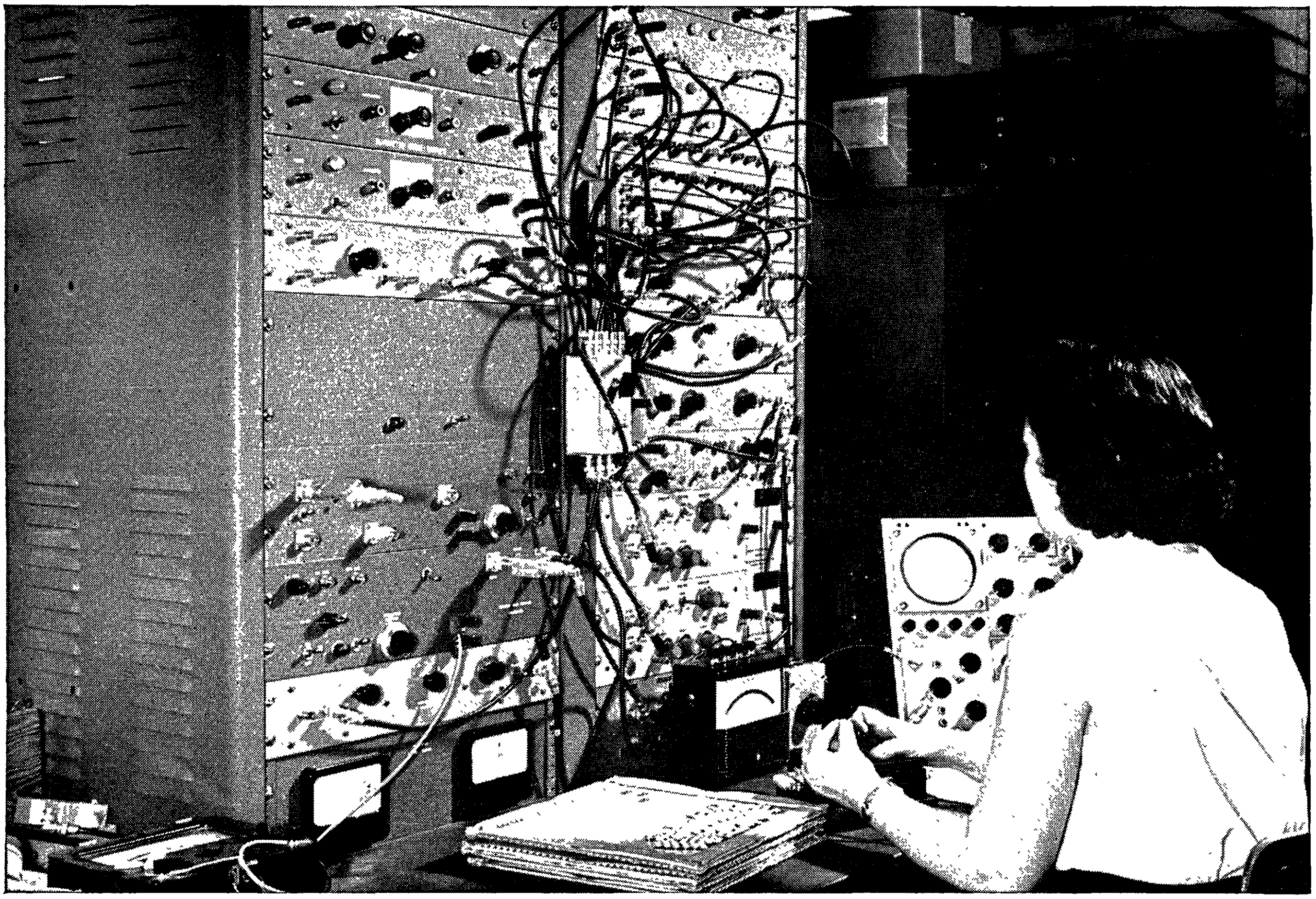

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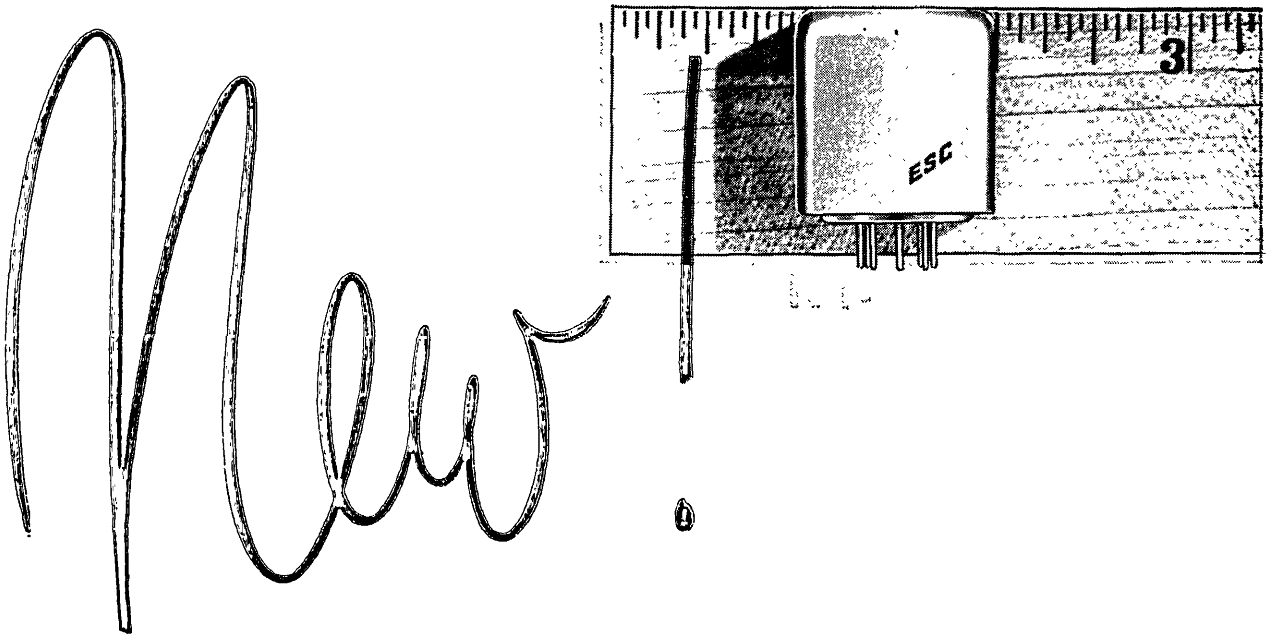

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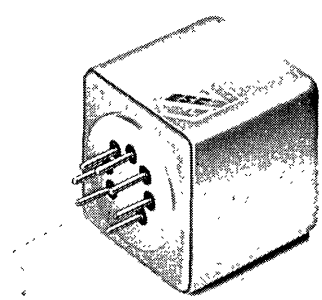

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Readers' and Editor's Forum

FRONT COVER: SEMI-AUTOMATIC DATA REDUCTION

THE FRONT COVER shows two machines being operated to convert analog information from oscillograph records into digital information punched in cards. After the operator aligns the cross hairs of the "Oscar, Model J" (made by Benson Lehner Corp., Los Angeles, Calif.) over the desired point on the curve, he presses a button, and then the machine assembly converts the point to a four-digit number automatically punched into an IBM punch card. The scene is in the computing service at Datics Corp., Fort Worth, Texas.

THE NAVIGATION OF THE NAUTILUS

THE MARVELOUS history-making trip of the U.S. atomic submarine Nautilus under the North Polar ice cap, from the Pacific Ocean to the Atlantic Ocean, is, among many other things, another remarkable instance of what is almost becoming commonplace today: that automatic, reasonable, information-processing of a kind which is altogether impossible for human beings, is possible for machines and devices.

The Nautilus' navigation devices included: automatic depth controls, automatic course keeping controls, gyrocompasses of submarine and aircraft types, and inertial navigation systems. One of the devices was a Sperry Celestial Altitude Recorder (SCAR), which "permits celestial navigation while submerged," and enables the inertial navigation system to be checked and corrected. "Details on the SCAR system, developed by Sperry's Marine Division, remain classified." How to perform "celestial navigation," presumably navigation with reference to the sun and the stars, while submerged under water and ice, a feat totally impossible to a human being, is, according to the news, possible for the machine. But we are not permitted to know the fascinating details because the "details are classified."

We can predict however that the knowledge that something is possible will enable other scientists also to solve the problem, duplicating or improving on the solution. The secrets of nature are open to determined scientists adequately supported, and after a few years or decades, arrive in the textbooks for everyone to learn.

INTERESTING COMPUTER SOCIETY MEETINGS

I. To the Editor from Jackson W. Granholm

Editor and Publisher, *Computing News*
Seattle, Wash.

YOU ARE TO BE commended for that portion of your notes in the June issue on p. 6 entitled: "Is the Computer Field Staying Together or Separating?", in which you pointed out, among other things, that "92% of the papers presented at the ACM meeting in Urbana required specialized knowledge to be understood," and that "probably no one enjoys sitting in a lecture hall and hearing a person present a paper which starts off beyond his comprehension, and then goes much further."

You have hit the nail on the head. If anything, your comments are too gentle.

You wrote about computing machines when it was hardly popular and surely not monetarily rewarding to do so. You have always written in simple, understandable fashion. You know what you are talking about.

For some time I have worried about the tendency toward what can be described as "pseudo-intellectual snobbery" in computing meetings. Nor is this limited to meetings of the Association for Computing Machinery. There is no reason to turn computer meetings into a poor copy of a mathematical society meeting. Nor is this to speak out against those vital contributions that mathematicians make to the computing field. When well-done they are a joy to behold.

Fred Gruenberger expressed it well when he observed that undertakers probably have more fun at their conventions than computer people do.

One need only read the writings of Albert Einstein to know that what is profound and vital need not be pompous and brontosaurian.

Keep up the good work.

II. From the Editor

A perennial problem that faces many computer people from time to time is: "I should like to give a paper at a computer meeting. How shall I present it? How shall I be interesting? How shall I say something worthwhile?"

To solve this problem, a few, simple, fundamental considerations apply, because the persons who may listen to the paper have some simple, basic questions uppermost in their minds. The first one is:

"What is this paper about? What is the subject?"

The first duty of any author of a paper, therefore, is to make the subject clear, in simple language that people can understand. This permits those who are not interested in the subject, and those who are already experts in the subject, to go away and not listen.

Clearly, when an author is thinking about a paper, and has settled on a subject, the next thing he should do is estimate the number of persons interested in it. If his estimate indicates that there will be fewer than a dozen persons interested in his subject, it would be wise for him to change his subject to one in which at least thirty people will be really interested.

After this step, the assumed audience is smaller, consisting just of persons interested in the subject, and so easier to talk to.

The next question uppermost in the mind of a listener is:

"How shall I understand what this author is talking about?"

In order to understand what an author is talking about, a listener needs to know the terms the author is using. These divide into two kinds of terms. The first kind of terms is the kind which people who are interested in the subject surely already know; and when you as author decide which are these terms, please think of your less

[Please turn to page 24]

A SMALL ELECTRONIC COMPUTER APPLIED IN A RETAIL DEPARTMENT STORE

C. Fred Flannell

Director, Electronic Computer Dept.
Royal McBee Corp., Port Chester, N.Y.

ELECTRONIC COMPUTERS of the present day which are designed for application in business data processing often need a large random access memory unit or very fast input-output. By a random access memory unit, we mean a memory unit in which a piece of information stored may be called for and obtained in approximately the same amount of time regardless of its location in the memory. Magnetic drums, short magnetic tape files, and magnetic disks are examples of such memory units. With such a unit data may be stored and called out at random, without paying attention to its sequential position in the memory. This is not true for long reels of magnetic tape, where attention must be given to the sequential position of information in the memory, for otherwise a great deal of time may be needed to search the long tape for the desired data, and in addition sorting of the calls for desired information may be necessary.

