One microscopic bump or particle on a computer tape—equivalent in size to a grapefruit sitting on a 500-mile, four-lane highway—is all it takes to cause a parity error. There are no “grapefruits” on Ampex tape. New formula Ampex computer tapes are clean and error-free to begin with, and are formulated to stay that way for hundreds of thousands of equipment passes. You get more data throughput, unparalleled data reliability. Prove it on your own computer. Call your Ampex representative for a demonstration. Or for the latest information write Ampex Corporation, 401 Broadway, Redwood City, California 94063. You can be sure we won’t sell you a lemon — or a grapefruit.
Prefab

Building with pre-tested, standardized digital Flip Chip™ modules has these advantages.

You can build what you need now and expand later. You can get another piece exactly like the one you already have. Everything fits with everything else. Plans are available. Mass production allows favorable pricing. You have a wide selection to choose from.

Experience has eliminated the bugs. Every module is guaranteed for 10 years.

Power supplies, mounting panels, cabinets and assorted hardware are also standard. Try a prefab. Try a whole Levittown.

Write for a catalog.
We will be very surprised if the rest of the industry catches up with our new computer system in the next 5 years.

It is called Sigma 7.

It does time sharing in a real-time environment.

It is a totally integrated hardware and software package.

It was designed first of all to handle the heaviest demands of priority-interrupt processing—easily, simply, naturally.

Next it was designed to handle conversational time sharing, and all the tasks of science, engineering and business, concurrently, with the same ease and naturalness.
It can completely change its environment from one PL/I program to another in 6 microseconds, under the control of an operating system.

It can simultaneously perform real-time on-line control, time-shared conversation, batch processing, and high-speed input/output, with full protection for every user.

The only system on the market now that even tries to do what Sigma 7 does costs six times as much.

Deliveries will begin in six months. With software.
ANNOUNCES
the
UCC PROGRAM
TRADING CENTER

If You or Your Company:
- has developed and implemented a new EDP application solution
- has designed and implemented an efficient operating system
- has built and implemented a new or modified language or compiler

UCC will purchase Your system, or market Your system on an attractive royalty basis. This will enable you to:
- recover most or all of your development costs
- produce a regular repetitive income with little or no assistance on your part

Programs accepted for distribution will be nationally advertised and marketed in key metropolitan areas.

In the event your system is presently being marketed, we can assist in selective areas.

Give our Program Trading Center staff an opportunity to study a narrative description of your program.

For additional information regarding The Program Trading Center contact:

*Pricing, documentation and distribution will be supplied by UCC

UNIVERSITY COMPUTING COMPANY
Attention: PTC
1300 Frito-Lay Building
Dallas, Texas 75235
Telephone: 214 FL 7-0246
Raytheon Computer's FORTRAN IV is language compatible with FORTRAN IV (version 13) used with IBM's 7094 and is a sub-set of the FORTRAN IV designed for System/360 machines. This compatibility in an efficient one-pass processor is available only with Raytheon Computer's 520.

With Raytheon's FORTRAN IV you can exchange programs between the 520 and the 7094 and you can debug many 7094/360 programs on a 520 when either of the other machines is not available. Debugging is done faster if the 520 is equipped with its optional 1 microsecond memory and at lower cost, since the 520 runs about 1/20 the cost of the 7094 on an hourly basis. Equipment requirements are minimized too, since Raytheon FORTRAN IV runs on a 520 with an 8K memory.

FORTRAN IV is the third major FORTRAN package Raytheon has made available to 520 users and is a separate and distinct processor from the other two—FORTRAN II and Real-Time FORTRAN IV. This eliminates the overhead processing penalties usually associated with multi-purpose FORTRAN processors. Raytheon FORTRAN IV and Real-Time FORTRAN IV include all the features of the ASA standard.

Raytheon's FORTRAN IV enables real-time and hybrid installations to use the 520 for data reduction and hybrid support programs which otherwise have to be run on a 7094.

The majority of FORTRAN programmers are familiar with this language; those who do require training will be spending their time and your money learning a language that is the most widely used in the industry. Documentation effort and expense are also reduced.

The Raytheon 520, with your choice of either a 2 microsecond or 1 microsecond main memory, and input/output features like keyboard/CRT display station, disc pack and drum memory, direct memory access and improved analog interface units, is currently being specified for hybrid and real-time systems in the $100,000 to $300,000 price range. Your first step is to read the literature. Write today for Data File C-131.

Raytheon Computer, 2700 S. Fairview
Santa Ana, California • 92704
(714) 546-7160 • TWX 714-546-0444
Most people like Computape

A few don’t

The way repeat sales are going lately, there are an awful lot of people out there who like Computape.

But occasionally we run into someone who doesn’t.

Bound to happen, of course. Once in a long while it turns out to be someone who has a legitimate gripe. Like the little car ad says, nobody’s perfect.

Much more often, interestingly enough, it’s someone who has never even tried Computape. Maybe he’s found another brand that seems adequate and would rather fight than switch. Or maybe he has a feeling that the company that does the most and the loudest advertising just naturally makes the best precision tape.

We will respect his opinion without subscribing to its validity.

Nevertheless, we would like the chance to prove to him that Computape is the finest, most dependable tape that money can buy. Tape is our only business, so it jolly well better be.

Maybe you’re missing out on something good, too, just because you’ve never tried it. Why not investigate? After all, most people like Computape.

Visit our exhibit at AFIPS—Booth No. 1202-1203

A PRODUCT OF COMPUTRON INC.
MEMBER OF THE BUSH GROUP
122 CALVARY ST., WALTHAM, MASS. 02154
22 TIME-SHARING MEASUREMENT, by Allan L. Scherr. This unusual study, made with access to the Project MAC system, gives specific figures on user characteristics and the system's response, giving a measure of performance that may be useful in future design.

27 A PUSHBUTTON TELEPHONE FOR ALPHANUMERIC INPUT, by Leon Davidson. The author sees the increasingly familiar Touch-Tone telephone as a device easily adapted to fill the need for low-cost input stations.

31 PROGRAMMING THE COMPACTS, by Charles W. Walker. To reduce word length and consequently cost, many of the new small computers use sectored memories. The author describes the method used by his company to simplify programming with this type of machine.

39 DATA COMPRESSION, by Ware Myers, Michael Townsend, and Timothy Townsend. An explanation of the techniques necessary to keep up with high speed data acquisition systems in recording and reducing data.

47 ON-LINE BRANCH BANKING, by Elmer C. Miethaner. Describes a system that places teller machines at branches on-line to a central file, enabling depositors to use the facilities of any branch, and speeding both window transactions and internal operations.

54 TIME-SHARING IN BIOMEDICAL RESEARCH, by T. Allan Pryor and Homer R. Warner. A time-shared CDC 3200 system, supplemented by an analog computer, is described with examples of experiments now being monitored and analyzed.

67 ARE SMALL, FREE-STANDING COMPUTERS HERE TO STAY?, by Fred Gruenberger. The hullabaloo about time-sharing of large systems may make the 1401 user moving up to a 360/30 wonder if he's all alone in his decision; the author discusses some advantages of his position.

70 SPECIFYING OBJECT-CODE EFFICIENCY, by Christopher J. Shaw. Compiler buyers are offered a method to make sure they get their money's worth in minimum instructions and execution time.

73 THE FLIGHT TO TOKYO—1984 STYLE, by Lt. Dorian de Wind. In a sequel to Ascher Opler's article Bon Voyage—1984 Style, the author presents a transcription of the pilot/computer conversation during a flight from San Francisco to Tokyo.

75 THE BURROUGHS B2500 & B3500. Falling between the B200 and B5500, new decimal computers feature multiprogramming, hardware memory protection, and 100-nsec registers. The internal code is EBCDIC. New peripherals are also announced.

79 SPRING JOINT COMPUTER CONFERENCE. A special section highlights the technical sessions, exhibitors by product category, preview of new products to be shown, and special events.

113 A BOSTON PROMENADE, by James Peacock. Charted is a walk through downtown Boston, with rests at the Algonquin Club and Locke-Ober's, through the Public Garden, the Commons and Beacon Hill, and "Clocktail Hour" at MIT's Technology Square.
Introducing two new Burroughs 500 Systems:

B 2500 and B 3500

They’re built to respond to your needs instead of making you respond to theirs

These two new user-oriented computers are the latest Burroughs 500 Systems to be built by teams of hardware and software experts.

Burroughs started this new trend in 1960 with the B 5000, which established the value of integrated hardware/software design.

That system’s more powerful successor, the B 5500, is still unmatched by the new competitive systems that are modeled after it.

The other Burroughs 500 System, the B 8500, is the most powerful computer system yet designed.

Now, this new level of computer responsiveness to business and scientific problems is available to even the smallest organization with a requirement for electronic data processing.

Here are just a few of the impressive characteristics of the new Burroughs B 2500 and B 3500:
1. Extremely fast hardware speeds, with multimillion digit-per-second data transfers and control memories that operate in billionths of a second.

2. The ability to do many unrelated jobs at once (multiprocessing) — and to continue doing them without interruption even if you drop in a rush job on the spur of the moment.

3. An unprecedented degree of self-regulation in low-cost computer systems via a choice of two operating systems: the Basic and Master Control Programs. The Master Control Program, for example, not only does more, but requires far less resident core memory than any other on the market. It provides automatic scheduling, control over multiprocessing, memory and I/O allocation, automatic maintenance of a library of programs and data, program selection and initiation, error correction functions, interrupt handling, maintenance of the system log, and much more.

4. Programming that's so simple it can be started by one programmer and continued by another — or divided up and then integrated by the operating system. Since the housekeeping details are taken over by the operating system, the programmer is free to concentrate on the problem, not on the machine.

5. Higher level programming languages (COBOL and Fortran) which save time and money. They improve supervision by facilitating review and control of programs and by demanding standardized documentation. They improve communication by removing the "machine language curtain" between those who understand the problem and those who understand the computer.

6. A special suitability to real time, data communications and time sharing problems. With the B 3500, it is possible, for example, to process order-entry from remote locations and compile from remote locations and execute major production runs at the computer site — all at once. Yet every program is written solely to solve the problem it was assigned to handle. Automatic interrupt, full memory protection, an interval timer, program segmentation, automatic priority scheduling and other features combine to provide quick response to a wide variety of simultaneous demands, with no interference between jobs.

7. The ability to accommodate the fastest random access disk file on the market. Operating speed of this already fast device may now be multiplied by simultaneous use through up to four I/O Channels.

8. From 4 to 20 I/O channels (all of which may be active simultaneously and still leave ample time free for computation) plus multiplexors and exchanges that allow great flexibility and simultaneity of I/O operations.

9. Monolithic integrated circuit design which produces greater speed and reliability and reduces size and costs. The B 2500 and B 3500 make use of two proven concepts in the very forefront of this development: complementary transistor logic and array monolithics.

10. Emulators which make it simple and quick to convert from our B 200/B 300 systems or from 1401, 1440, or 1460 systems. These conversion aids make your old programs immediately usable on the faster, more powerful B 2500 and B 3500.

11. A responsiveness to change in all aspects of computer use — from a change in the number of peripheral units to a change in program priorities. From a switch of card to tape or from random access to real time. And under MCP control, when you add new components, more memory, more I/O capacity, or upgrade from a B 2500 to a B 3500 — anything short of changing the basic method of processing data — absolutely no reprogramming is necessary. Change on these systems is economical, quick, and orderly.

The B 2500 and B 3500 share in one other important characteristic. They are both products of Burroughs acknowledged excellence in electronic data processing.

Burroughs Corporation
Detroit, Michigan 48232
If computer experts tell you it's crazy to expect a full performance hybrid computer system that starts at a ridiculous $5,970...

See if they can wriggle out of this:

The fact is, that the CP Ten-Fifty is designed as an Analog/Hybrid main frame completely prewired and tested for simple plug-in module expansion to full hybrid capabilities. No re-wiring. No new patch boards. No re-engineering. No lost time.

Start on a minimum budget. Get just what you need right now... a fully wired console... basic controls... analog components. Then, as your needs increase, further budgeting gets you expanded capabilities... 3-mode electronic high speed switching... considerable digital logic. Finally, as your requirements grow, full expansion can include digital computer, in an all desk top hybrid facility — still at less money than you'd ever guess.

So why stay simple when you can get so beautifully complicated? The CP Ten-Fifty Analog and its built-in Logic Control System is fully compatible with major digital computers.

You've only read half the story. Send for the other half — a new brochure and a Buyers Comparison Chart that shows you where the value lies in analog computers.

Booth 509 at SJCC Boston, April 26-28

COMPUTER PRODUCTS, INC.
55 Chapel Street, Newton, Mass. 02158 Tel. (617)-244-7575

CIRCLE 10 ON READER CARD

- Honeywell 400/1400 Users Association will meet May 4-6, King Edward Sheraton Hotel, Toronto, Canada.
- National telemetering conference will be May 10-12, Prudential Center, Boston, Mass.
- National colloquium on information retrieval is scheduled for May 12-13, Univ. of Pennsylvania, Philadelphia, Pa.
- Meeting of the Canadian Operational Research Society will be May 12-13, McGill Univ., Montreal, Canada.
- SHARE Design Automation Committee Workshop will meet at the Jung Hotel in New Orleans, May 16-18.
- Course in SIMSCRIPT will be given May 16-20, Southern Simulation Service, Tampa, Fla.
- Seminar on “Management for Numerical Control” is scheduled for May 18, IIT Research Institute, Chicago, Ill.
- Technical symposium on “Developments in Multiprogramming and Multiprocessing,” sponsored by the San Diego Council of Data Processing Societies, will be held May 20, San Diego Community Concourse.
- GUIDE International Users Organization will meet at the Queen Elizabeth Hotel in Montreal, Canada, May 24-27.
- Joint spring conference of the Univac Users’ Association and the Univac Scientific Exchange will meet May 25-27, Royal York Hotel, Toronto, Canada.
- American Bankers Assn. national automation conference will meet June 6-8, Palmer House, Chicago, Ill.
- Conference on “Advances in Computing” will meet June 10 at the State Univ. of New York at Stony Brook, N.Y. Sponsors are the Long Island chapter of the ACM, and the Computing Center at State Univ. of N.Y.

April 1966

... of smaller drum memory systems. Just one advantage of the 1264B—our large economy size. Stores more than 2,000,000 36-bit words. Costs less than 5¢ per word.

Then, too, the 1264B adapts to any computer with direct memory access... offers phase modulation recording with internal parity generation and checking... is word addressable with 17.3msec average access (sequential words at 36msec).

Your application demands even higher transfer rates? Then we’ll build into your 1264B bit, byte or word parallel data format. All of this... plus electronic switching... and you still pay less than 5¢ per word.

Visit our booth #602 at SICC April 26-28

COMPLETE SPECIFICATIONS...

on the Type 1264B Drum Memory System are yours for the asking... along with our brochure providing basic data on all VRC product lines: Drum Memories, Modules and Systems.
Why invent a rack-sized mil-spec incremental tape system? Cubic has one!

Need one for your own program? A compact, rugged incremental/continuous magnetic tape system that performs the same functions as a medium-scale computer’s tape stand and synchronizer? If you need one to fit in a 10” space within an ordinary rack, then save the lead-time and trouble needed to develop it. Call on Cubic.

Cubic’s militarized tape system contains integral and replaceable control and buffer logic—all in a 105-pound unit measuring only 23”x10”x17”. It is designed to read and write computer compatible tapes in a relatively program-free manner.

It provides 23 separate and distinct I/O commands—can stack many of them to be performed in sequence. The system writes binary tapes incrementally at a speed in excess of 300 steps per second—can be converted to handle BCD tapes by moving 3 plug-in wires. Continuous forward and reverse speed is 30 IPS.

The system offers read-after-write performance, generates parity, sends a “complete” signal to the computer as operations are performed.

You get all this and more—in a system that is already on the line and at work in a military application. It provides another example of the inventive work now being done at Cubic Data Systems Division. Cubic is also producing special purpose buffers, and computer peripheral equipment.

If your needs go beyond the standard, get in touch with Cubic. Write Cubic Corporation, Data Systems Div., Dept. E-173, San Diego, Cal. 92123.

letters

priorities & costing

Sir:
In “Controlling Computer Operations” (Feb., p. 53), R. S. Haas posed a question about better ways to allocate machine time than by “signature” authority. The local laundry is a simple example of this way in that priority jobs are priced higher. Modern economics proves the virtue of such action for the most efficient allocation of fixed supply products. One direct result of such a course would be to confront the customer with the very proper question: “How important is this job to the person who is most capable of judging its importance, namely me?”

WILLIAM HURDLow
Livermore, California

The author replies: “Yes, I agree with his recommendation and see no reason why it can’t be implemented in a production shop.”

process control software

Sir:
I concur with the author’s statements (“Process Control Software,” by James D. Schoeffler, Feb., p. 33) that existing languages simply do not adequately fit all the needs of contemporary process control programming. However, in the area of scanning and logging, both common functions of all computer control systems, there is a very adequate and widely-known language which can be used to generate flexible, versatile, and surprisingly efficient programs. I refer to the everyday English spoken by all engineers.

The reality of this can be attested to by the fact that we are presently implementing a system that allows an engineer to “write” these programs by simply filling out a form in the language he commonly uses. It might be of interest to note that the word “standard” does not precede the word “form” in the previous sentence.

I must also take exception to the redundancy of having an off-line monitor as well as an on-line monitor. This is perhaps the basis for the implication in the article that monitors, by their very nature, require enormous quantities of memory when, in
If you can use a display system generating up to 500,000 char/sec...

Tasker has it: the new high-speed 922—a modular, customized system for a variety of exacting requirements in computer communications and input/output control.

Here is high-efficiency man/machine interfacing... with a system that displays analog and digital data as well as dynamic data against static backgrounds. It also features random access: 3.5 microseconds to any position. Basic equipment includes the CRT, high-speed deflection circuits, controls and power supply. Optional accessories are five input and five output devices that give the 922 flexible, universal interface compatibility. Characters are bright, flicker-free, variable in size from 0.1 to 1.5 inches, and can be shaped to conform to customer specifications. Shapes generated by the optional stroke-writer comply with MIL-C-18012.