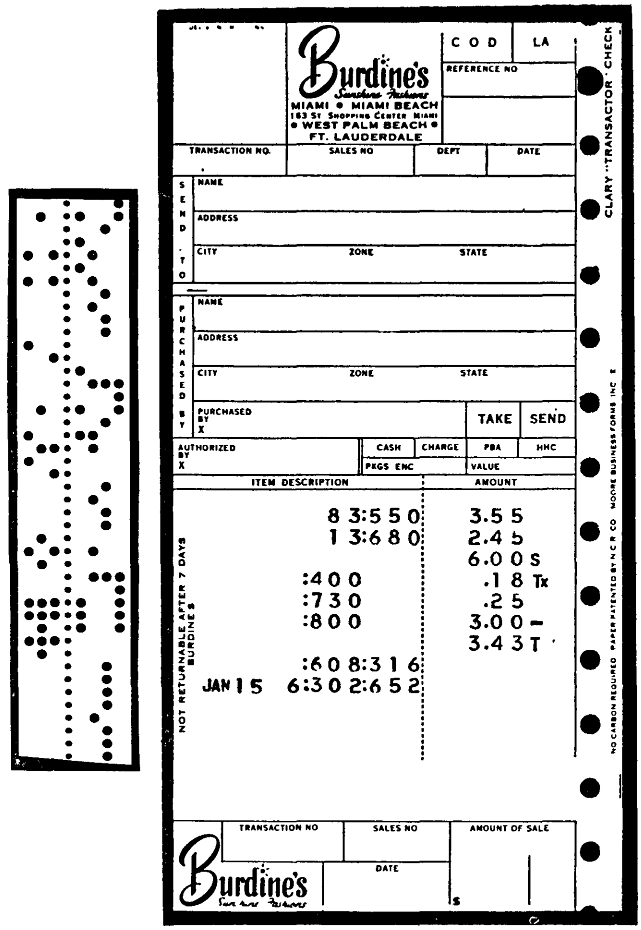
Since many applications require a large random access memory, attention has been directed toward large capacity computers with maximum access time of about one second. (Maximum access time is the longest time required to find any data.) But the price of such machines frequently precludes their use.

However, a large, random access memory in many cases can be avoided. In such cases, a computer like the Royal McBee LGP-30 may be used. Its magnetic drum memory containing 4096 words (a word consists of nine digits and sign) may serve as a very fast random access memory device. The maximum access time of the LGP-30 is 17 thousandths of a second. In applications where a medium memory may be used, an inexpensive computer with a high speed drum memory may actually process the data faster than a computer with a very large memory device.

The following case history illustrates how a relatively inexpensive, physically small computer with a relatively large drum memory is used in a retail electronic data processing system. This system resulted from a joint effort of personnel from Burdine's Department Store in Miami, Fla., and Royal McBee.

Choosing Equipment

Burdine's is one of the stores of the American Merchandising Corporation. As a group these stores joined forces to study EDP equipment. The program started with the procurement of an RCA Bizmac Computer which was located at Higbee Department Store in Cleveland. All of the stores in the group contributed personnel to the study. Mr. Mike Zappia of Burdine's joined the other members of AMC in working on various applications for the giant computer.



SAMPLE OF SALES CHECK

Figure 1

Over two years ago, Mr. Zappia became interested in the application of a small computer to department store operations. He thought there were many problems involved in using a large computer which could be solved by placing a small computer in the store, thereby avoiding the bottleneck of one large centralized data processing installation. Burdine's management decided to lease an LGP-30 for Burdine's sales audit application in their newest Miami branch (163rd Street store). Management expects this store to do business amounting to about five million dollars per year involving two to four thousand transactions per day.

The existing cash registers in the store were replaced by new cash registers which produce a punched paper tape and a sales ticket as a by-product of entering a sale. The new cash register has eleven columns of keys —

three for department number, two for class of merchandise, one for multiple item sales, and five for price. This equipment eliminates writing sales tickets by hand and punches a paper tape used for subsequent data processing. About fifty of these new registers have been installed in the Burdine's store.

Point of Sale Operation

On the sample sales ticket (see Figure 1) you will notice that for each item sold the sales person enters department number, class of merchandise, number of items involved if a multiple sale (0 represents 1 item — no key is depressed), and price. After all items have been entered, a sub-total may be taken. This total is followed by special charges such as taxes, C.O.D. charges, gift wrapping, etc. Each special charge entry can be identified by the identifying code number. Prices are entered as negative numbers on items such as deposits on lay-aways and employee discounts.

After all special charges have been recorded, striking the total bar on the register records the total. (Totals are not punched on the tape.) Then the sales person enters clerk number and "type of sale" code (type of sale includes cash, C.O.D., lay-away, 30 day charge, etc.). Striking the End-of-Transaction bar records this information plus store number, register number, and transaction number.

It would be presumptuous of us not to provide a procedure for marking a mistake; therefore a void key is provided on the register; this key punches a "void code" in the paper tape. The tapes are read into the computer backwards so that any void code enters first and the computer skips that transaction. The numbers on each line of the sales ticket are punched in reverse order so that they enter correctly.

At the end of each day the tapes are gathered from all registers and taken to the LGP-30. Punched paper tape for input is taken directly from the point-of-sale device in a form which is acceptable to the computer; no manual punching of additional information is necessary. All of the information which is required for the sales audit is already punched in the tape by the point-of-sale device.

Data Processor

The LGP-30 used for processing the data will accept information from the attached typewriter keyboard, its tape reader, or a photoelectric tape reader. The photoelectric reader was selected for this application because its maximum reading speed of 12,000 characters per minute is suitable for the large amount of input data.

The computer uses the stored program principle of operation, which means that instructions for solving the problem are stored in the drum memory and executed automatically. As sales data enter the computer, the specified totals (sales person, class, department, etc.) are up-dated. The magnetic memory retains information in a manner similar to tape on a home tape recorder: information remains on the drum until new information is recorded replacing old totals. Since data enters at random, all tapes must be read and the totals retained in memory before any reports are printed, except for the error report, which will now be explained.

Error Checking

The first job of the computer is that of policeman. Error checking is built into the physical components of the system and into the program. As tapes pass through the reader, a parity check circuit stops the reader if a punching error or reading error is detected. We accept the fact that mechanical and electronic equipment will occasionally make a mistake. We also admit that people in the system make even more mistakes. The computer searches for human errors by checking for inconsistencies in the data which the clerk has punched. Some of the errors detected are: non-existent department or sales person; parcel post charge on lay-away; C.O.D. fee on other type of sale; cash deposit on cash sale; etc. As errors are detected the transaction number and type of error is recorded. Thus the first important report printed by the computer is an error report. The alternative of manually checking each sales slip for preparing such a report would be very time-consuming and expensive.

Cash Report

The second report produced by the computer is a cash report for all registers. The sample report illustrates the actual appearance of the reports. Since the computer may receive and print all typewriter characters, the headings are printed automatically by the computer program.

Chart 1 — Sample of:

CASH REPORT

Register Number	Net Sales
1	262.05
2	195.15
—	——
—	——
49	24.04
50	202.40
TOTAL	7111.85

Sales Report by Type of Sale

The third report is a report by type of sale. All activity including charge sales and returns are entered into the registers. The six types of sales listed in the report are:

1. Cash Sale
2. C.O.D.
3. Lay-away Sale
7. Household Club Charge
8. Permanent Budget Account Charge
9. Thirty-day Charge

Chart 2 — Sample of:

SALES BY TYPE

Type Sale	Gross Sales	Returns	Net Sales
1	7439.53	327.68	7111.85
2	20.44	16.42	4.02
3	282.40	4.96	277.44
7	3281.12	493.74	2787.38
8	230.02	98.64	131.38
9	2674.77	116.09	2558.68
TOTALS	13928.28	1057.53	12870.75

Sales Report by Salesperson

The fourth report is a report on salesperson performance sorted by department and clock numbers. The program will accommodate 400 sales people.

Chart 3 — Sample of: SALES BY SALESPERSON

Dept. No.	Clock No.	Gross Sales	Returns	Net Sales
001	007	211.25	22.86	188.39
	009	56.71	7.62	49.09
	013	432.73	183.38	249.35
	016	353.46	181.84	171.62
002	006	414.70	182.40	232.30
—	—	——	——	——
—	—	——	——	——
—	—	——	——	——
198	009	98.76	3.99	98.76
TOTALS		13928.28	1057.53	12870.75

Sales Report by Department

The fifth report provides an analysis by department. Burdine's has 93 retail departments, 2 special retail departments, 6 leased departments, 3 cost departments, and 9 workroom departments. Special charges (taxes, C.O.D. fee, etc.) are included on this report.

Chart 4 — Sample of: SALES BY CLASS

Dept.	Class	Net Sales	Dept. Totals
01			134.62
	4.33		
	21	8.75	
	22	9.10	
	23	6.40	
	24	12.00	
—	—	——	——
—	—	——	——
92			132.16
	16.75		
	81	17.21	
	82	21.02	
	83	16.57	
	84	29.20	
93			119.77
	41.07		
	11	45.09	

Sales Report by Class of Merchandise

The sixth report gives an analysis of sales by class of merchandise within each department. For example, department 63 is Men's Hats and the classifications in this department are 71 Felt, 72 Panama, 73 Straw, 74 Caps, 75 Cloth Hats, 76 Uniform Caps, 77 Braid Hats, 78 Helmets, and 79 Berets. The program provides for 1000 classifications. If the number of classifications were increased, the processing could still be completed by sorting the tapes and running the tapes from one or two floors at a time. This system does not provide for item control but item control could be accomplished in some departments by assigning a class number to each item. The offset amounts were entered without a department number indicating clerical error or unclassified merchandise.

If you desire to punch the totals as the reports are printed, the "Punch" switch on the typewriter may be depressed. These tapes may be used for preparing weekly or monthly reports.

A quick glance at the number of totals carried in

Chart 5 — Sample of: SALES BY DEPARTMENT

Dept.	Gross Sales	Returns	Net Sales	Net Discount	No. of Sales Transactions
01	139.50	4.88	134.62	12.32	196
—	——	——	——	——	——
—	——	——	——	——	——
93	142.21	22.44	119.77	33.61	374
348	12.29	.93	11.36	2.21	15
368	13.70	17.53	3.83	.41	194
Total Retail	13535.08	1049.95	12485.13	1220.51	13434
102	228.46	.53	227.93	.57	57
106	.26	.26		.73	10
118	17.45	.19	17.26	4.91	15
120	9.97	1.01	8.96	15.36	11
124	16.38		16.38		204
Total Leased	272.52	1.99	270.53	21.57	297
306	14.29	1.01	13.28	.22	15
309	13.16	.97	12.19	1.06	07
353					
Total Cost	27.45	1.98	25.47	1.28	22
200	13.01	.21	12.80	.13	11
203	9.85	.93	8.92	1.07	24
205	.93		.93		04
206	14.29	1.01	13.28	1.01	186
209	14.34	.26	14.08	.89	11
218	14.36	.13	14.23	.93	12
232	15.50	.34	15.16	1.04	13
330	8.66		8.66		13
332	2.29	.73	1.56	.85	12
Workrooms	93.23	3.61	89.62	5.92	286
Grand Total	13928.28	1057.53	12870.75	1249.28	14039
400	209.43	720	21.76		
500	218.70	730	33.88		
600	169.56	800	321.66		
700	120.91	900	321.32		

memory will indicate that more totals are held than the number of available memory locations. But the totals do not require 9 digits of magnitude, and so two units of data may be stored in one memory location and separated by the program for processing. This effectively doubles the size of the memory, from 4096 locations to 8192 locations.

Time Required

The time required to process the tapes and prepare the reports may vary a great deal depending on the number of errors in the tapes and the number of transactions. Initially, processing required two to five hours, and even longer on some days; much of this time was spent in error checking. This running time has subsequently been cut considerably by improving the program.

The Old System and the New System

Under the old system, one department processed sales audit information for the other five Burdine's stores, using a manual method of sales audit with modified bank machines. This department employed 24 girls. The

Salesperson and Class Reports were not prepared in the old system.

The reports from the new system are prepared by the computer and one of the sales audit girls. The computer is simple enough to operate so that no special personnel are required.

Cost

The cost of any electronic data processing system is certainly an important factor. The following equipment is used.

LGP-30 Computer	$1100/mo.
Photoelectric Reader	$ 200/mo.

Applicable taxes are not included in these prices since they vary with location. Maintenance service is included. Included in the cost of computer is a tape typewriter with a tape reader and tape punch for input-output. Instruction manuals and free training are also included. The prices listed include installation (shipping charges are extra but should not exceed $225 in the U.S.). The system operates on a standard 110 volt power supply; so no special wiring is needed. Little special provision must be made since the computer is no larger than an office desk and requires no special air conditioning.

Recent reports from Burdine's indicate that the system is not only providing extra information but is economically justified. Since the computer is now operated only part of the day producing the sales reports, additional applications are being programmed. With these additional jobs the computer can reduce operating costs still further.

This system is an example of how a low cost computer may serve as an electronic data processing system with its relatively large drum memory serving as a high speed random access memory device. It indicates some of the types of data processing problems which may be solved on such a system.

A LINE PRINTER MEMORY UTILIZING MAGNETIC CORES

B. Goda, S. Markowitz, and E. Jacobi

Telemeter Magnetics, Inc.
Los Angeles, Calif.