The 922 typifies Tasker's ability to solve tough, special problems in the new electronics generation. To prevent your project from snagging on displays and computer controls, get the best of help—ahead of time—from Tasker.

look to Tasker

Tasker Instruments Corp. / 7838 Orion Ave. / Van Nuys, Calif. 91409 / (213) 781-3150

April 1966
You'll pay a little more for digital computer tape with this label on it.

800 BPI

Gladly.

Let's talk tape testing at BOOTH 508 — Spring Joint Computer Conference.
Now you can save man hours, lost data, computer time and dollars with

**NEW 8+8 TOTAL SURFACE TESTED U.S. TAPE**

Here — available from stock in 200, 300, 600, 900, 1200 and 2400 ft. lengths — is the first digital computer tape to be meaningfully certified error-free.

New 8+8 Total Surface Testing is the most stringent test procedure ever devised. Study the chart below to see why this procedure is at least eight ways better than the techniques most widely used today.

Then try 8+8 Total Surface Tested tape on your compatible system with this assurance: you will be immediately aware of superior quality, higher reliability and significant cost savings in daily use. Each reel is individually registered and guaranteed by the U. S. Magnetic Tape Company.

<table>
<thead>
<tr>
<th></th>
<th>7-track</th>
<th>9-track</th>
<th>Full-width 7/9-track</th>
<th>Total Surface 8+8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Usable area tested</td>
<td>52%</td>
<td>76%</td>
<td>88%</td>
<td>100% none</td>
</tr>
<tr>
<td>Usable area untested</td>
<td>48%</td>
<td>24%</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>2. Head alignment compatibility (of user's tape transport and tape manufacturer's test equipment)</td>
<td>critical</td>
<td>critical</td>
<td>critical</td>
<td>not critical</td>
</tr>
<tr>
<td>3. Untested edge</td>
<td>25 mils</td>
<td>10 mils</td>
<td>10 mils</td>
<td>8 mils</td>
</tr>
<tr>
<td>4. Track width</td>
<td>30 mils</td>
<td>40 mils</td>
<td>30-40 mils</td>
<td>32 mils</td>
</tr>
<tr>
<td>5. Possibility of missing migratory particles</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>6. Possibility of undetected permanent dropouts</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>7. Possibility of errors in recording channels caused by dynamic skew</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>8. Test track overlap</td>
<td>none</td>
<td>none</td>
<td>partial</td>
<td>complete</td>
</tr>
</tbody>
</table>

**Want more information?** Write today for your free copy of a new booklet entitled "The facts about testing magnetic tape for digital computers."
ASI's \textit{ADVANCE} Series computers are more than just compatible...they're downright congenial

Do you have an on-line systems problem—an engineering or scientific computer application? Consider the advantages of the low-cost 6020. An \textit{ADVANCE} Series customer can start small, develop his programs on the 6020 and when he's ready, field-upgrade to...

...the high performance 6040. Use of monolithic integrated circuitry allows extremely fast program execution. \textit{ADVANCE} Series software is designed to take full advantage of the high speed hardware. The next step in added productivity is to...

...the \textit{ADVANCE} 6050 which incorporates floating point hardware and, like all members of the series, includes the full measure of ASI's customer support program.

For special applications, ASI has designed the \textit{ADVANCE} 6070 incorporating an auxiliary arithmetic unit capability. The modular concept of the \textit{ADVANCE} Series has been designed to save you time and money. Let us give you more facts. Write or call: ASI Computer Division—EMR—8001 Bloomington Freeway, Minneapolis, Minn. 55420. Phone: 612-888-9581.
MANUFACTURERS COME ALIVE

Charles Adams, who keeps track of such things, notes that no new computers were introduced during the first quarter of '66. Thus no Adams Characteristics in this month's issue. As if to make up for this dearth, March saw two major announcements by SDS and Burroughs (see p. 75). We understand that the Burroughs announcement is only the beginning, folks. Look soon for the 6500; other "500's" will be announced later. Sigma, too, will expand.

ASI makes its move soon with a new member of a new family (see below), and Univac can be expected to remove the veils in June, when it will probably announce a "New Family Line" ranging from small- to medium-scale. A second NFL, medium- to large-scale, incompatible with the first one, will come out later. There are one or two new firms ready to jump into the game ... NCR will have to do something this year, and GE will soon upgrade its 400 family. Let's see ... who does that leave?

IF SDS IS SPRINGING, CAN ASI BE FAR BEHIND?

Following up its family of four 24-bit computers, ASI computer department of Electro-Mechanical Research is switching to the "compacts"—a series of 16-bit (plus parity and protect bits) machines. First to be announced will be the $28K Advance 6130, a totally monolithic i.c. model with cycle times of 0.9 or 1.8 usec; faster memories will be offered as available. Features will include 4-32K core, three index registers, dual indexing, hardware multiply and divide, multilevel indirect addressing and priority interrupts, hardware memory protection, single and double word-length instructions, and up to six 8- and 8-bit (2 MC) I/O channels. Optional features: direct memory access, real-time clock. Numbering is two's complement. Software will include a basic Fortran, operating and monitoring systems.

1700 COMES ON STRONG, 6800 DISAPPEARS

A shot in the arm for Control Data, lurching recently, is an order for 50 1700's from Motorola's Semiconductor division in Phoenix. (Price of a basic 4K 1700: $30K.) On one line, the machines will test transistors, look at costs, orders, then route appropriate numbers of units to customer bins. Other 1700's will be used for quality tests of integrated circuits. Now using 8090's, the company will start switching to 1700's in June, when the new machines start coming in at the rate of two per month. One source says that CDC plans to sell a thousand 1700's over the next two years.

Meanwhile, CDC has decided to pull a curtain of secrecy over its 6800, which is now considered company private. Salesmen are admonished not to quote prices. But there will be a follow-on to the 6800. Deliveries will start in the first quarter of '68.

TAPE CLINIC

A new outfit in Los Angeles called Certron is heading for nationwide marketing of its mag tape rejuvenation and recertifying service. Headed by Ed Gamson, former Ampex vp, the company looks at their business as preventive maintenance — signing up big users for
change converter function, add multiplexing in seconds

...with high accuracy, at high conversion speeds.

You get the flexibility of modular construction, together with outstanding electrical specifications in the Model 848 A-D Converter! Modular construction allows quick, easy, functional conversion changes and the addition of up to 96 single-ended channels of multiplexing (48 differential channels). Specifications include a true 0.01% accuracy (±0.1% LSB), including built-in sample and hold, and throughput greater than 30,000 conversions per second, including multiplexing. The 848 Converter is a 15-bit binary instrument which uses integrated circuit logic throughout, giving you a reliable instrument in a compact (5 1/4" high) package. Logic levels are 4 to 10 volts, output is single or double rail, with four code options: sign and absolute value; offset binary; two's complement; and one's complement.
look ahead

periodic tape cleaning and repair. Gamson sees an inviting market — about 1½ million reels of computer tape sold last year and that much again in instrumentation tape — and claims that about 80% of the tape thrown in the corner because it won’t work anymore can be brought back to life. They’ve already convinced much of the local aerospace industry and a few dozen other big installations that the plan is a money saver.

Hoping to take advantage of more reasonably priced Japanese programming talent, International Computing Services has set up shop in Tokyo, is offering its services to U.S. firms. Headed by Joe Berston, edp pro with six years experience in Japan, the company has a good head start with contracts to develop a banking package for a major American manufacturer, is also translating a 1401 program for the Univac III for a Detroit clothing chain.

TRANSPACIFIC PROGRAMMING

LITTON FINDS MARKETS FOR SPECIAL-PURPOSE MACHINES

Amid monthly announcements of gp computers, a "systems house" is quietly designing special-purpose machines for specific systems, and developing for itself a chopper of its own market. The application, automatic revenue control, cuts horizontally across the entertainment, distribution, and transportation industries — in short, wherever crowds of people with money or tickets in hand must be accommodated.

For those interested in getting into the game, the ante is high, and most $ must come from in-house. But Litton Industries' Advanced Data Systems Div. is leading the way. Installing an automatic fare-collection system for Illinois Central Railroad and the London Transport system, the ADS is also making a study and developing prototype equipment for the San Francisco Bay Area Rapid Transit District.

The systems include machines to make change, vend, collect, and cancel rides on tickets (some with oxide backing to record rides remaining), and the latest in turnstile design. Change the backdrop but not the props, and you can see this working in parking lots, theatres, and sports arenas — moving people, counting cash, and developing traffic studies simultaneously. And not a nickel is stolen.

RUMORS AND RAW RANDOM DATA

Briskly marketing its 60 megabit, 20-msec access disc, Burroughs expects to have 700 installed by the end of '66. TWA and U.S. Steel have placed orders for 200 102-million-bit, 30 msec access units; USS will have 150 units (that's over 15-billion bits worth) on line.

Meanwhile, we understand that Bryant has decided to stay out of the removable disc pack business, despite some fairly hefty order temptations. ... We hear that Tektronix, leading scope maker, will enter the display biz. ... Decimal Asci for punched cards, now being voted on as a proposed standard, will probably fail to achieve X.3 "consensus." If an IBM-led assault succeeds, extended bod -- as a de facto standard -- will be the likely winner. ... Conversion aids developed by customers may be offered 1108 users by Univac. One is a Lockheed-developed "decompiler" which converts 7094 machine language to Neliac for input to the 1108. Another, from Boeing, translates 7080 Autocoder programs into 1108 language. ... Bob Bemer, who has been coordinating GE software out of Paris, is now stationed at Phoenix. ... Persistent rumbles indicate that Fred Lang, founder and former president of Aries, will form a new software firm. He'll try to attract top-flight people with juicy stock options. HQ will be in Minneapolis.
ONLY 3C OFFERS
30 DAY DELIVERY
ON THE HOTTEST COMPUTER
IN THE $28,500 PRICE RANGE

DDP-116 computers are now operational in over 50 installations including communications, data acquisition, hybrid and other real-time control applications. Specifications include: 16-bit word, 1.7 µsec cycle, expandable 4096-word memory and keyboard with paper tape I/O unit.

Software is a proven factor! The compact DDP-116 offers as many as 134 subroutines in its ASA FORTRAN IV library. Also, it is compatible with the DAP assembler and desectorizing loader. A/D and D/A subsystems, a full peripheral line and special purpose systems capability are available to extend the flexibility of the basic DDP-116.

Write for full details, or telephone today to test operate the DDP-116 at a selected 3C regional office nearest you.

DDP-116

COMPUTER CONTROL COMPANY, INC.
OLD CONNECTICUT PATH, FRAMINGHAM, MASSACHUSETTS, U.S.A.
LONDON PARIS FRANKFURT

See Us at SJCC, Booth No. 201-205
ATTITUDES, BELIEFS AND COMMUNICATIONS

Last month in a sunny, windy San Diego, representatives of four major manufacturers faced several hundred SHARE attendees to discuss their companies' plans for PL/I. Speaking for their organizations were Lon Grace (RCA), Dick Zemlin (CDC), Charles Bachman (GE), and Bill McClelland (IBM). (Other manufacturers are thinking about or working on PL/I, but these were the only companies of those invited who accepted.)

Grace noted that while the goal of PL/I might well be machine independence, that the language—which he characterized as "very messy"—is not independent of a certain keypunch. He said RCA's effort so far is "very modest" (a subset called PL/11), but that the language, like Mt. Everest, cannot be ignored. RCA, quite interested in the prestandardization movement (see last month's Look Ahead), is "delighted at IBM's apparent willingness" to let other manufacturers take a whack at the language.

Zemlin's one-word reaction to PL/I: "expensive." And, he pointed out, the user—whether he realizes it or not—will pay for it what he hinted will be an exorbitant price. He argued that a number of small simple languages would be more economical than a universal language like PL/I, which he described as monolithic. He too stressed the importance of prestandardization development, and suggested that a Language Institute might offer a more orderly approach to software design.

Bachman thinks that the original goal of PL/I—one language for the mixed commercial-scientific installation—might be fading: PL/I is now a replacement for assembly languages. He discussed the economics of software production, indicating that PL/I could bankrupt the smaller manufacturer, prevent all from doing any one thing well. He also discussed standardization.

McClelland stressed the difference between prestandardization and standardization. PL/I, he said, is not ready for standardization; but prestandardization work might help avoid the development of different dialects.

The standardization issue dominated the discussion arising out of questions from the floor. One user said, in effect, to hell with standardization. We want a PL/I compiler now. Let IBM go ahead with it. "If this delays the other manufacturers two to three years, that's tough!" (Applause.)

The discussion revealed and underlined several attitudes about programming language development, standardization and the industry in general... attitudes which cloud cognition and impede, if not paralyze, progress.

Some statements indicate that most users really do not understand that they are paying—and paying dearly—for manufacturer-developed software. In an earlier talk at SHARE, IBM's T. J. Watson pointed out that 360 software costs (which are now estimated at $60 million for 1966) will exceed those for hardware. This is not to say, that at present, a suitable alternative exists. But belief that software is free cripples any attempt to start assessing the true cost—and worth—of software in general and specific programming support packages in particular. And it seems to us that such an attempt is necessary if information processing is ever going to apply some of its techniques to its own affairs.

Another attitude uncovered is that a language in the hand is better than two in the (standards) bush. This one is hard to debate, especially when we contrast the important programming and production problems being faced by the user right now to the pace of standards progress... and because IBM, with the help of SHARE, made a strenuous effort to come up with one language which would help solve the Babylonian programming languages dilemma. But these facts should not obscure the desperate need for an intelligent industry-wide attack on software design.

Finally, the statements about standardization—the failure to distinguish between that and prestandardization effort (whatever that is), the feeling that standardization sets upper boundaries on and freezes progress—indicate an alarming ignorance of the technical importance of standardization, its effects on compatibility, and the economics thereof. More on this topic in a subsequent issue.

We need more frequent dialogues between manufacturers, users and standards workers. And we need clearer definition and understanding of the attitude underlying their attempts to communicate.
TIME-SHARING MEASUREMENT

by ALLAN L. SCHERR

This article describes measurements made of time-shared system performance and user characteristics and discusses how they might be applied to the design of future systems. These measurements, taken on the Project MAC time-shared IBM 7094, were made as part of a larger study of analysis techniques for time-shared system performance. Users are characterized by the computational load they place on a system. The system's response to this load is a measure of performance. The statistics presented are the results of measurements made during the three-month period from December, 1964, through February, 1965, and of simulations run thereafter.

First, the operation of the MAC system is briefly explained, and the user community described. The parameters measured are defined, and the measurement techniques described. Then, the results of the measurements are presented. Finally, the usefulness of these measurements in determining aspects of the performance of future systems is discussed.

description of the MAC system

The MAC system, during the period of measurement, consisted of an IBM 7094 (Model I) two 32K 2 usec memories, IBM 1301-2 discs, an IBM 7320 A drum, and an IBM 7750 connected to Teletype Model 35 and IBM 1050 terminals. Other equipment is present (e.g., two tape channels), but is not used during "normal" time-shared operation.

By typing at his console (terminal), a user may communicate with either the supervisory program or a program activated by this supervisor. A line of input for communication with the supervisor is called a "command." Commands cause programs to be loaded from the disc. These programs are queued, and each is executed for a short period of time, not necessarily to completion. The sequence in which programs are run and the duration of each period of processor time is determined by a subroutine in the supervisor called the "scheduling algorithm".

The supervisory program is permanently resident in one of the 32K memories; the other memory is used to hold the command-activated programs while they are being executed. This second memory holds only one compiler program at a time. The other programs waiting for execution are either on the drum, split between the drum and core, or on the disc prior to the initial loading into core. At the end of a period of processing or "time-slice," the currently running program is dumped into the drum, and the next program to be run is loaded either from the drum or, if it has never run before, from the disc. Only as much of the former program is dumped as is required to make room for the latter. This process is called "swapping." The information swapped between drum and core and loaded from disc to core is called a "core-image."

Users or the programs serving them are considered to be in one of six states. These are:

a. Dead. No program is waiting to run for this user; moreover, there is no core-image being saved on the drum. This state is the normal starting point for a user just entering the system. All input lines typed while in this state are commands. After a command is typed, the user's state becomes

b. Command Wait. A program is waiting to run for this user, but has not yet run for the first time. When the scheduling algorithm decides to run this program, it is loaded from the disc, and the user's state becomes

c. Working. A program is running or waiting to run for this user. A core-image is either in core, on the drum, or split between core and drum. Upon completion of the program, the next state is Dead, Dormant, Input Wait, or Output Wait, depending on the nature of the completion. The Dead state is re-entered on the majority of final program completions; the core-image is erased.

d. Input Wait. The user's program required a line of input from the console. Input typed while in this state is sent directly to the program and is not interpreted by the supervisor. Upon the completion of the input line, the program is returned to the Working state. During the time a program is in Input Wait the core-image is saved on the drum.

e. Output Wait. Output lines to the console may occur at any time during program execution and are buffered within the 7750. If the program's buffer is full, and the program attempts to write additional

The author is now a staff engineer with IBM's Systems Design Department in Poughkeepsie and was previously associated with Project MAC for two years. He holds SB, SM, and PhD degrees in electrical engineering from MIT and is the author of the book "An Analysis of Time-Shared Computer Systems," published by the MIT Press.

Work reported in this article was supported (in part) by Project MAC, an MIT research project sponsored by the Advanced Research Projects Agency, Department of Defense under Office of Naval Research Contract NONR-4102(01). Reproduction in whole or in part is permitted for any purpose of the United States Government.

22

system & user characteristics
output, the program is placed in Output Wait. When the buffer is sufficiently empty to permit restart, the program's state is returned to Working.

f. Dormant. This state is functionally identical to Dead except that the core-image is maintained on the drum instead of being erased. This state is entered when it is anticipated that subsequent commands will make use of the core-image. This state may be entered at any time under the control of a key on the user's terminal. In addition, Dormant may be entered for a program-specified period of real time. At the end of this "sleep period" the program re-enters Working and execution is resumed.

the MAC users

The user community, during the period of measurement, consisted of nearly 300 people. Approximately 10% of the usage of the system could be attributed to the staff programmers of Project MAC who were engaged in system maintenance and the development of new time-sharing software. The remainder of the usage was due primarily to research-oriented personnel whose use of the system included simulation of computer systems, (crsp, etc.), natural language processing (snobol), artificial intelligence (lisp), data reduction, graphical data processing, numerical analysis, (fortran, mad, fap, and a version of algol), etc., etc. A small percentage of the usage could be attributed to the administration of Project MAC for personnel records, budget control, etc. It is felt that the Project MAC user community is representative of that found in the computer center of any large university. It is, perhaps, less representative of the typical scientific installation. No claims are made in this regard.

definitions of parameters measured

Most of the measurements which follow are based on what might be considered a basic unit of work on a time shared system, the interaction. The usual form of an interaction is the following sequence of events: the user thinks, types input, waits for a response from the system, and finally watches the response being printed. The process then begins again. The user may be thought of as being in either of two states: 1) The user is waiting for the system to execute a program, or 2) the system is waiting for the user. These two states correspond to Working and Command Wait, respectively. An interaction can now be precisely defined as the activity that occurs between two successive exits from either "working" or "command wait" (transitions between these states excepted).