IN MANY RESPECTS, ferromagnetic cores are ideal for storage in line printer systems. They permit simplicity of design, economy of components, high speed, and very high reliability. An example is provided by a magnetic core "corner turner buffer" which has been produced for several companies currently manufacturing high-speed line printers. A *corner turner buffer,* as applied to magnetic core storage memories, means a high-speed memory system which will take in data serially from a computer and put out data in parallel to a line printer, for simultaneous printing of a whole line of characters; information comes into the buffer one character at a time and is put out by the buffer as one full line at a time.

This buffer is used in conjunction with a high-speed line printer of the UNIVAC, ANELEX, Shepard, or National Cash Register types. These printers have a configuration of 120 or more print wheels containing 56 or more alphanumeric characters and print symbols. The magnetic memory of the buffer represents an image of the wheels of the print drum. It contains 56 core rows (Y lines) and 120 columns (X lines). The 6720 storage cores located at the intersections of the rows and columns thus correspond exactly to the 6720 characters on the print drum. Selection of a given core during the WRITE cycle results in printing of the corresponding character during the READ CYCLE.

Four inputs are required for the random selection of any one of the 6720 storage cells in the buffer. The Y addresses are initially stored in a block buffer in the form of binary characters. In a succeeding stage these are decoded so each energizes two Y address lines, which select one of 56 Y lines. The X addresses are supplied from a program counter, which energizes two X address lines for the selection of one of 120 X lines.

The coincidence of two currents — one through the X line and one through the Y line — is required to set a selected core from the original ZERO to the ONE state. Since the storage core used has a square hysteresis loop, single currents pulsing the unselected cores on the selected X and Y lines will do no more than disturb their ZERO states slightly. During unloading, which is done with currents pulsing the cores in the direction opposite to the load, the cores storing a ONE produce a "turnover" signal owing to the change of flux, and the cores storing a ZERO do not.

Characters are loaded into the buffer sequentially, but are unloaded in parallel by simultaneous read-out of an entire character row. The expression "corner turner" buffer is derived from the corner-turning effect of driving the cores in the Y direction while reading at right angles to it on 120 individual sense windings running parallel to the X lines.

Unload commands are given by the printer in synchronization with the revolution of its print drum. The sequence in which the buffer Y lines are scanned corresponds to the character sequence on the print wheels; therefore, one complete revolution of the print drum results in a scan of all 56 Y lines and clears the buffer.

The buffer may be loaded at a rate of up to 50,000 characters per second, and unloaded at a rate of up to 20 micro-seconds per line. Loading is performed during the 20-millisecond interval while the paper is shifted to the next line. The buffer is for use with printers having a printing rate of up to fifteen lines per second.

Therefore a print hammer cycle should occur in about 65 milliseconds.

The storage section of the buffer consists of one folded matrix whose two identical sections have the 56 Y lines (rows) in common but contain two different sets of 60 X lines (columns) each. These lines are driven by means of the "end fire" system which requires that two switches, one at either end of the driven line, be activated simultaneously. The advantage of this method is that (M + N) drivers can select (M $\times$ N) lines. The two types of switches used are a digit driver and a transistor switch. The digit driver has one side tied to ground, but is capable of a 100% duty cycle. The transistor switch is highly versatile in that it can be connected between a variety of power sources and loads, but it has a more limited duty cycle.

The driving scheme of the buffer is economical, in that it requires a total of only 39 drivers for driving 176 lines in the load or the unload direction. For driving the 120 X lines, for instance, eight lines fan out from each of 15 digit drivers, each of them connected to one of eight different transistor switches. In this manner, energizing one of 15 digit drivers and one of eight transistor switches results in the selection of one of 120 lines. The 56 Y lines are driven similarly by eight digit drivers and seven transistor switches. The 39th driver is for the Z plan winding which substitutes for the X lines during unloading by providing the required coincident half current in the unload direction.

Bi-directional driving with only one set of drivers is achieved by means of a wiring scheme which loops each Y line through the matrix twice so that current flows in the load direction through one row of cores and in the unload direction through the other.

Discrimination of the two lines is accomplished by means of an address shifter consisting of an array of level gates wired to enable either one in a set of two transistor switches to accept current from a digit driver. The gates are enabled by the flip flops controlling the mode of operation for the equipment. This makes it possible to drive a given core row in either the loading or the unloading direction by selecting two different Y address lines from identical inputs. The current flowing through the other loop of the same Y line in the unwanted direction can, in each case, be disregarded; during loading it is opposed and cancelled by the current through the X line, and during unloading by that through the Z lines.

The timing and control circuits of the unit are quite simple. Two parallel flip-flops provide the various enabling levels required by each mode of operation. Two one-shot multivibrators are incorporated, each containing a delay and pulse section. One generates timing pulses for enabling the transistor switches. The other generates strobe pulses to sample the turnover signals to the print hammers at their peak amplitude.

Since it is necessary to sense the output from up to 120 storage cells simultaneously, the buffer contains 120 individual read amplifiers, one for each column of the matrix. These units are mounted five to a printed circuit card.

The power supply for the unit is operated from 115 volts, 60 cycles per second and provides regulated outputs of +14 and +5 volts in addition to a number of other unregulated ones. A transistorized negative current stabilizer is furnished to regulate the Y current during the read-out operation.

The equipment is entirely transistorized. All electronic circuits are mounted on printed circuit boards which are easily accessible for probing and testing. Feed-throughs and pin jacks are provided for convenient testing of the unit's X, Y, and Z drives.

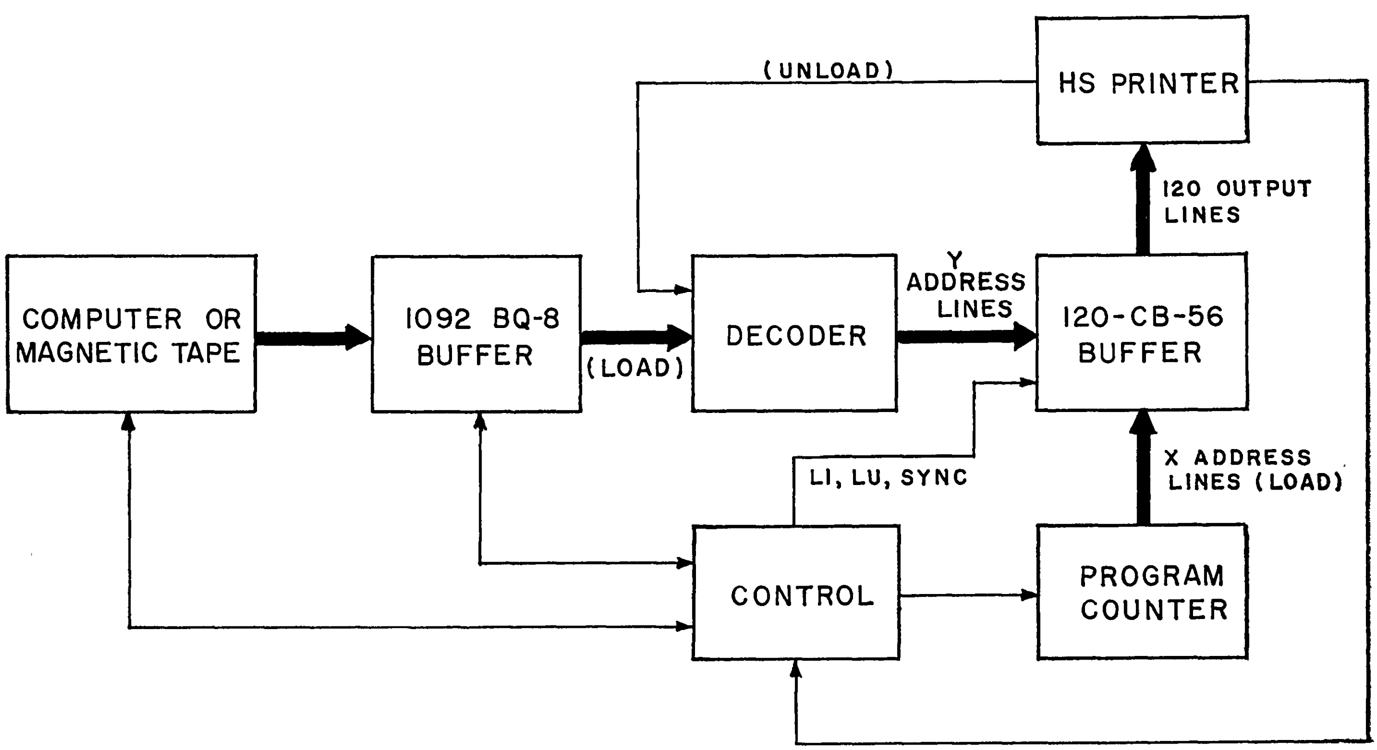


Figure 2 Block diagram — high speed line printer system

THE APPLICATION OF DIGITAL CONTROL SYSTEMS IN THE PROCESS INDUSTRIES

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(based on a paper given at the 8th National Conference on Standards, San Francisco, November, 1957)

The Basic Problems in Controlling a Process

Obtaining the best profit possible from his investment in the plant is, of course, the manufacturer's central objective in running a chemical plant or a steel mill or a petroleum refinery.

A very large number of complicated strategic and accounting problems enter into determining the best way to make a profit; but the profit problem is somewhat simplified at the plant operating level. Specifically, in a particular operating unit in a plant in a process industry, the various raw materials and products are assigned values, and certain costs are allocated to the running of the process; then it is the operator's objective to obtain the maximum return, based on these values and costs. At the same time, he wishes to maintain some minimum level of product quality. Putting it another way, the operator is required to make a standard product at highest possible profit.

Plant operators have available many instruments and much laboratory apparatus and equipment to help them control the process in such a way as to solve the problem. In order to see precisely how they exercise control and why their problem is difficult, let us examine a typical control system in a little more detail.

The operators are concerned primarily with three different kinds of variables. They must watch the *product variables* — that is, the variables which determine the character of the product, and in terms of which the product standards are specified. These variables include, for example, the chemical composition or color or weight or other dimensions of a product. Next, there are the *intermediate variables* over which the operators can exercise direct control. For example, an operator can directly control the flow of a liquid in a pipe by opening or closing a valve. Notice that operators control the product variables only indirectly by exercising control over the intermediate variables. There is no knob labeled "color" which an operator can use to adjust the color of his final product, but he may be able to affect the color by making an adjustment in a flow here and a temperature there, for example. Finally, there are the *independent variables* over which the operator has no control. These are the ambient conditions — outside temperature and direction and force of wind, for example — and, in general, the chemical, physical, and other properties of the materials being fed into the process. For example, in a steel mill, the characteristics of the iron ore are independent variables dictated by nature. These characteristics may vary over a fairly narrow range, but nevertheless their variation is an important factor in the operation of the process.

With these three kinds of variables in mind, it is possible to state the operator's and control system's function a little more definitely. The purpose of a control system is maintenance of a standard product quality and operation of the unit at its highest profit, by making adjustments in the intermediate variables (over which the operator can exercise some control) to compensate for variations in the independent variables. Note that if there were no independent variables — that is, if nothing in the process, its environment, or in the materials used in the process ever varied — it would be necessary only to adjust the intermediate variables at some fixed setting which corresponds to best operation of the unit, and thereafter and forever the unit would operate without the need for further attention. Unfortunately (or perhaps fortunately for those of us interested in automatic control systems), the plants having a great many important independent variables far outnumber those which can be operated so uniformly.

The operator, working carefully with his instruments and other apparatus, at the present time does an excellent job of handling this very difficult control problem. However, in some processes the relationships between control variables are very complicated, and the way they should be manipulated in order to operate the plant in the best possible way is not at all obvious. The result is that a plant may be run in a somewhat erratic way, so that the quality of the product and the profit derived from operating the unit vary considerably from minute to minute and hour to hour. Because many of these processes involve profits of thousands of dollars every day, the elimination of these variations can be a very profitable objective, even if the variations are slight. It is here that the digital control system can be of use.

Functions of a Digital Control System

A digital control system can be thought of as an operator who follows a very complicated set of instructions which direct him to make many arithmetic calculations, to "read" many process instruments, and to adjust many intermediate variables, automatically, continuously, and without error prejudice. A digital control system has facilities which make it possible to connect the temperature, flow, level, composition, and other process measuring instruments directly to a digital computer, so that the computer can determine which adjustments should be made in the process to operate it in the most efficient manner while holding product quality or standards within specified limits. The computer is also connected directly to the equipment which adjusts the intermediate variables, so the computer can take action directly on the process when it has determined that some modification is necessary or desirable. A typewriter input-output system is also provided with a digital control system to enable it to communicate with a human operator.