Fig. 1 shows the sequence of events comprising a typical interaction. The activities at the console and processor necessary to complete the interaction are shown along with the states the user's program moves through. Note that the beginning and end of output at the console and the beginning of input have no bearing on the boundaries between interactions. Terminal I/O constitutes a minor load on the system and is therefore subordinated to program activity.

The interaction is divided into two segments. The first portion is the time that the user is in any of the following states: Dead, Dormant, Input Wait, or Output Wait. This part of the interaction will be called the "console portion." The time spent for the console portion is determined by activity at the console: output, input, and thinking. Since the last is generally the chief activity, this time will informally be called the "think time per interaction."

The processor time per interaction is the sum of all time slices used by the program serving the user during an interaction. This time includes processor idle time due to disc I/O not overlapped with processing. It is approximately equal to the real time in which the program would run if it were not for time-sharing. The degree of overlapping of disc I/O with processing is strictly a function of the programmer (user). Also included in this time is a small amount of overhead due to the supervisor processing interrupts-scheduling.

The second part of the interaction will be called the "working portion," and corresponds to the user's program being either in Working or Command Wait. The time spent in this portion of an interaction is defined as the response time per interaction.

In the MAC system, the program size parameter is defined as the size of the core-image. Each core-image is assigned a memory bound which may be dynamically changed. For example, the link-loader expands the size of its core-image as it loads subroutines. In order to minimize program size, "common" storage is assigned starting at location zero rather than at 32767 as is conventional in 7090 fortran, etc. Program size was measured on a command entry to either Dead or Dormant.

A command can be alternately defined as being the cause of a sequence of interactions between successive entries into either the Dead or Dormant states. A task is defined as a sequence of commands of the same type. Commands are defined to be one of five types:

1. File Manipulation-printing, combining, splitting, indexing, etc. of disc files (or "data sets").
2. Source Program Input and Editing-typing in and editing of files containing source programs written in fap, fortran, mad, etc.
3. Program Execution and Debugging-link-loading, debugging, and execution of object programs.
4. Compilation and Assembly-processing of source program files to produce object program files acceptable to the link-loader.
5. Miscellaneous—programs to save and resume core-images, programs to generate commands, etc.

The boundary between two different tasks is the changing from one command type to another. This is assumed to occur upon the entrance to either Dead or Dormant.

measurement techniques

The scheduling algorithm in the Project MAC system is entered on every user state change, at the beginning and end of every swap, and every 200 ms. Thus, the scheduling algorithm is constantly aware of the exact status of the system and all its users and provided an excellent point to place a data gathering program. Therefore, data was gathered by a program which ran as part of the scheduling algorithm. This data was reduced to frequency distributions, running totals, etc., as it was gathered. This technique eliminated the need to record an elaborate "event stream" for later processing and turned out to require very little space in the supervisor memory (about 20000 locations). Moreover, there was a negligible amount of computation added to system
overhead. Approximately 100 usec of computation was required per data point and only on the order of two or three data points were processed per second.

Because it is impossible to accurately control many of the parameters of an actual time-shared system (e.g., the number of interacting users varies with time as people "connect" and "disconnect" their consoles), the results of several simulations are also presented. Suffice it to say that elaborate checks were made to insure that the simulations matched reality by comparing the results of the former with the measurements of the latter. Much more detail may be found in Reference 4.

Except where noted, all of the measurements were made between December 29, 1964, and February 4, 1965, during 112 hours of weekday, 9 a.m. to 5 p.m. operation. Approximately 80,000 commands were monitored. The day-to-day changes in the character of the data was slight, and there was stability in the system as well as user behavior during the period of measurement.

user measurements

Fig. 2 shows the distribution of "think" time per interaction. The impulse of area .12 at time zero is caused entirely by program-generated commands. Other phenomena can be readily identified. The peak under 3 seconds can be attributed to the easily made, trivial responses (e.g., a carriage return on a blank line) occurring while in Input Wait. The peak at around 7 seconds corresponds to the user typing simple commands at their maximum rate. The user must remain in Dead or Dormant for at least two seconds due to the fact that he must wait for a standard "ready" message for the previous command. Superimposed on these maxims is an extensive uniformly distributed time corresponding to both responses requiring the user to stop and think and the times in Output Wait.

The relative probabilities of the user's activity during the console portion of an interaction are:
- User typing next command (Dead or Dormant) .23
- User typing program input (Input Wait) .58
- Program waiting for output buffers to empty (Output Wait) .05
- Program "sleeping" (Dormant) .01
- Program-generated command .12

Fig. 3 shows program size distributions. Most of the peaks in the distribution can be identified as being specific programs (e.g., the MAD compiler). The peak between 1000 and 1500 words can be attributed to the large number of programs consisting only of a few instruc-
tions and two 470-word buffers for disc I/O. Program
sizes were measured in the weeks prior to the remainder
of the data due to a size limitation placed on the data­
gathering program.
Fig. 4 shows the distribution of processor time per
interaction. Measurements have shown that the processor
time per interaction includes 3-5% overhead computation
by the supervisor and the unoverlapped I/O time re­
quired to read, write, or erase approximately 3000 words~
of disc storage. Swapping time is not included in proces­
sor time.
Fig. 5 shows the distribution of interactions per com-
mand. Table 1 shows a breakdown of all of the above
parameters except program size by task type. The pro-
portion of processor use and of user's time spent for each
task type is derived from the measured parameters and
is also shown in Table 1.

**System performance**

Perhaps the most interesting of the performance param­
eters from the individual user's point of view is the
response time per interaction.

Fig. 6 shows a typical response time distribution, meas­
ured from a simulation of the MAC system under a con­
stant load of 25 interacting users.

Fig. 7 is a graph of response time versus processor

*Measured by Mr. Thomas Hastings of the programming staff of
Project MAC during the fall of 1964.
TIME-SHARED SYSTEM . . .

operation (i.e., not simulation results). Data from weekend and evening operation is included to give points with fewer numbers of users. The ratio of response to processor time is used rather than just response time in an effort to normalize the effect of the slight day-to-day changes in mean processor time per interaction. A least-squares, 3rd degree polynomial fit to the data points is also shown.

system saturation

The phenomenon of saturation can be defined in different ways. The author prefers to express saturation in terms of the utilization of the system. Specifically, as the probability that no interacting user is in Working or Command Wait state gets smaller, the system goes further into saturation. Since this probability may become infinitesimal but never absolutely zero, a system is never "completely" saturated. Thus saturation is relative, and a saturation "point" must be defined accordingly.

The degree of saturation can be reduced in many ways: by limiting the total number of interacting users; by decreasing overhead and running times through more efficient system programming; by installing a faster CPU (or an additional processor); better swapping devices, etc.; by using slower consoles, etc.

Saturation can be clearly seen in the plot of the ratio of response time to processor time per interaction as a function of the number of interacting users. At higher loads, the curve of Fig. 8 becomes nearly a straight line. This effect can be derived mathematically.²

The saturation point can be defined as the intersection of this straight line with the horizontal axis. For the MAC system, the saturation point is at a load of approximately 22-23 users. This point can also be derived⁴ and is the quotient of the mean "think" time per interaction divided by the sum of the mean processor time and mean swap (i.e., idle) time per interaction. For the MAC system, this quantity is 35.2/(.98 + .56) = 24.4 users.

acceptable performance

Performance has been defined in terms of response time, but it should be clear that there are many other performance metrics of importance. An acceptable performance level for a particular system has no relation to the saturation point. It may, for example, be desirable to operate a system in saturation in order to use the hardware efficiently. However, the response times obtained in saturation operation may be unacceptably high. At Project MAC, it was decided that the system performance with a load of 30 users was adequate. This decision was made after varying the maximum number of users allowed on the system and balancing the user's reactions to the changes in the character of the service provided against system efficiency. Once in saturation, hardware utilization remains nearly constant; and the problem becomes that of balancing the dissatisfaction of some users because of decreased service against the satisfaction of others because more consoles are available. This problem boils down to a question of the desirability of easily available but poorly serviced consoles versus well serviced but relatively unavailable consoles.

With 30 users, the MAC system was saturated, the mean response time per interaction was approximately ten seconds, and CPU utilization for servicing users was 61%. Usage of the drum and disc for the purposes of swapping amounted to 10% and 29%, respectively. It is interesting to note that this CPU utilization is comparable to that of a conventional, batch-processing 7094 installation.

performance predicting models

One of the chief results of the author's use of this data was that accurate performance predictions can be obtained from relatively simple mathematical and simulation models derived from the parameters measured. This accuracy was confirmed by comparing the predictions of models to the actual measured performance of the Project MAC system.