It is important to note that, in addition to "tuning up" or "trimming" the process in order to keep it at its best possible operation, the computer may have a number of other useful functions. It can be used to interpret instrument readings and to calibrate instruments periodically. It can be used during process start-up or shutdown to insure that operations are carried out in a proper (predetermined) sequence. It can be continually and tirelessly on the lookout for instrument or process failures or other troubles, and it can collect and interpret process data for later study by engineering and research staffs.

Advantages

It seems very likely that control systems of this kind will become as widely used in the process industries in the next five years as business data processors have been in the past five years. If this is so, it will be true for only one reason: such control systems pay for themselves by virtue of the improvements they make possible in process operation. The improvement, in general, will come in one or more of these specific areas: from increased production through better control; from improved quality; or from reduced operating costs. Generally, the improvement will arise as a result of some optimum balance between gains in these three areas. To make it possible to see a little more precisely where these gains may come from, let us examine them in greater detail.

Increased production may arise from a number of different improvements attributable to a digital control system. The continual "tuning up" of the process may mean that the yield of the product from a raw material is higher than before. Better control may make possible reduced maintenance so that an operating unit may be "on stream" for a higher percentage of the time. (For example, the digital control system provides the possibility of eliminating process upsets which would otherwise require that the operating unit, whatever it might be, be closed down for repairs.) Better control may result in fewer periods of off-specification production, when materials are wasted or must be rerun. A digital control system may make possible a quicker start-up and shutdown time which will result in increased total production.

Better quality control is a natural benefit obtained from a digital control system, and one which, in some instances may be the most important feature of all. Through the better use of current information about the process and the products it makes — information derived from data continually being read from process instruments — a digital control system may make possible a substantial reduction in product variability. Alternatively, or perhaps at the same time, it will be possible to improve the average quality if that is desirable for competitive or other reasons. The continual tightening-up of product standards and specifications leads to an ever-increasing demand by industry for methods which will make possible a better control over product quality, and the digital control system is in its element here.

Finally, the employment of a digital control system makes possible a reduction in operating costs. There will be less waste through the better use of raw materials, catalysts, etc. Better use will be made of the energy supplied to the process, whether it be electrical energy or chemical energy in the form of burning gas, coal, or fuel oil. The trouble-shooting attributes of the digital control system will reduce maintenance costs. Finally, extensive applications of these control systems may make possible a reduction in manpower. It should be noted, however, that manpower is already used very effectively in the process industries, and that such a reduction is not likely to be as important as the applications of computers to business data processing, for example. A process control computer will be employed to make decisions so complex that they are not made now at all, and we are therefore not contemplating the use of a computer to replace a man or a number of men currently making the same decision. Instead, the present operator or operators will be better able to make use of their time and of their knowledge of the process. They will be freed of the routine and tedious operations they must now perform, and they will be able to devote their time and energy to making still further improvements.

One aspect of the usefulness of digital control systems, which is particularly appropriate and very important, has not yet been mentioned. A computer control system can be extremely flexible, so that simply by changing a set of instructions stored in the computer memory it is possible to change slightly, or even completely, the control actions taken by the computer. This means that it will be possible to improve or to relax product quality in order to meet competition or to handle emergency situations. It will be possible to take into consideration changes in operating costs or in raw material costs or in product prices and make sure that such changes have the proper influence on operating conditions. It will also be possible to modify process operation in order to take into account new technical information about the process and to use this technical information most effectively.

So far, I have discussed only the application of a digital control system to an existing plant, and the economic savings which can be effected by such an application. In addition, there will be important implications in the application of such systems to new processes and to the construction of new plants. Generally speaking, the improved control of processes through such control systems will permit substantial reductions in plant investment. The reduced investment will come about for several reasons. The prospect of tighter control will mean that some of the sizing safety factors which are put into new plants can be reduced, so that, for given plant output, smaller reactors, furnaces, pipes, heat exchangers, conveyors, etc., may be employed. Furthermore, the very large and expensive storage capacity which must sometimes be provided to help smooth out variations in product quality may be vastly reduced.

The most interesting implication of all, however, is the prospect of the use of digital control computers in the control of presently uncontrollable processes. Nowadays products are made in plants which could not possibly have been operated twenty years ago without modern instrumentation. Twenty years from now there will be processes run by digital control systems which cannot be run today using the conventional methods. In this regard, such systems may have a tremendous impact on process technology.

MEETING OF
ASSOCIATION FOR COMPUTING MACHINERY
URBANA, ILL., JUNE 11 to 13, 1958
PROGRAM, TITLES and ABSTRACTS
Part 2
(Continued from the July issue)

23. AN ALGORITHM FOR THE DETERMINATION OF THE POLYNOMIAL OF BEST MINIMAX APPROXIMATION TO A FUNCTION DEFINED ON A FINITE POINT SET

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University of California and the Ramo-Wooldridge Corp., Los Angeles, California, AND
WERNER L. FRANK
The Ramo-Wooldridge Corporation, Los Angeles, Calif.

Let $f(x)$ be a function defined on a finite point set S of more than $n + 2$ points. Let $p(x)$ be the polynomial of degree n of best minimax approximation to $f(x)$ on S. The algorithm describes a process of constructing a finite sequence $T_0, \ldots, T_m$ of sub-sets of S each having $n + 2$ points such that the polynomial of best minimax approximation to $f(x)$ on T_m is identical to $p(x)$. The procedure is applicable to more general families of approximating functions and to arbitrary bounded closed point set S.

24. PANEL DISCUSSION ON MATRIX COMPUTATIONS AND PROGRAMMING METHODS

This may best be described as an hour and forty minutes of free consultation on matrix computations and programming methods for the benefit of the audience. There are no prepared talks. The audience is invited to come prepared with questions for the panel on machine methods for matrix inversion, solution of large linear systems, matrix eigenvalue and eigenvector problems, and linear and nonlinear programming problems. The answers should be better if questions are given to the Chairman in advance. The answers should be still better if questions are mailed by June 1 to the Chairman at the Department of Mathematics, Stanford University, Stanford, California.

25. BINARY ARITHMETIC FOR DISCRETELY VARIABLE WORD LENGTH IN A SERIAL COMPUTER

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Istituto Nazionale per le Applicazioni del Calcolo Rome, Italy

An arithmetic unit dealing with words of discretely variable length can be advantageous in a serial computer, permitting the choice of ranges of accuracy and speed according to the stability of solutions.

The FINAC computer was originally equipped with 20 or 40 bits words. The necessity of greater accuracy arose, especially in order to solve large and particularly ill-conditioned systems of algebraic linear equations.

Two different possibilities are discussed: that of increasing the speed of multiplication and of performing by program double-precision arithmetic with the already existing word length of 40 bits, and that of installing an arithmetic unit operating also on 80 bits words. The latter solution was chosen and the new facility has been installed and is in full operation.

The report presents the results of the statistical considerations on which the decision was based and describes the logical features of the unit and the arithmetic rules according to which round-off is performed in multiplication.

26. ON MULTIPLICATION AND DIVISION WITH THE FEWEST POSSIBLE ADDITIONS AND SUBTRACTIONS

GEORGE W. REITWIESNER
Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland

Multiplication/division is performed in digital calculations by iterated addition and/or subtraction of the multiplicand/divisor from an intermediate product/dividend, where the additions and/or subtractions are interspersed with shifting to accommodate increasing or decreasing associated powers of the number base with the applicable digits of the multiplier/quotient. This paper exhibits a set of examinations whose results yield individual multiplier/quotient digits such that the number of individual additions and subtractions of the multiplicand/divisor during the multiplication/division is irreducible. Argument is conducted for base-complement representation for arbitrary number base b; it is extended to accommodate the representations of magnitude with appended sign and of complement with respect to $b - 1$; clearly it specializes to $b = 10$ and to $b = 2$.

27. AN ANALYSIS OF CARRY TRANSMISSION IN COMPUTER ADDITION

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IBM, Poughkeepsie, New York, AND
G. H. ROSSER, JR.
Duke University, Durham, North Carolina

Since all arithmetic operations reduce ultimately to addition, a basic consideration in designing a high speed computing automaton is fast addition; and a basic difficulty in achieving fast addition is the carry problem. This paper determines the effect of various methods of increasing binary addition speed by "carry sensing," designed to increase the speed of carry propagation. By $T: c_j \rightarrow c_i$ we mean a carry transformation T which transforms a carry of j places into a carry of i places. By determining the various carry transformations and expressing them in closed form, we can accomplish several objectives: infor-

mation about carries in the binary system yields equivalent information in the transformed system; successive transformations may be applied to the same circuit, the closed form solution permitting easy evaluation of the transformed system with given ground rules; and any other number system may be regarded simply as a transformed binary system. The problem for various types of grouped and simultaneous systems is shown to involve solving a system of difference equations; closed solutions are exhibited for cases of interest. Finally, the analysis is applied to circuitry in which carry completion is sensed. Tables and circuit diagrams are included.

29. TRANSLATION BETWEEN ALGEBRAIC CODING LANGUAGES

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Engineering Research Institute, University of Michigan Ann Arbor, Michigan

Some results of a study of the problem of translation from one algebraic coding language to another. During the study a machine program was written to translate programs in the Carnegie Tech Internal Translator (for the IBM 650) language into programs in the FORTRAN (for the IBM 704) language. Specific examples of the difficulties encountered, arising in most cases from seemingly minor differences between the two essentially equivalent languages, are given. A few comments are made on the general problem of translation between formal languages assumed to be approximately equivalent.

30. A COMMAND LANGUAGE FOR HANDLING STRINGS OF SYMBOLS

A. J. PERLIS AND J. W. SMITH
Computation Center, Carnegie Institute of Technology Pittsburgh, Pennsylvania

There now exist automatic programming systems for existing computers that are reasonably flexible, and, in some cases, quite efficient. There also exists a growing body of programming experts — compiler technicians — who, for a given machine, can construct in an astonishingly non-routine way systems of assemblers, interpreters, and compilers for mathematical language problems. They find it difficult, however, to train others, to communicate the techniques they possess, and to describe the systems they build in any language other than that of the machine itself or English.

It is necessary, then, to construct a computer language which admits statements that describe precisely the complex choice of symbol manipulations which determine the translation process, for then not only may one describe the process, but it may be described for a computer which may interpret it and accomplish it. Such a language will simplify the construction of compilers and make possible reasonably simple natural language translation routines.

A string language is defined in this paper which has the proper structure to define the translation process for Russian-English, IT to FORTRAN, formal differentiation, and formal integration. The language is essentially machine independent.

31. COMPUTER LANGUAGE COMPATIBILITY THRU MULTI-LEVEL PROCESSORS

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IBM, New York, New York

Both inter-computer compatibility and advanced automatic programming features can be included in a programming system by means of multi-level pre-processors forming a superstructure upon an existing coding system. These modular elements are called for in a sequence determined dynamically during processing. This online switching results from intelligence gathered in previous modules and may cause local modifications or complete elimination. This provides flexibility for modification and logical control, allowing source language expansion by combinatorial synthesis of primitives of any lower level. Thus, in the absence of certain knowledge of what the ultimate language should be, progress may be made by addition and gradual assimilation, still allowing old language to function without being made obsolete. Replaced elements eventually decay and become inutile. Although non-stop processing is imperative, an important by-product is the movement of error detection toward the earliest level for each type, thus allowing earlier decisions to stop processing.

Two systems designed by the authors, FOR TRANSIT (IBM 650) and XTRAN (IBM 709) are discussed as examples of modification of existing coding systems through source language to source language translators.

32. A NEW METHOD OF SYMBOLIC STATEMENT FOR DATA PROCESSING OPERATIONS

NED CHAPIN
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Estimates of computer operating time, of storage capacity required, and of other parameters of data processing have typically missed the mark. Part of these difficulties can be attributed to the lack of good methods of representing data processing operations symbolically. In an attempt to remedy this, coding was devised to represent the relationships of any input to any output. The coding shows the nature of the relationships, the identification of the items of input and output, and any conditional situations.

By machine processing of the coded information, improved bases of estimate have been obtained for applications that have been expressed in terms of this special coding. But perhaps more importantly, an analysis of the actual use of the special coding indicated that close parallels exist with certain logic operations. By modifying the coding to strengthen those parallels, the power and usefulness of this method of symbolic statement is being increased.

33. AN ABSTRACT FORMULATION OF DATA PROCESSING PROBLEMS

JOHN W. YOUNG, JR., AND HENRY K. KENT
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A method of formulating a data processing problem with pseudomathematical terms is developed. The statement of the problem is independent of any specific mechanization and details in an unambiguous form the relationships between the inputs and outputs of the problem. The transformations to be applied to the input information and the volume and time requirements of the system are stated in precise abstract notation. A graphical version of the notational system permits a quick check for redundant information and helps in the study of alternative ways of organizing the system.