A simple continuous-time Markov Process was used as a model for predicting mean response time and processor usage. Approximating the "think" time and processor time (including overhead swapping time) distributions as exponential distributions with the same mean, it was possible to predict the performance parameters within two or three per cent.

A simulation model was generated which used the distributions of Figs. 2 - 5, and the overall averages of Table 1 as input parameters. The simulation was of sufficient detail so that each of the major events recognized by the scheduling algorithm could be present. Thus, it was possible to use in the simulation program exactly the same subroutine used to schedule the MAC system. Essentially, the level of detail of the simulation matched the data: program execution was handled as merely a requirement for so much processor time; transmission of words between bulk storage and core was simulated as a requirement for a statistically chosen amount of channel time. I/O at the user's console was not included in the simulation because it was considered to place a negligible load on the system.

The above simulation was verified by comparing its predictions to measured data from the actual system. It was then possible to study the behavior of variations on the MAC system with a degree of confidence in the results.

It is felt that similar simulation models could be developed to predict the performance of proposed time-shared systems. Of course, the data presented here must be appropriately translated to reflect the environment of this system. Processor time per interaction must be scaled, the program size distribution changed to reflect the sizes of the standard command programs, etc. It is felt that the think time distribution will remain relatively unchanged under many different circumstances. In any case, using the data of Table 1 and changing the task probabilities appropriately should allow parameters to be selected for a different type of user community.

The author would like to thank the IBM Corporation, his former colleagues at Project MAC, and especially Prof. Herbert M. Teager of MIT for the aid and encouragement of this work.
Two current developments in the telephone industry are the gradual conversion to all-numeric calling and the introduction of pushbuttons to replace dials. The telephone companies are making steady progress in their campaign to remove the letters from telephone dials. Each year, more all-numeric local exchange "names" appear. Meanwhile, the pushbutton telephones (Fig. 1, p. 28) are also coming more and more into common use, as the availability of this service steadily increases in all areas of the country. This form of dial provides increased dialing speed since the digit 8, for example, can be transmitted just as rapidly as the digit 1 (as compared with a conventional rotary dial, which takes three times as long to send an 8 as a 1).

Considering both developments in combination leads to an interesting and timely question: Can the telephone dial be used as an alphanumeric input device for computer systems? This paper shows how a 12-button version of the new pushbutton telephone (Fig. 2, p. 28) might be used in a rather simple way as a mixed alphabetic-numeric input device for modern computer systems, without interfering with its ordinary use in placing telephone calls.

Present experiments with multi-terminal computer systems have indicated a current lack of low-cost, simple, input/output devices. This article presents some results of recent studies which show that the pushbutton telephone has many good features when used as a computer input device. Extension of computer services to the average home or business seems to be a reasonable and realistically attainable goal. Wider interest and discussion along this line should stimulate the early availability of other related devices (such as low-cost printer attachments) needed to make the system feasible.

status of telephone dial development
The tone-generating pushbutton telephone is now made and supplied by a number of different telephone equipment manufacturers under various trade names. There is

Dr. Davidson is currently manager of research and development at the computer laboratory of Western Union Management Information Systems Div. His previous experience includes ten years with the Atomic Energy Commission and, most recently, as manager of advanced application development at IBM's Mohan­sic Laboratory. He received a Ph.D. in chemical engineering from Columbia Univ.
enough standardization in the industry to permit discussion of the subject technically without reference to a specific line of equipment.

Each pushbutton telephone can generate two sets of quasimusical tones, one consisting of four tones and the other of three tones. These tones are assigned to four rows and three columns of a grid layout, respectively. (A tone for a fourth column has been assigned, but is reserved for future use.)

The 4 x 3 grid, defining 12 intersections or tone-pairs, has been used to lay out the present pushbutton dial shown in Fig. 1. Note that the two lower corners are not used, thus providing only 10 “tone-pairs,” which are taken to correspond to the 10 digits as used for present telephone calling purposes. Each tone-pair is recognized as a distinct digit by receiving equipment in the telephone company switching system for call purposes.

The design and manufacturing process for these telephones makes it fairly easy to provide working buttons in the two missing corners. Fig. 2 is the layout of a telephone set produced on a commercial basis by a leading manufacturer. The standard receiving equipment can be used at a computer input subsystem or input channel to recognize the full “12 digit” set as sent from such a telephone.

Note that any 10-button arrangement, in which a single button represents a single digit as when dialing a telephone number, can provide only numeric input, whether or not letters also appear on the buttons. The letters on 10-digita rotary dials or 10-button pushbutton telephones are only mnemonic guides to the user, and play no part in the actual switching operation. For obvious reasons, an input string of data composed only of the 10 digits cannot conveniently handle even the most elementary arithmetic problems, let alone handle alphanumeric requirements. There is, for example, no good way to show the start, end, sign, or decimal point in any input number. With 12 buttons, however, a good arithmetical input procedure becomes possible, and a full alphabetic capability can be provided. The remainder of this paper will discuss the use of the two extra buttons to set up a character code for specifying alphanumeric input to a computer via the 12-button telephone dial.

**Assignment of pushbutton character codes**

Any alphanumeric character set, to be generally useful, should contain all 10 digits, all letters of the alphabet (26 in English, a few more or less in the alphabets of some other countries) and at least some minimum number of essential punctuation marks, signs, or symbols. Thus, 39 or 40 characters seems to be a reasonable lower limit on the size of a useful character set. For purposes of this discussion, it is assumed necessary to provide a set which includes the 26 English letters, 10 digits, and the four symbol characters:

- Space
- Minus
- Plus
- Dot or Period

making a total of 40 characters.

**Subdividing the character set**

The concept of encoding a character set into subsets, distinguished by characteristic “zone bit” combinations, is familiar to most people who have worked with punched card or punched paper tape systems, character-oriented computer systems, or magnetic tape systems. A broadly similar concept has been used in setting up the character code for the alphanumeric pushbutton dial system discussed in this paper.

The alphabet and the four “punctuation” symbols (30 characters in all) will be divided into three convenient subsets, containing exactly 10 characters each. The assignment of characters to particular subsets depends only on the desired layout of the characters on the faces of the buttons, as will be discussed in the next section. For convenience, the three alphabetic subsets are called the “left,” “middle,” and “right” subsets, respectively. The digits will be considered to form a fourth 10-character subset.

In the 12-button telephone, 10 of the buttons are called “data buttons.” The 40 characters can now be placed on these buttons in any useful or meaningful arrangement, provided that one and only one member of each of the four subsets is placed on each data button. One such layout is shown in Fig. 3, where each data button carries a digit and three letters, one each from the left, middle, and right subsets.

Each of these 10 data buttons can be thought of as generating the computer input character which represents

---

2 Morrison, L. G., “Central-Office Receiver for Touch-Tone Calling,” Bell Lab Record, June, 1961, pp. 201-204.
the actual digit which appears on the button, whenever it is pressed.

The two remaining buttons will be called the "function buttons." These carry no characters or symbols, but generate unique characters as computer input when pressed. Call the left function button the "Left" button, and assume it generates some unique computer input code which will be represented by the letter "x" (Greek letter "lambda"). The right function button will be called the "Right" button, and the unique character which it will generate will be represented by the letter "y" (Greek letter "rho").

Several procedures may be set up for using the two function buttons in various sequential combinations to select or identify one of the four subsets: "left," "middle," "right," or "digit." One method, for example, is to depress the Left function button to identify the left subset, the Right function button to identify the right subset, and both function buttons (in succession) to identify the middle subset. When no function button is depressed, the digit subset is automatically selected.

Note that simultaneous depression of two or more buttons on a pushbutton telephone does not generate a valid tone-pair. Therefore, the combination of function buttons and data buttons must be made sequentially, rather than on a simultaneous-pressing basis.

pushbutton layout

An astronomically large number of different 12-button alphanumeric layouts may be conceived. A full "human-factors" study would be required to select a standard layout for the industry. However, from a number of cases considered in this work, two are presented here as preliminary choices (Fig. 3 and 4). In both, the present "industry standard" arrangement of the 10 digits is preserved (as in Fig. 1 and 2). The new lower left and lower right corner buttons are restricted to use as "function" buttons, and do not represent any specific digits or characters. All alphabetic and other characters appear on the 10 "data" buttons.

For telephone-dialing compatibility, it is desirable to retain the present industry-standard arrangement of the 10 digits themselves. (However, they could easily be converted to the standard office-machine 10-digit keyboard layout by interchanging the second and fourth rows, without affecting the dialing function). Experimentation was limited to assigning the alphabetic and other characters to the digit-buttons, in order to try to meet various criteria. Fig. 3 shows one case which is of special interest. It is based on precisely the same alphanumeric layout used on the present pushbutton telephones (Fig. 1) and, of course, agrees with the present rotary dials. Thus, A, B, C, are on the same button as digit 2, while P, R, S, are on digit 7 and W, X, Y, on digit 9. To produce the full alphabet in this case, the missing letter "Z" is restored to the zero-digit button, along with the "minus" and "plus" symbols. The letter "O", which has never appeared on the American telephone dial, and the characters "space" and "dot" are placed on the digit 1 button.