This notation can be used as a tool by the system analyst to prepare a particular mechanization of the problem or could be used in the input to a new type of automatic programming system which would generate the mechanization desired. This represents the first step in the development of a language which will serve the same purpose for data processing problems as algebraic notation does for scientific problems.

34. THE ROLE OF ISOMORPHISM IN PROGRAMMING

SIDNEY KAPLAN
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Recent advances in inventory and supply control, scheduling, queueing theory, etc. have demonstrated that many so-called commercial and industrial problems are governed by mathematical theories. It is shown in this paper that machine programs for file processing and file retrieval — sorting, searching, inserting — are isomorphic to some well-known arithmetical routines. Sorting, for example, turns out to be machine-wise isomorphic to division.

It appears that the vast differences between commercial-industrial problems and mathematical problems which were claimed to exist are ever diminishing.

37. AN ANALYSIS OF ROUND-OFF ERROR IN THE NUMERICAL SOLUTION OF THE HEAT EQUATION

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The purpose of this paper is to discuss the effect of round-off error for a particular implicit difference analog of the heat equation when this difference equation is used, and a normalized form of Gaussian elimination applied to it. The round-off error analysis is based on the actual sequence of arithmetic operations that take place in proceeding from the initial time to the final time; no propagation via the difference equation is assumed to simplify the nonlinear additivity of the errors. It is shown that, for a fixed ratio of the time increment to the square of the distance increment, the total error is proportional to the reciprocal of the time step.

38. GENERATED ERROR IN ROTATIONAL TRIDIAGONALIZATION

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J. W. Givens has obtained sharp bounds for the errors introduced into the characteristic values of a symmetric matrix as a result of his routine for rotational tridiagonalization (Oak Ridge National Laboratory Report ORNL 1574, 1954). Since the analysis is detailed and laborious, an alternative is presented here which, though less sharp, is much simpler and, in a sense, more general. Specifically, the result is as follows: In a rotation in the (i, j)-plane, let r bound the error generated in any element α_{ii}, α_{jj} or $\alpha_{ij} = \alpha_{ji}$; let α_k ($k \neq i, j$) bound the error generated in $\alpha_{ik} = \alpha_{ki}$, β_k that generated in $\alpha_{jk} = \alpha_{kj}$. Then the error introduced into any characteristic value is bounded by

$$r + \left[r^2 + \Sigma\alpha_k^2 + \Sigma\beta_k^2\right]^{1/2}.$$

These bounds are to be summed over all $n(n-1)/2$ rotations.

39. AUTOMATIC PROPAGATED AND ROUND-OFF ERROR ANALYSIS

PATRICK C. FISCHER
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A modification of the Carnegie Tech compiler for the IBM 650 enables automatic computation of a bound upon round-off and propagated errors present in a floating-point variable. Computation of the error bound proceeds as the variable itself is operated upon by the arithmetic subroutines of the compiler system. Bounds upon errors in initial data may be read into storage along with the data. Provision is made for handling truncation errors also so that an upper bound upon total error in a variable is available at any time during the computation. Empirical analysis of the generation and propagation of errors by any program written in the Carnegie Tech compiler is thus possible.

41. SOLUTIONS FOR INCOMPATIBILITY IN MULTIPLE MEDIA DATA PROCESSING

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The paper describes two highly versatile data conversion systems which have been designed and constructed during the past year. It also discusses the philosophy and peculiarities of most common conversions. A brief description of the finished equipment and the operating experience is included.

The types of input and output are plastic and metallic tape, perforated paper tape, continuous input data such as is generated by an analog to digital converter, and unformatted data from single wire or radio links. All conversions are performed at speeds limited only by the input/output tape handlers; both input and output units operate as simultaneously and continuously as the relative tape speeds will allow.

Elaborate code conversions permit major rearrangement of format. Several types of editing are provided which include selection of specific words, word groups, records or blocks, and collation of two input tapes. This can greatly assist in efficient preparation of data for the "on-line" equipment. Completely variable word or block lengths can be handled, with variable format being converted to fixed format.

Among the problems and solutions discussed are (a) the impact of error checking and correction, (b) code conversions, (c) word length conversion, (d) editing, and (e) the need for legislation.

42. COMPUTER TRANSCRIPTION OF MANUAL MORSE

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Many attempts have been made to construct a machine that will automatically transcribe hand-sent Morse code into printed copy. In the past, each new proposal has been tested by constructing an operating model of the device. By using a general purpose digital computer to simulate suggested transcription machines, it has been possible to test their merits without the expense and delay of building special-purpose equipment.

Even Morse operators who send copy that is acceptable to a large percentage of human receivers introduce a considerable amount of variability into the formation of the information-bearing elements. The basic problem, then, is to devise a procedure that will automatically associate related elements despite their dissimilarity. A process that produces a satisfactory transcription for a group of senders of widely differing competence will be described in detail

This procedure is sufficiently general that it can be applied to many other one-dimensional pattern recognition problems.

43. A PHYSICAL MODEL OF AN ABSTRACT LEARNING PROCESS

Joseph M. Wier

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An abstract model of a learning process which is more or less completely disembodied from its normal physical form is given. This process can exhibit some of the more interesting properties of human learning. The model is based on the use of an associative memory and allows for rather close analogs to the processes of abstraction and extrapolation from known to unknown relations. A number of physical devices can be used to simulate this model, the most useful one of which is a random access memory of the type found in most digital computers. An example is given which demonstrates the use of the process embodied in the model for the solution of a problem requiring the extrapolation from known relations to provide an additional piece of information.

45. METHODS FOR THE NUMERICAL MINIMIZATION OF FUNCTIONS OF SEVERAL VARIABLES; EVALUATED FOR THE REDUCTION OF SATELLITE RADIO INTERFEROMETER DATA

James N. Snyder, Donald B. Gillies, and Ivan R. King

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A large class of problems can be treated by defining a suitable function of the variables of the problem in such a way that these variables constitute the desired solution to the problem when the function takes on its minimum value. A computer program exploiting this minimization technique would start at some point in the space defined by the variables and by using an auxiliary routine which evaluates the function would progress to the minimum point of that function. The efficiency of such a technique is measured by the rapidity (in terms of function evaluations) with which this progression is made. Several different methods have been developed in the Digital Computer Laboratory at the University of Illinois and used on various problems drawn in the main from the area of the physical sciences. The behavior of the methods applied to several of these examples will be discussed. One of these is the reduction of satellite radio interferometer data in order to find the time of closest approach to the observing station, and the direction, distance, and altitude at this time.

47. A PROGRAM FOR APPLYING THE PRINCIPLE OF PARSIMONY IN MULTIPLE REGRESSION

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The multiple regression analysis program which is described includes, as an optional feature, a procedure for eliminating from the regression equation a set of independent variables which contribute little to reduction of the residual variance about the regression function. Basically, the program first obtains the full regression equation by inversion of the correlation matrix. Then, selecting appropriate variables as candidates for elimination, reduced regression equations are obtained by pivotal condensation. The elimination process is stopped at a point such that elimination of another variable would cause the contribution of the aggregate of variables eliminated to be significant. Several other optional features contribute to the usefulness of the program. The program is used with a medium-scale computer, PENNSTAC.

48. MAGNACARD SORTING TECHNIQUES

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The Magnavox Company has recently announced Magnacard, based on the storage of information on magnetic cards, each with a capacity of 5,000 bits. These cards can be sorted and collated at speeds up to 100 cards per second and can be read at rates up to 60,000 alphanumeric characters per second. This paper is concerned with a procedure for efficiently using such a system in sorting a group of items each of which is much smaller than the capacity of a card. The procedure is applicable to any storage medium with a fixed block length. It is based upon combining the high-speed card sorting capability of Magnacard with the high speed computing capability of a central processor. The sorting procedure involves storage of multiple items to a card. These cards are then sorted into chains on the basis of the sorting fields of a single item on each card. The items on the resulting sets of cards then are merged by the central processor into completely sorted chains. By an alternation of such card sorts and data sorts, a completely sorted sequence is produced. Time savings over either solely computer performed sorts or solely card performed sorts are significant.

50. ON INITIAL ESTIMATES FOR COMPUTING $a^{1/p}$ BY NEWTON'S METHOD

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In order to evaluate $a^{1/p}$ for a in the interval $[0, 1]$ by Newton's method, the standard practice for digital computer programs is to use the uniform initial estimate of 1. By using the piece-wise linear approximation

$$x_0(a,p) = \begin{cases} \dfrac{p-1+a}{p} & \text{if } (p-1)/(2^p-2) \le a \le 1 \\[2ex] \dfrac{p-1+2^p a}{2p} & \text{if } 2^{-p} \le a \le (p-1)/(2^p-2) \end{cases}$$

the computational effort can in the general case be considerably reduced.

We describe some analytical formulas for estimating convergence and with the "first-guess" for $a^{1/p}$ determined by the above approximation we tabulate the maximum number of iterations required for convergence as a function of p.

Our results indicate that for a reasonably small p it becomes more economical to compute $a^{1/p}$ by evaluating $e^{(\log a)/p}$.

51. GENERATION OF SPHERICAL BESSEL FUNCTIONS IN DIGITAL COMPUTERS

Fernando J. Corbató and Jack L. Uretsky

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A method of computation for spherical Bessel functions of real and imaginary argument is given which is especially suitable for digital computers. The method involves the use of recurrence relations with unnormalized values of the function. The accuracy and convergence are examined and criterion formulas are given. A procedure based on the Wronskian is used to simplify the final normalization.

52. SECOND ORDER FORMULAS FOR FOURIER COEFFICIENTS

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The use of a digital computer for the calculation of Fourier coefficients of empirical functions requires formulas for the numerical evaluation of integrals of the form form ${}_0\int^{2\pi}$ y sin nx dx and ${}_0\int^{2\pi}$ y cos nx dx. If the empirical data are originally in the form of a graph, such as an oscillograph tracing, and if there are a great many such tracings requiring harmonic analysis, then the large part of the human labor is in the reading and recording of enough points to represent the curves with sufficient accuracy. The usual formulas for Fourier coefficients require that points be read at equal intervals close enough together so that the polygon connecting successive points is a reasonably good fit to the original curve even in the region of greatest curvature. In order to reduce the number of points to be read, without sacrificing accuracy, formulas were developed for Fourier coefficients of the piece-wise parabolic curve through the triples of points determined by successive pairs of unequal intervals.

53. RESULTANT PROCEDURES

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The resultant procedure is a method for finding simultaneously all zeros of a polynomial with real coefficients. There are no restrictions on the multiplicity of either the real or complex zeros. The principle of the resultant procedure is as follows.

Assume that the absolute value ρ of a root α of the equation $P(x) = a_0 x^n + a_1 x^{n-1} + \ldots + a_n = 0$ is known. Then the resultant R(p) of P(x) and $Q(x) = x^2 + p x + \rho^2$ is computed by a simple recurrence relation. The real roots p_j of the equation $R(p) = 0$ that satisfy

$$-\rho \leqq p_j/2 \leqq \rho$$

determine the real parts of the roots α of modulus ρ.

The absolute values of α and p are obtained by the Graeffe root-squaring algorithm. To be applicable to exceptional polynomials and to polynomials with roots of multiplicity up to n, the theory underlying the root squaring method has been redeveloped and refined.

The resultant procedure has been coded for the IBM 650 and IBM 704 and is in successful operation. The advantage of the code is that it furnishes all roots with predetermined accuracy in a predetermined number of steps. Although the theory of the resultant procedure is complicated, the resulting formulas are simple. It is believed that this is the first completely automatic code which is based on the root-squaring method. However, semi-automatic codes have been in use for a long time.

54. DETERMINANTS WITH POLYNOMIAL ENTRIES

MAX OJALVO

North American Aviation, Bellflower, California

The paper describes a computer program for the evaluation of the determinant of an nth order square matrix, $2 \leqq n \leqq 20$, whose elements are mth degree polynomials with real coefficients, $m \geqq 0$, and for the extraction of the roots of the resulting mnth degree determinant-polynomial.[1] Storage limitations of the program require that $n^2(m+1) \leqq 1200$. In addition, it describes a mathematical analysis to determine the exact number of arithmetic operations of each kind, in terms of the order of the square matrix and the degree of each element. A comparison is made, in this respect, between the method due to Laplace and the method herein described.