The chief advantage of the layout in Fig. 3 is that it is compatible with the letter arrangement on existing pushbutton telephones, should any letter-prefixes still be in use by the telephone companies (or the public) at the time that the system might be installed.

The major disadvantage of the "conventional" dial layout of Fig. 3 is the well-known and confusing difference between the locations of the letter "O" and the digit "0". Fig. 4 shows a 12-button dial layout designed to minimize this confusion by putting the "O" and the "0" on the same button. It also, incidentally, restores the letter "Q" to its proper place in the alphabet. (Note that this dial layout could also be used for 10-button telephones of the type shown in Fig. 1, although it is obviously not adaptable to a circular layout of the digits as used on present-day rotary dials.)

effect of frequency distribution on layout

There is a good reason for placing the dot character after the letter B in the alphabetic layout of Fig. 4. It is necessary to press both the Left and the Right function buttons to define the middle letter on any data button. Thus, letters which are used relatively infrequently should be included in the middle subset. The frequency distribution of English letters is often taken to start off something like "etaoin shrdlu . . ." Any letter arrangement should try to keep most of these high-frequency letters out of the middle subset. In Fig. 4, this is done by placing the "dot" character after the letter B, thus keeping both "A" and "E" out of the middle subset. Only "S" and "D" of the 12 letters noted above are found in the middle subset in Fig. 4, and neither of these is in the top six in frequency.

The conventional industry-wide layout of Fig. 3 compares poorly with Fig. 4, when judged on the above basis. Five of the 12 most frequent letters (E, N, H, R, and U) fall in the middle subset, and two of these are among the top six in frequency, E, of course, normally being the letter most frequently used.

For applications which do not involve long input messages consisting of alphabetic text, either layout should prove satisfactory.

procedure for alphanumeric input

The procedure given here would apply to any 12-button layout in which the two function buttons (in this case, the lower left and right corner buttons) do not carry any characters at all. The 10 "data" buttons each carry four alphanumeric symbols, one of which is a digit. The other

---

4 As shown in Figs. 2-4, these "function buttons" have been arbitrarily marked with a star and a diamond symbol, respectively, by the telephone companies.
PUSHBUTTON TELEPHONE...

three characters (in the layouts shown here) lie in a separate horizontal line on each button, which permits reference to the "left," "middle," and "right" characters (non-numerics) on each data button.

The essence of the input coding system proposed in this article is that any given non-numeric character or symbol is to be selected and defined by the user as follows:

1. Locate the data button on which the character appears. (Since the alphabet is laid out fairly well sequentially in either layout, this is not difficult after a short learning period.)

2. Push (tap) the button and, at the same time, observe the position of the desired (non-numeric) character on that button.

3. a. If the desired character was the left character on its button (for example, "A"), push the corresponding "Left" function button.
   b. If it was the right character on its button (for example, "+"), push the corresponding "Right" function button.
   c. If the desired character was the middle character on its button (for example, "B"), push both "function buttons," one at a time, in any order.

If the user wants to select a digit, rather than an alphabetic or special character, it is sufficient merely to press the data button on which the desired digit appears. The user must not press any function button immediately after this. Thus, a string of consecutive digits may be entered with no use at all of the function buttons.

This system of input provides for very simple computer handling and interpretation of mixed alphanumeric input strings. There is no need for any specific user action to identify the start or end of a string or substring of digits or other characters.

Each appearance of a "data button" character (i.e., digit) in the input string is a signal to the computer to decode the preceding part of the input string, starting with the most recent previous "data button" character. The function buttons that have intervened will determine the subset to be applied in translating that previous data character. (In handling the end of an input string, the end-of-message character will serve as the appropriate signal, so the last intended character will not be lost.)

Using the dial layout of Fig. 4, the message "8446T44 EAGLE." would generate the following character string as input:

\[
8 \ 4 \ 4 \ 6 \ 3 \ p \ 4 \ 4 \ 4 \ 1 \ \lambda \ 7 \ p \ 4 \ \lambda \ 2 \ \lambda \ p \ 8 \ \lambda \ \lambda \ 7 \ p \ 4 \ p
\]

For the reader's convenience, this is shown below grouped for decoding, where each appearance of a digit is a signal for the start of a decoding group:

\[
8 \ 4 \ 4 \ 6 \ 3 \ p \ 4 \ 4 \ 4 \ 1 \ \lambda \ 7 \ p \ 4 \ \lambda \ 2 \ \lambda \ p \ 8 \ \lambda \ \lambda \ 7 \ p \ 4 \ p
\]

The message, as decoded by the computer, when working with the layout of Fig. 4, is then of course:

\[
8 \ 4 \ 4 \ 6 \ T \ 4 \ 4 \ E A G L E.
\]

punctuation and formatting

Punctuation may be specified in a variety of ways, depending on the application being handled. A few simple examples follow, based on the character set used in Figs. 3 and 4.

a. A number is ended by entering its algebraic sign, + or −, or a space character, at the end of its string.

b. A number may include a decimal point or "dot" within its string.

c. An alphanumeric word or name ends with the space character.

d. The end of a sentence or statement may be defined by a dot character followed by two space characters, as in typing.

e. The "end of message" signal can be three or more consecutive taps of either function button, recognizable by hardware.

In an actual installation of the system, a suitable consistent set of punctuation could be set up for each application, and for the system in general.

application considerations

Many forms of output from a computer over telephone lines already have been developed, including "voice-answer" systems as used at stock exchanges. Small low-cost strip printers could readily be developed and produced for use as "hard-copy" output devices. With such outputs available, services could be provided from metropolitan computer centers to professional and business people, as well as to the household. Applications which do not require extensive data-base files would be the most suitable for early exploitation, since there would be no need for long trunk-lines or toll charges to obtain data from a distant computer center and no need for extensive data-gathering for file-updating. Thus, a reminder-message service or an adding-machine service might be an early application. Likewise, a "Shopping-by-phone" service could be provided, in which the housewife could directly enter catalog numbers (which usually contain letters) and other alphanumeric information.

A noteworthy aspect of the use of the 12-button push-button telephone is the capability which it provides for direct entry of machinable data into a computer system. In the reminder-message service, the future date and time for issuance of a reminder (back to the originator) can be entered by anyone, over his own office or home telephone, a roadside telephone, or a hotel phone. The text of the reminders might well be audio-recorded for future playback, but the automatic retrieval indexing would be based on the alphanumeric machinable input from the telephone dial. The reminder would be issued to the (stated) home or office phone.

collection

The technique of alphanumeric input to a computer system over telephones has been discussed in this paper from the viewpoint of the user, sitting at his telephone.

The economics of these applications will depend on many factors which need still to be resolved by discussions within the industries involved. The outlook seems good for providing low-cost access to computers for use by the general public, if the public interest is aroused in time to help shape these trends.

Although there is much still to be resolved regarding applications and hardware for telephone input-output computer service, wider discussion of these possibilities should help promote the early development of such systems.

ACKNOWLEDGMENTS

The procedure for use of the two "function" buttons to define the four alphanumeric subsets was developed with the assistance of Dr. Gerald Goertzel. The adapter used to connect a standard 12-button telephone to the computer system was designed and provided by Messrs. R. A. Jensen, W. J. Levine, T. J. Carlton. Thanks are also expressed to the staff of the Time Sharing Project, who established and maintained the real-time multi-terminal environment in which this system was run. All of the above and the author were in the IBM Advanced Systems Development Division, Mohansic Laboratory, when this work was done.
PROGRAMMING THE COMPACTS

by CHARLES W. WALKER

The recent trend in small computer design has been away from what might be called the classic single-instruction, single-address format that most word-type computers have traditionally employed. The most significant departure is in the method used to address memory. Typically, these computers are unable to directly address more than a small portion of the total memory at any given time. They generally have a memory structure of \(2^n\) words divided into \(2^m\) sectors, each sector having \(2^{m-n}\) words.

The fundamental reason for this type of memory structure is to reduce the number of address bits required in an instruction word. This is very important in the design of short-word-length computers. Take, for example, a computer having a 16-bit word length and \(2^{14}\) (16,384) words of memory. To directly address any word in a 214-word memory requires an address of 14 bits. If this 14-bit address were required in every instruction word, only two bits would remain for specifying operation codes, indexing and indirect addressing—hardly a practical arrangement. If the memory is divided into \(2^n\) sectors, the address field of the instruction can be reduced by \(n\) bits. If the 214-word memory is divided into \(2^5\) (32) sectors, the address field can be reduced to nine bits, leaving seven bits to specify the operation code, indexing, etc. This is a very workable arrangement. Several computers have been built with this general structure, some having words as short as 12 bits and sectors as small as 32 words. Of course, as the sector size decreases, the probability of any instruction being able to directly address its operand decreases.

The usual design has the contents of one or two sectors directly accessible to any given instruction. Numerous techniques have been devised to enable any instruction to access all of memory. Among the more common schemes are bank selection, displacement addressing, two words per instruction (to permit a full instruction address), indirect linkage, indexing and various combinations of the above. With instructions generally unable to directly access all of memory, the interaction between hardware and software becomes even more important a consideration than it is with computers employing the classical structure.