In the determinant evaluation the square matrix of polynomial elements is decomposed into a sum of homogenous square matrices, which we shall call "simple" matrices. Eg., for n = 2, m = 1:

$$\begin{vmatrix} a_{11}S + b_{11} & a_{12}S + b_{12} \\ a_{21}S + b_{21} & a_{22}S + b_{22} \end{vmatrix} = \underset{(1)}{\begin{vmatrix} a_{11}S & a_{12}S \\ a_{21}S & a_{22}S \end{vmatrix}} + \underset{(2)}{\begin{vmatrix} a_{11}S & b_{12} \\ a_{21}S & b_{22} \end{vmatrix}} + \underset{(3)}{\begin{vmatrix} b_{11} & a_{21}S \\ b_{21} & a_{22}S \end{vmatrix}} + \underset{(4)}{\begin{vmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{vmatrix}}$$

The evaluation of (1) produces the S^2 term, the sum of the evaluations of (2) and (3) produces the S term, and finally the evaluation of (4) produces the constant term.

For the sake of simplicity we shall assume that all terms of all polynomials elements are non-zero.[2] The evaluation of each simple $n \times n$ matrix requires $1/3n(n^2-1)$ divisions, $1/2n(n+1)$ multiplications, and $1/6n(2n-1)(n-1)$ subtractions. These expressions times the number of simple matrices, $(m+1)^n$, equal the total number of arithmetic operations of each type. On the other hand the Laplace method requires, for m = 2, $(n!)3(n^2-1)$ multiplications and approximately the same number of additions. Assuming that multiplications and divisions are weighted twice as heavily as additions and subtractions, in computing time the method described herein is 612 times as efficient as the Laplace method for a 12th order square matrix with quadratic elements! This ratio increases rapidly as the order increases.

[1]The program was written and checked out for the IBM Model 704. This paper further describes how the former may be adapted to handle polynomial elements with *complex* coefficients.

[2]Six separate methods of efficient zero handling, as used in the program, are fully described.

56. PROJECTIONS, LEAST SQUARES, AND CONSTRAINED MINIMIZATION PROBLEMS

DAVID MORRISON

Ramo-Wooldridge Corporation, Los Angeles, California

The notion of a projection appears in least squares problems and in problems of constrained minimization. The projection of a vector onto a subspace is usually found by solving a system of linear equations (the "normal" equations of least squares problems) and then performing some additional calculations. We propose another method for obtaining projections which is based on an unusual application of the rotation matrix technique used by W. Givens for the solution of linear systems of equations. The method described appears to be particularly promising as a means for improving some existing numerical techniques for constrained minimization problems.

57. THE ORIGIN OF THE ABACUS AND ITS DEVELOPMENT

SHU-T'IEN LI

Palmer and Baker Engineers, Mobile, Alabama

Since the appearance of electric calculating machines and electronic computers, the abacus, being the oldest, simplest, and most efficient computer, taking cost into consideration, has been very frequently referred to in contemporary writings in the Western world. Unfortunately, different authors in their fragmentary statements have attributed the development of the abacus to diverse origins, none being free from historical speculation. This paper presents the authentic origin of the abacus and its development. It traces the pre-abacus computing device to 1100 B.C., its first improvement to "Chu Pan" or bead-tray between the sixth and third centuries B.C., and its next improvement to half-size "Chu Pan" with beads having two colors; gives authentic ancient accounts about the "Chu Pan," written early in the third century; proceeds with the third stage of improvement in the form of the abacus with unattached beads early in the seventh century; accounts for the perfection of the abacus since the seventh century; presents the development of rapid calculation methods especially characteristic with the abacus mathematics; and concludes with the improvements on the abacus during the past twenty-three years.

58. S.E.A. GENERAL PURPOSE COMPUTERS C A B

P. Namian and F. H. Raymond

Societe d'Electronique et d'Automatisme, Paris, France

As early as 1948, the Societé d'Electronique et d'Automatisme started the study of problems concerning the development of new electronic numerical computing means with the designing of a first computer, which was followed in 1950 by the manufacturing of a first numerical computer intended to calculate the trajectories of a fast missile.

The studies carried out since that time, on the technological standpoint (design and development of computing circuits using at first diodes, later transistors and magnetic cores; design and development of core matrix memories and magnetic drums; design and manufacture of various kinds of input and output devices) as well as on the logical standpoint (logical structure and design of several numerical computers with built-in program) have lead us today to presenting a range of general purpose computers having very broad uses — easy to run and very reliable in operation. These computers are called C A B and their main features are the subject matter of this report.

59. REPORTING COMPUTER PERFORMANCE TO MANAGEMENT

J. A. Campise

Hughes Tool Company, Houston, Texas

With the present levelling off in the economy, management is looking more closely at what it is getting for the dollars spent on computing. This places added emphasis on the performance data of the computing installation, the compilation and analysis of these data, and the effective statement of the results for the scrutiny of top management.

The primary aim of reporting computer performance at all is to answer the question, "Is our computer installation showing a profit to the company?"

This paper deals with the accumulation, compilation, analysis, and presentation of data pertinent to the performance of men and machines in a computing installation in order to answer this question honestly and still keep the computer installation going.

62. SOME REMARKS ON ABSTRACT MACHINES

Seymour Ginsburg

The National Cash Register Company, Hawthorne, Calif.

The Moore-Mealy concept of a machine is generalized and studied in its own right. Specifically, a machine is a 5-tuple (K, W, Y, δ, λ) satisfying the following properties: (1) K is a non-empty set of "states," (2) W (the set of "outputs") and Y (the set of "inputs") are non-empty semi-groups, W satisfying the left cancellation law, (3) δ (the "next state" function) is a mapping of $K \times Y$ into K such that $\delta(q,I_1I_2) = \delta[\delta(q, I_1)I_2]$ and λ (the "output" function) is a mapping of $K \times Y$ into W such that $\lambda(q,I_1I_2) = \lambda(q, I_1)\ \lambda[\delta(q,I_1), I_2]$, for each q in K and each I_1 and I_2 in Y.

The paper is divided into three semi-disjointed parts. In Section 1, the notions of machine and submachine are introduced. Some results on submachines and decompositions of machines into submachines are given. Section 2 deals with distinguishability and indistinguishability of states between machines in a family of machines. The final section is concerned with machines which have inverses. Roughly speaking, an inverse S* of S undoes the action performed by S. Questions on existence, uniqueness, and "practical tests" for inverses are then answered.

63. A SYNTHESIS PROCEDURE FOR A CLASS OF ASYNCHRONOUS CIRCUITS IN WHICH A PARTIAL ORDERING OF THE OPERATIONS OCCURS

W. Scott Bartky and David E. Muller

University of Illinois, Urbana, Illinois

In the past, the design of asynchronous circuits was, to a large extent, dependent on the capabilities, previous experience, and sophistication of the designer. Indeed, given any particular design problem, the number of possible circuit realizations was usually equal to the number of different designers working on it, assuming of course that each had attained some "satisfactory" logical design. Furthermore, the problem became even more difficult when the number of independent operations was increased. In such cases any given logical solution might have proved worthless when it came to its utilization since various "race" conditions might upset its behavior. This anomaly has arisen naturally since, for the most part, asynchronous circuits have been designed from static conditions and little attention has been paid to the dynamic conditions dictated by the given problem.

This paper will briefly discuss a relatively new method for the design of a class of asynchronous circuits for which it is always possible to describe a partial ordering of the operations. This method introduces a new way of describing a given design problem, lending itself quite elegantly to designing control circuits of a computer in which a large number of parallel operations occurs. Once the transformation of the given problem to this new description has been made, the task is simplified to such an extent that a circuit can be realized with very little additional effort. Furthermore, the circuit obtained by this procedure has the very desirable property that, regardless of the various operation times of individual components, the circuit will perform in accordance with the transformed description.

[To be continued in the September issue]

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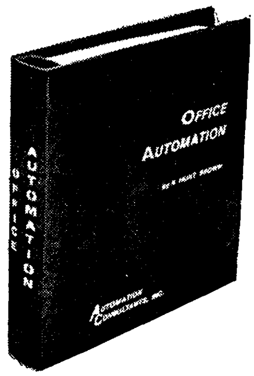

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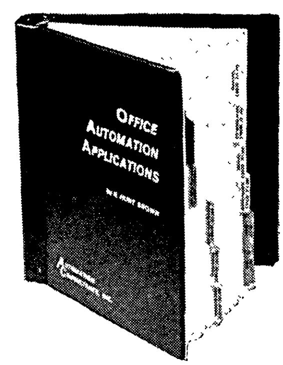

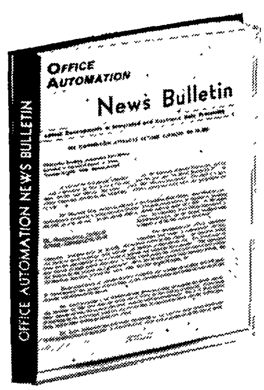

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Readers' and Editor's Forum

[Continued from page 6]

informed listeners: "Never overestimate a man's knowledge; never underestimate his intelligence." The other kind of terms is the kind which most likely your audience will not know; this includes the special terms which you yourself have defined.

It is a fact about human beings that an audience cannot be expected to learn more than a very few new terms in the course of a fifteen minute paper. In my case, I would not try to teach more than three or four important new terms in the course of fifteen minutes. Therefore, you as an author should cut down the terms you want to present to the limits of what your audience can probably absorb.

What then can you fill up a paper with, if you can't fill it up with abstruse terms and abstruse theorems and demonstrations?

Well, there are some more questions that are uppermost in the minds of your audience:

"For example? For instance?"

People love examples; they hate general statements. A good example is convincing, interesting, exciting, and may even sparkle with value for years and years. The very fact of its existence often demonstrates half a dozen important statements. Most general statements are uttered by people who can't think up examples. And most general statements have holes in them, areas in which they don't apply, exceptions that the person uttering the general statement has omitted to mention, and which listeners, being regularly distrustful, notice.

Every good teacher knows the value of examples and how much better they are than general statements. Somebody says: "Boolean algebra has useful applications." Oh, is that so? Can you give me an example? All right; here is an example. Here is a classic problem and its answer, which can be calculated by "Boolean algebra" to be correct:

Problem: A certain club has the following rules: (1) The financial committee shall be chosen from among the general committee. (2) No one shall be a member of both the general and library committees unless he is also on the financial committee. (3) No member of the library committee shall be on the financial committee. Simplify these rules.

Answer: The rules may be simplified as follows: (1) The financial committee shall be chosen from among the general committee. (2) No member of the general committee shall be on the library committee.

Even a listener who has no idea what in the world "Boolean algebra" is, can see that "Boolean algebra" is apparently some kind of technique which can take three statements with seven mentions of committees and turn them into two statements with four mentions of committees, and can demonstrate:

"The last set of rules is exactly equivalent to the first set of rules." To me, this example is convincing, interesting, and exciting; and it has been useful to me for changing people's minds for 25 years.

Perhaps the final question uppermost in the mind of a listener is:

"What can I myself use, apply, or remember out of the paper that I have just listened to?"

If the author puts himself into the position of the listener, and wonders what he can say that will be really useful and interesting to the listener for years and years (or even for a couple of weeks), and decides carefully what that is — then the author has a chance of being successful when he gives his paper. And if the author has decided on a good answer to this question, there is little wrong in saying it half a dozen times in different ways or with different illustrations, so that his fifteen minutes are devoted to making a concentrated, worthwhile impression on the mind of a listener.

Computer meetings would change if these suggestions were applied. There would be a change from a "pseudo-intellectual snobbery" to an attempt to teach, and teach well, and teach with excitement, and with due regard to the nature of human beings as listeners.

LOCKS FOR FRONT DOORS

Neil Macdonald

New York, N.Y.

IN REGARD TO my paper "An Attempt to Apply Logic and Common Sense to the Social Responsibility of Computer Scientists," published in the May issue, in the last part of the discussion, pp. 28-29, where four hypothetical computer scientists are quoted, expressing four stages of attitude, several people have asked me to clarify whether I approve or disapprove of all the four stages.

Personally, I think there is a great difference between working on instruments that can only be used for defense, such as locks for front doors and early warning radar computers, and working on instruments that can only be used for offense, like brass knuckles and poison gas. Personally I am convinced that locks for front doors help honest people stay honest, and that an early radar warning network is an invitation to law-abiding foreign countries to remain law-abiding.

It is nevertheless true, I believe, as Dr. W. H. Pickering of the Jet Propulsion Lab. of Cal. Tech. pointed out in "Machine's Mistake May Doom World," published in the March issue, p. 14, that computer scientists are developing intricate automatic computing devices which, coupled with ICBM's and nuclear warheads, will decide whether or not mankind survives on the earth. Computer scientists therefore, along with certain other scientists, are receiving in their hands a more terrible power than any dictator of past ages.

THE ULTIMATE COPY

Mel Carlson

Detroit, Mich.

(Reprinted with permission from The Adcrafter, May 10, 1957)

I FEEL like a war correspondent sitting here at my typewriter, trying to record the almost unbelievable events of the past ten days. Even now, with the clicking and buzzing and flashing of that THING along the wall and the utter confusion of this office, even now, it all seems impossible.

Perhaps I'd better begin at the beginning.

They brought that Electomic Cybernetic Creative Assimilator — Ecca-I, they call it — into the twenty-second floor offices of the Johnson, Jenson, Jackson & Steinmetz Advertising Agency (*where I am employed as copy chief*) shortly before dawn on July 25, 1965. I was there along with Mr. Johnson, Mr. Jenson, Mr. Jackson (*Mr. Steinmetz passed away some years ago*) and we looked on while

istered by and charged to the sales or advertising department.

Advertising Agency Buys Robot Brain

CAMBRIDGE, Mass., July 24—(UNS)—The first of two Electomic Cybernetic Creative Assimilators left the General Robotic Corporation's Cambridge plant late yesterday for delivery to the New York office of the Johnson, Jenson, Jackson & Steinmetz Advertising Agency. The remaining machine is slated for delivery sometime this week to the Lipton-Ewing Advertising Agency, also of New York.

An attempt was made to learn the function of the ECCA's but officials of General Robotic's stated only that the machines were, ". . . of a new and revolutionary design."

Orders for the assimilators were received in 1960 and they have been under construction for the past five years.

The first ECCA left here in a sealed boxcar under company guard. A spokesman for the JJJ&S agency was contacted but he refused to comment on the probable use of the "electomic brain."

white-coated electronic technicians reverently installed that massive maze of machinery.

The Ecca-I was in six units, six shiny-gray plasteel boxes, eight feet high by five wide. It looked to me like an elaborate cooling system for a king-sized soft drink vending machine . . . until it was assembled and the covers removed.

The entire thirty foot face of the machine was arrayed with an inconceivable number and variety of dials, switches, buttons and colored-lensed panels. A Rube Goldberg nightmare come to life.

The chief technician stood before the assimilator's power box, a self-contained electomic reactor-generator, and began to speak. "Gentlemen, you are about to witness the activation of the first Electomic Cybernetic Creative Assimilator ever constructed. Before throwing the switch, however, I will attempt to explain, in relatively simple terms, its function and design.

"The primary purpose of this machine is to produce creative ideas that will stimulate the emotions and the intellect into a desired reaction.

"Example: As an advertising agency you will undoubtedly want creative ideas and stimuli that will induce people to buy a certain product. By following the proper procedure, this complex electomic apparatus will not only provide those ideas, it will actually write your commercials!"

I winced at the thought. This guy should have been a salesman.

"The first step," he continued, "is to assemble all available data on one particular subject or product and then tell the operator what medias you want the copy written for: steevee, newspapers, magazines and so on so he can make the necessary adjustments. Next, you insert the statistics into this slot here," he indicated a small slot at one end of the machine.

"The data, which must be typewritten, are scanned by photoelectomic cells and then translated into a mathematical code and transmitted into the memory banks by a series of electrokinetic impulses. The memory banks, incidentally, contain every scrap of fact and theory on the psychology of *Homosapiens.* Every facet of human behavior has been electrostatically recorded along with such unrelated subjects as hypnotism, superstition, salesmanship and the study of symbolism, to name just a few.

"Now, the intricate rhythm of the electrokinetic impulses attract all related electrostatic charges as they proceed through the memory bank. Upon leaving the bank, the correlated data contained in the electomic beam is relayed to the creative assimilator. The assimilated statistics are then reduced to an equation and fed into the cybernetic calculator. The resulting mathematically correct formula will contain all the intellectual and emotional stimuli necessary to produce the desired reaction.

"At that point the main function of Ecca-I has been completed. There only remains the translating and transcribing by the machine's teleprinter."

There was along digestive silence as we stared in fascination at the gleaming plasteel giant. I had written enough engineering copy in my time to grasp the basic idea of the operation but some of my eminent colleagues seemed to have been struck speechless.

The electomic's chief was speaking again, ". . . know that when I throw this switch, the circuit will automatically lock and the power output will go on indefinitely. Ecca-I will be activated at all times."

His stubby fingers gripped the knife-switch and — like the little Dutch boy pulling his thumb out of the dike — he closed the circuit.

The room was filled with a low whine that progressed up the scale in the nerve-scratching screech of chalk on a blackboard, multiplied a hundred times. It ceased abruptly as it passed the limits of audibility.

The gray plastimetal monster next emitted a queer *chucking* and *clicking* and its many multi-colored panels glowed on and off in succession. I felt like one of Snow White's seven dwarfs as I stood watching that gibbering electomic brain trying out its circuits and relays for the first time; a giant flexing new-found muscle.

"We'll write some copy now, eh Archie?"

I repressed the remark that lay trembling on my vocal chords. You couldn't ask the senior head of the company that employed you what the hell he thought you'd been doing for the past six and a half years? Writing science fiction stories for juvenile magazines?

A mechanical copywriter. Each time the thought hit me I was filled with an impotent rage. Why, the first thing you know these *machines* would be writing novels and turning out great paintings and *manufacturing* original works of sculpture!

Johnson turned to me again. "Put a notice on the bulletin board, Archie, announcing a meeting of the entire office staff in the conference room at 9:00 this morning."

"Yes sir." Though I couldn't be sure what he was thinking, the expression on Johnson's face reminded me of a painting I had once seen of Nero playing his fiddle while Rome burned.

Johnson's explanation, later that morning, of Ecca-I's purpose and operation was met by heavy silence from my copywriting staff. Their obvious reactions ranged from amazement to amusement. They knew the tremendous cost of the machine and they also knew JJJ&S was not throwing money away on harebrained ideas but . . . *a machine write advertising copy?* The look on their faces spoke their opinion much plainer than words.

They listened while Jackson outlined the new program. ". . . and it will take from six to twelve hours to produce finished copy," he was saying. "We plan to devote the facilities of this electomic assimilator exclusively to one account, our largest, the International Tobacco Company. Our other accounts will be handled as they have in the past."

The meeting broke up on a note of amused speculation. No one believed for a minute that a conglomeration of vacuum tubes, circuits, relays and electomic energy could out-think a human mind; creatively, anyway.

We would all find out soon. They were already compiling material on International's Harem cigarettes and a copywriting demonstration was tentatively set for 12:00 noon.

The supreme insult came to me shortly before lunch time. Johnson called me into his office and asked if I would mind feeding data into the assimilator for the demonstration. He wanted me, *me* his chief copywriter, to play stooge to that king-sized erector set!

"I will be unutterably grateful, *Mister* Johnson, for the opportunity to feed typewritten fodder to that intellectual elephant." I believe he detected a slight note of sarcasm in my voice for his craggy features took on the aspects of a floating iceberg.

But I didn't care. The prospect of playing nursemaid to that *thing* aroused in my breast a primitive emotion slightly akin to murderous rage.

It was 12:30 by the teleclock on the wall as I stood watching the slot accept the typewritten sheets I nervously inserted into it. It immediately began its frenetic chattering and a weird glow was thrown onto the walls and ceiling from the tubes and flashing colored-lensed panels. The room was filled with a cacophony of noises — not sound but noises — and underlying it all came the crackling chatter of a thousand mice chewing on stiff bond paper.

In the shimmering glow of Ecca-I, the faces of the silent observers had an unreal quality, as if viewed through a camera lens just slightly out of focus. But I noticed they were no longer quite so doubtful or amused.

5:00 came but no one left for home. Ecca-I was still *chucking* and *clicking* and everyone stayed over to see the results. I felt like an old-time blacksmith awaiting his first shipment of machine-made horseshoes.

Suddenly all activity ceased. For about sixty seconds there was complete silence and then the machine's teleprinter began rattling out finished material.

I grabbed the first packet of paper before it hit the exit tray and scanned it hurriedly. There were three printed sheets fastened together (unlike the old-fashioned tele-

[Please turn to page 28]

BOOKS

and

OTHER

PUBLICATIONS

(List published in COMPUTERS and AUTOMATION, Vol. 7, No. 8, August, 1958.)

WE PUBLISH HERE citations and brief reviews of books, articles, papers, 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.**

Booth, Kathleen H. V. / Programming for An Automatic Digital Calculator / Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y. / 1958, printed, 238 pp., $7.50.

The author, a lecturer in numerical methods at Birkbeck College, University of London, discusses here the preparation of calculations for electronic digital computers. She divides the organization of such calculations into two parts: the mathematical formulation and then its actual programming. Whereas the first part requires a sound knowledge of mathematics, the second requires simply that a person have a "capacity for detailed thinking." Her text includes some of the programs used for the APEXC, a Birkbeck College computer primarily useful for its simplicity of design, rather than for speed. Because of its simplicity, the order code of the APEXC is short, and so it serves as an excellent instrument for teaching the basic ideas and techniques of programming. Techniques of programming, mathematical methods, interpretive routines and pseudo-codes are among the topics covered. Illustrative material is detailed. A short bibliography is included.

Cogan, Edward J. and Robert Z. Norman / Handbook ot Calculus, Difference, and Differential Equations / Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N. Y. / 1958, printed, 263 pp., $6.00.

The authors intend this to be a supplement to a textbook used in a calculus course covering difference and differential equations; therefore, they have presented here in concise form a review of "often-used functions as well as tables of values of the more common transcendental functions and a table of integrals." Pages 27-148 constitute tables, except for pp. 140-1.

James, Glenn, editor, and 20 other authors / The Tree of Mathematics / The Digest Press, 14068 Van Nuys Blvd., Pacoima, California / 1957, printed, 403 pp., $6.00.

This text, an outgrowth of "The Mathematics Magazine," represents the collective work of twenty-one authors to produce a book of mathematics which starts on "ground familiar to everyone," then constructs "a highway, free from road blocks, through the wonderful world of mathematics." The first four chapters introduce algebra, plane geometry, and trigonometry to readers having a background only in arithmetic. Irrational numbers, analytic geometry and calculus are then developed in turn. Vector arithmetic, infinite sequences and series, metric differential geometry, non-Euclidean and projective geometry, topology, advanced algebra, probability, and the theory of games are among the other topics developed in the total of 27 chapters. The explanations and illustrations are excellent. Bibliographies are included in case the reader wishes to carry his studies further into any specific mathematical field.

[Please turn to page 29]

[Continued from page 26]

type, Ecca-I's printing unit preferred standard-sized bond paper).

The first batch was slanted for stereovision and gave the written commercial along with the layout, setting and presentation. My worst fears were realized. Like the blacksmith who found the machine-made horseshoes better than his own, I examined the best advertising copy I had ever seen.

"Well people," I announced to the waiting group, "this copy should increase Harem's sales by at least 100 per cent. It's that good."

"I don't mean to sound disrespectful, chief," said one of my young assistants, "but how about reading it aloud so we can judge for ourselves just how good it is?"

I read just the commercial. "Savor the cigarette of Sultans. Harem's have the heady . . ." as I read on I could see the facial expressions of my audience change from doubt to wonder and then I noticed a curious thing. The printed words on the page I held were not uniformly inked. Some were lighter in color and others much darker. I listened to myself reading and noticed that I put more emphasis on the darker words and less on the lighter. The result was a strange rhythm in my voice that was almost hypnotic in effect. I even noticed a head bobbing here and there in an unconscious acknowledgment of the tempo.

When I stopped reading and looked up, my listeners seemed in a trance. You'd think advertising people would be immune to this sort of thing.

I crumpled my empty pack of Old Sols and dropped it in the disposal unit. Have to remember to pick up a carton of Harem's on the way home.

During the next few days we undertook the Herculean and improbable task of recording the sale of Harem cigarettes in New York in an up-to-the-minute report. Keeping track of the current number of cigarettes sold in a city of ten million would have been impossible without the cooperation of the merchants and the services of a statistical polling agency.

We made arrangements with newspaper, radio, steevee and the outdoor advertisers to place our new commercials as soon as they were received. Since they were already handling previous Harem copy, they merely switched in favor of the latest ads. Weekly magazines followed suit at a slower pace and we disregarded, for the time being, the monthly periodicals.

We discovered that by feeding Ecca-I all the advertising copy of rival cigarette accounts, the assimilator was able to better their ads by an incalculable margin. The buying public was inundated with Harem cigarette commercials.

By noon of July 28 — under the prodigious drive of American advertising — Mr. Consumer was on a Harem cigarette buying orgy that surpassed anything the country had ever seen. In less than four days from the time the electomic brain started to work, the whole country became cigarette conscious.

The man on the street was hit from all sides by newspapers, stereovision, radio (which even steevee had failed to put out of business) and colorful billboards ablaze in electomic splendor. And, if he lived in New York City, he was smote by giant stereovision screens — one in each of the five boroughs — displaying in full "lifecolor" the merits of Harem cigarettes.

The chaotic proof of the creative pudding was shown when *the sales figures for the other five leading cigarette companies dropped to zero!*

The JJJ&S offices were in a turmoil. Scores of people from other agencies, newspaper reporters and photographers, tycoons and stockholders, all were clamoring for admission.

The room containing Ecca-I was under armed guard.

I was sitting in the inner sanctum with the three J's (the office nickname of Johnson, Jenson and Jackson) smoking a two-dollar havana and basking in my small slice of the glory when Miss Bronson (the private, *private* secretary) wiggled in with a sheet of paper in her trembling hand. Her usual peaches and cream complexion looked like a bowl of Wheaties and buttermilk as she handed the typewritten sheet to Jackson.

Since the start of the Harem buying binge, we had been receiving an hourly report on the total sales from the Trot Polling Agency. That, I assumed, was what Miss Bronson had brought in.

I was just mentally commenting on the artistic workmanship of Johnson's dental plates when his triumphant grin froze into a sickly leer. "Good Lord," he breathed, "for the past forty-one minutes, there hasn't been a single package of Harems sold in the city!"

We gasped in unison. "B-but that isn't possible, sir, I mean . . . just a few minutes ago . . ." my voice trailed off as I tried to figure an explanation.

"Don't tell me it isn't possible," he roared, "find out what this is all about!"

I left the inner sanctum at a little more than a dead run and got on the visionphone. I found out, all right. The agency of Lipton-Ewing had just released the latest copy on their major advertiser, Bonanza cigarettes. The copy, of course, was the product of the mechanical imagination of Ecca-II. We had overlooked the fact that Lipton-Ewing had also ordered an Electomic Cybernetic Creative Assimilator.

There was nothing to do but wait until we could gather all the commercials put out by Ecca-II and run them through our machine.

This was war! And we had to mobilize. I dispatched a crew of spotters to cover the city and watch for the new Bonanza ads. The moment a billboard displayed our competitor's copy, it was called in on our private channel. There were people stationed at all the major newspapers, running over with the latest editions. We assembled a dozen steevee sets in the next office and put an observer on each one so they could watch all the channels for the latest commercials. The same was done for radio.

It was six long hours before we had compiled enough material for Ecca-I to start working again. It was another eight before the new copy was ready to go out.

All magazine contracts were temporarily cancelled. This was a war of speedy media.

I didn't even bother looking at the first batch of copy rattled off by the teleprinter. I simply snatched it out of the tray and handed it to the waiting messenger. Before I could even turn back to await the next packet, he was out the door and on his way to the steevee studios.

[Please turn to page 30]

Books and Other Publications

[Continued from page 27]

Dostert, Leon, ed. / Report of the Eighth Annual Round Table Meeting on Linguistics and Language Study — Research in Machine Translation / The Georgetown University Press, Georgetown University, Washington 6, D.C. / 1957, printed, 193 pp., $2.25.

All panel discussions and papers presented at the 1957 Round Table Meeting on Linguistics and Languages Studies were focused on various aspects of machine translation of languages, in the hope that such mechanical translation may aid in providing effective communication "among the peoples of this planet." This publication reports the study of machine translation in five main parts: "Systems of Logic in Machine Translation;" "Character Sensing as an Input to Machine Translation;" "Lexical Problems in Machine Translation;" "Scope of Syntatic Analysis in Machine Translation;" "Practical Objectives in Machine Translation Research."

Operational Research Conference, members of / Proceedings of the First International Conference on Operational Research / published by the Operations Research Society of America, Mount Royal and Guilford Avenues, Baltimore 2, Md. / 1957, printed, 526 pp., $7.50.

Reported here are the proceedings of the conference on operational research held at Oxford, England, in September, 1957. This First International Conference was attended by 250 delegates from 21 countries, and aimed "to unify and extend the science of operational research." Twenty-eight papers presented are included in the volume; also panel discussions and various reports on the progress of operational research in 16 countries.

Weinberger, A., J. L. Smith, and A. L. Leiner / System Design of Digital Computers at the National Bureau of Standards: Methods for High-Speed Addition and Multiplication / National Bureau of Standards Circular 591, Section 1; Supt. of Documents, U.S. Govt. Printing Office, Washington 25, D.C. / 1958, printed, 22 pp., 20c.

For some important applications of digital computers, increased speed is highly necessary. For this reason, there is some interest in gaining over-all speed by finding methods for organizing slower electronic circuit elements into faster over-all systems, especially by carrying out an operation simultaneously by different units in the same machine, using faster logical connections among the circuit elements. The high speed addition method described may gain a factor of 150; the high speed mulitplication method described may gain a factor of 2.5 to 3.

Readers' and Editor's Forum

[Continued from page 28]

The next seven days were a continuing repetition of the first. When our copy hit the stereo screens, the public immediately stopped buying Bonanzas and turned to Harems with increased vigor. When the new Bonanza commercials came over steevee and splashed across the electomic signboards, Harem's sales evaporated and Bonanza became the preferred product.

On the morning of the eighth day, Bonanza's were taking their turn again as the most popular cigarette and their latest slogan, BUY BONANZAS AND STRIKE IT RICH!, was on everyone's lips.

Sales were stupendous. People were seen cashing their paychecks in Bonanza cigarettes! During the fourteen-hour Bonanza craze, not another thing was sold in the city. Nothing. Not even a cup of coffee!

Ecca-I worked twelve and a half hours on our rival's newest ads and I couldn't help but wonder what it would be like when the machine released advertising copy that was infinitely better than the existing Bonanza commercials. Do these assimilators have a limit, I wondered? The buying public certainly did and they had already reached the peak of their purchasing power.

Time was so important that we didn't even allow the steevee writers the few minutes needed to layout commercials. The cameraman just focused on the printed copy and the studio writers worked right from the screen. It was quicker that way and the effect was the same. The sooner our latest fanfare reached the consumer, the more sales we rang up for Harem cigarettes. Quite a ratrace.

It's now 6:30 on the evening of August 4, 1965, and that THING along the wall has finally ceased its nerve-racking *chucking* and *clicking*. The woodpecker chatter of the teleprinter has been beating my eardrums for the past ten minutes but it will be through soon; the last messenger is awaiting his batch of copy. I no longer have to stand at the exit tray and hand the stuff out, the messengers know the routine well enough now.

I should get up and take a look at the latest Harem ballyhoo but I can wait until it comes on steevee. There's a dozen sets in the next room and at least that many people watching.

What's that strange noise? And what's wrong with the assimilator? There's a weird glow behind the quartz screen shielding the memory bank and the operator is backing away from it.

Well, that's all she wrote . . . copy or anything else. The whole front section of one unit just went sailing across the room. Lucky no one was hurt.

The machine's dark and silent now except for the occasional hiss and pop of a cathode tube. The rise and fall of the Electomic Cybernetic Creative Assimilator. I guess there was a limit. At least it went down in a blaze of glory.

Now where the hell's everyone going with that wild look in their eye? A couple of dozen people are erupting from the next office — the one containing the stereo sets — and scurrying out the door as though their pants were on fire.

Just a moment, the visionphone is flashing.

Blaze of glory, did I say? That was one of the spotters calling in on our private channel. He's trapped in a phone booth and from what he just told me, New York City's gone mad!

The new Harem copy flashed on the steevee screens a few minutes ago and people went berserk. They're rioting in the streets; breaking into stores and stealing all the Harems they can carry.

If you'll excuse me for a second, I'll go take a look at one of those steevee sets and find out just what kind of advertising commercial it is that can burn out an electomic assimilator and incite a riot.

My God, you'd never believe it! Just one little sentence. Nine ordinary words. Yet they represent the ultimate copy!

I'm afraid I'll have to leave you now. You see, I know where there's a carton of Harems and I don't want anyone else to find it.

What? You want to know what the sentence is? The ultimate copy? I should tell you so you can go looking for my carton of Harems?

Ha!

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.

WHO'S WHO IN THE COMPUTER FIELD, 1958

Each year we like to bring up to date our "Who's Who in the Computer Field." We are currently asking all computer people to fill in the following Who's Who Entry Form, and send it to us for their free listing in the Who's Who that we publish from time to time in **Computers and Automation.** We are often asked questions about computer people — and if we have up to date information in our file, we can answer those questions.

If you are interested in the computer field, please fill in and send us the following Who's Who Entry Form (to avoid tearing the magazine, the form may be copied on any piece of paper).

Name? (please print) ....

Your Address? ....

Your Organization? ....

Its Address? ....

Your Title? ....

Your Main Computer Interests?

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

....

....

Year of birth? ....

College or last school? ....

Year entered the computer field? ....

Occupation? ....

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

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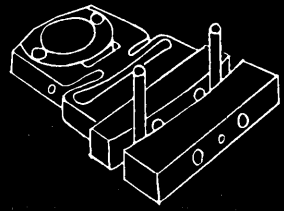
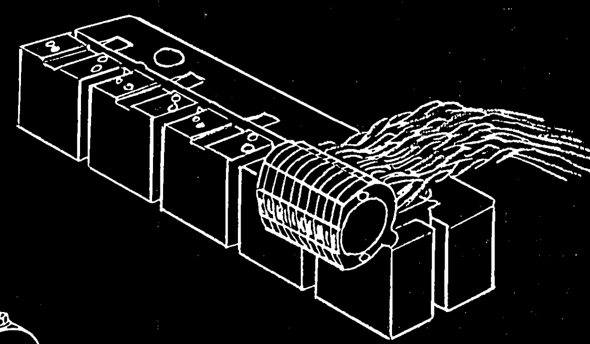
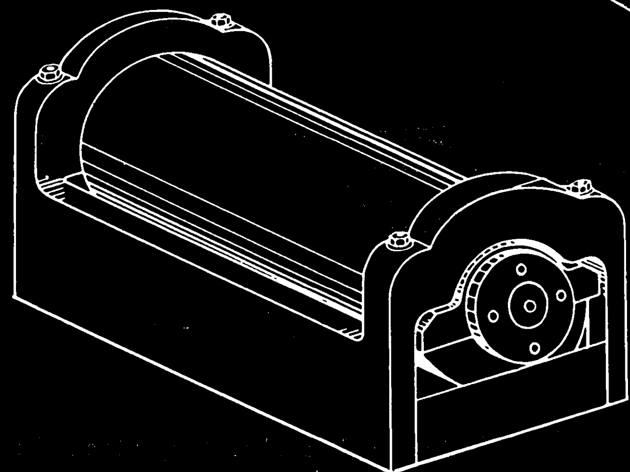
When you have filled in this entry form please send it to: Who's Who Editor, **Computers and Automation,** 815 Washington Street, Newtonville 60, Mass.



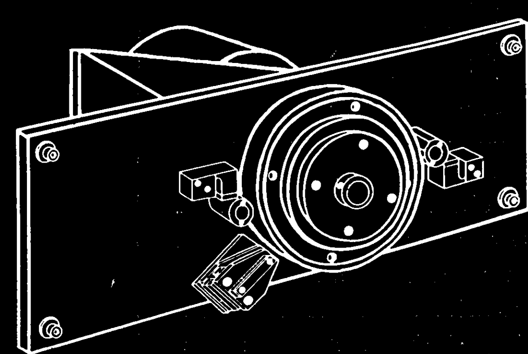
Here are High Performance Components at Budget Prices





Every project engineer can now afford to have his own magnetic storage drum . . . a truly versatile memory system . . . to expedite many jobs. Costing less than the price of a good oscilloscope, a Monrobot modular storage unit offers high performance characteristics with near custom-designed flexibility. Drum speed and head layout may be selected by the systems engineer to meet his individual requirements; belt drive models and open head mounting allow field alteration to accommodate major system changes which require different speeds or delay times. Thus, engineers can "prove out" logic without risk of obsoleting the drum before the system is complete.

Both drums and heads have shown high mechanical stability under rough field conditions and over a wide range of temperatures. The drums, offering information storage at a high density, are rigid and stable with a minimum of run-out. The read/record heads feature built-in fine calibration adjustments and can be adjusted over a delay of forty pulses while the drum is rotating. For complete specifications, write: Monroe, Dept. E, Orange, N. J.



MONROE

for CALCULATING
ADDING, ACCOUNTING
DATA PROCESSING MACHINES

Monroe Calculating Machine Company, Inc., Orange, New Jersey
A DIVISION OF LITTON INDUSTRIES, INC.
Offices for sales and service throughout the world