Desectorizing \(2^n\) software was developed to make a computer having a sectored memory appear to the programmer as if all of its memory were contiguous and at all times directly addressable, and to make possible the writing of highly efficient (both in terms of memory utilization and program execution time) relocatable programs. One of the fundamental advantages of desectorizing to the programmer is much the same as one of the fundamental advantages of an assembly program: the programmer need not concern himself with where in memory an operand is located. All that is necessary is to symbolically refer to that operand, and the assembly program will provide the proper instruction address. Desectorizing in conjunction with an assembly program provides, in addition to the symbolic reference to operands, the automatic generation of any linkage necessary to reach that operand if the operand is not directly accessible.

Before embarking on a more detailed description of Desectorizing, it is necessary to describe in some detail the type of computer to which Desectorizing is applicable.

**typical sectored memory**

Desectorizing has been developed for the Computer Control Company DDP-116 computer, which typically has a memory of 16,384 words divided into 32 sectors, each sector having 512 words. The DDP-116 instruction word consists of an indirect address indicator, an index indicator, a four-bit operation code field, a one-bit sector indicator and a nine-bit intra-sector address.

If the sector indicator is zero, the nine-bit intra-sector address addresses any location in sector 0. If the sector indicator is 1, it addresses any word in the currently active sector. The currently active sector is specified by the most significant five bits of the 14-bit program counter. This means that the DDP-116 instruction can access any one of 512 words in the currently active sector or any one of the 512 words in sector 0. If the indirect indicator is set, specifying indirect addressing, the referenced indirect address word contains an indirect indicator for multiple level indirect addressing, an index indicator for multiple level indexing, and a true 14-bit address. The true 14-bit address in an indirect address link, of course, can specify any word in the total computer memory. Basically then, for the DDP-116 instruction to access an operand neither in the currently active sector nor in sector 0, it is necessary to go through an indirect link to specify the actual operand address. It is this link that is automatically generated by the Desectorizing logic.

Desectorizing is applicable to any machine of similar

---

Mr. Walker is supervisor of software development at Computer Control Company, Inc., responsible for conceptual design, writing, and checkout of programming systems. Previous affiliations included RCA, GE, and North American Aviation. At RCA's Data Systems Division, he was a senior member of the engineering staff.

April 1966
design. The primary requirement is that the address extension (which is primarily what the indirect link is in the DDP-116) be located outside the code string—i.e., that it not be necessary for the assembly program or the loader to insert instructions in the code string during assembly or loading. We find that this basically excludes machines utilizing bank selection or two words per instruction because these methods would require that the address extension be inserted in line in the code in the form of a bank select instruction, or the second word of an instruction where necessary in the two words per instruction configuration. Of course, Desectorizing is not necessary with a computer having a two-words-per-instruction configuration provided it is acceptable that every instruction occupy two words. This in effect means that every instruction has a full address and therefore need not be desectorized; however, the program would require up to twice as many memory locations for instructions, and would take up to 50% longer to execute than a comparable desectorized program.

**Desectorizing operation**

Desectorizing results from the combined operation of the assembly program and the Desectorizing loader. The assembly program for the DDP-116 generates an extended object code which includes, in addition to the indirect and index indicators and operation field, a true 14-bit address; thus, the assembly program has generated code as if any instruction could access an operand anywhere in memory. Note that it is not necessary to include the sector indicator bit in the extended object code.

Relocatable programs, which would have been impossible had the programmer been required to do all his own address linkage, now become a trivial operation when applied to extended object code. The Desectorizing assembly program, like any other assembly program, must produce control codes for the loader in addition to the object code. These control codes provide the loader with information regarding the relocatability of each address.

Fig. 1 shows the treatment of memory reference instructions during desectorized program loading. When loading desectorized programs part or all of sector 0 must be reserved for the linkage table that is generated by the loader during the loading process. Referring to Fig. 1, we see that the loader, once having determined that it is processing a memory reference instruction, now checks to see if the instruction address is relocatable. If it is, the relocation factor is either added or subtracted depending on whether the address is positively or negatively relocatable. Note that the relocation factor is added to the true 14-bit operand address taken from the extended object code.

Having now established the absolute location of the operand, the loader checks to see whether the address that it has just developed is in the sector currently being loaded. The sector currently being loaded would be the active sector when the program is executed. If the address is in the sector currently being loaded it is not necessary to generate an indirect link, and the loader truncates the address to nine bits and places this address in the instruction word. The sector bit of the instruction is then set to 1, indicating that the operand is in the active sector and the memory reference instruction processing is complete. If the address is not in the sector currently being loaded, a check is made to see if the address is in sector 0. If so, this is also directly accessible to the instruction and the address is again reduced to nine bits and placed in the address portion of the instruction. In this case, the sector indicator is set to 0 indicating that the operand is in sector 0. If the address is neither in the sector currently being loaded nor in sector 0, a link word is generated. The true 14-bit address is taken from the extended object code and placed in the address portion of the indirect link. A check is then made to see if the instruction is indexed. If it is, the index indicator of the instruction word must be set to 0 since indexing is not desired in accessing the indirect link. The index indicator of the link word must be set to 1 so that indexing takes effect when the final operand address is formed. If the instruction was not indexed, these two steps are skipped.

Next, a test is made to see if the instruction was indirectly addressed. If so, the indirect indicator in the link word is set to 1. If the instruction was not indirectly addressed, the indirect indicator of the instruction word is set to 1. At this point the link word is complete. A search is now made of the linkage table being developed in sector 0. If an identical link is not already in the table, the new link is added to the table. In either case the sector 0 address of the link word is placed in the instruction and the sector indicator bit of the instruction is set to 0. The desectorized memory reference instruction

---

**Fig. 1. Treatment of Memory Reference Instructions During Desectorized Program Loading.**

---
is now complete. Notice that the Desectorizing logic generates an address link only when determined to be necessary at load time and that, if a link is necessary, identical links are never duplicated in the linkage table. This results in very efficient utilization of memory and also permits very efficient relocatable programs since the determination for whether a link was necessary is made at load time and not at assembly time.

**advantages for the programmer**

Let's look now at how Desectorizing helps the programmer.

Fig. 2 represents, on the left, a segment of a program as the programmer conceived it. The fields on a line reading from left to right are: symbolic location, mnemonic operation, and symbolic address. An asterisk appended to the operation indicates that indirect addressing is desired. A comma appended to the symbolic address indicates that indexing is desired.

Fig. 2 represents, on the right, the same program segment with respect to its proper location in memory. The numbers in the left-most column represent the actual memory locations. We see that a sector boundary exists between location 1777 and 2000. Instructions appearing above the sector boundary cannot directly access operands below the sector boundary, and vice versa. We see on the left the program as it originally appeared. On the right is the program as the programmer must modify it without Desectorizing to take care of the intersector references. In location 1777 the programmer has had to change his instruction from ADD X1 to ADD* (indirect) Z1 and develop an address link Z1 containing the address X1. This address link Z1 must either appear somewhere else in sector 1 or in sector 0. In location 2001 the programmer has had to change the instruction from SUB A3,1 to SUB* (indirect) Z2 and again develop a link Z2 somewhere in sector 0 or in sector 2 containing the address A3,1. Similar changes must be made in locations 2003 and 2004. Note that the address link required in location 2004 is identical to the address link required in location 2001. Had the programmer failed to notice this he would have generated a redundant address link.

When we examine the program text on the right, we find that, although it performs exactly the same function as the program text on the left was intended to perform, it bears little actual resemblance. Instructions that were indexed and not indirectly addressed are now occasionally indirectly addressed and not indexed and the actual operand address is removed from the text of the program thus making the program considerably more difficult to debug. In addition, the programmer has the responsibility for developing three address links and finding some place for these links to be stored. Having modified the original program to load correctly is only half the battle. Next come the inevitable program changes.

Modifications of the desired program, seen in Fig. 3, account for crossing a sector boundary plus its new changes and also the new modifications required to make the changed program execute correctly. We find now in sector 1 that no indirect address links are required. However, the programmer was not sure that Z1 was not used somewhere else so he has not removed it. In sector 2 a new link is required at location 2000. This link is assigned the symbolic location Y1 and has the address A3,1. The programmer has failed to notice that a similar link was previously assigned and identified as Z2. In 2001, a link that was developed to make the program load correctly last time now must be removed because the operand is in sector 2, but the link is in sector 1. Thus another change has been necessary. We find that the programmer has now produced two redundant words to his program, one for being unsure whether he can remove the link in Z1 or not, and one for not observing that the address link Y1 was identical to the address link Z2. This may appear unlikely in a program of this size and certainly it is. However, in a program filling many sectors, it is not difficult to visualize how redundant links might be left in inadvertently or for new redundant links to be generated, particularly as the program grows older and is less fresh in mind. Again, since the programmer has created the address links at assembly time, it is impossible for the loader to relocate the program at load time.

In Fig. 4 (p. 34) the program is as originally written and loaded using Desectorizing logic. We notice immediately that the program as written remains exactly as the programmer conceived it, thus it is much easier to debug and to change at a later date. Sector 0 contains the necessary linkage table. We notice also that the linkage has not been inserted in line and thus has not violated one of our fundamental rules for Desectorizing. If we examine the program as loaded into memory we will find that it very closely
THE COMPACTS...

reflects the program changes that were necessary for the programmer to make as shown in Fig. 2. However, the programmer is not aware of these changes and has not had to concern himself with them.

Fig. 4. Desired Program as Loaded Into Memory Using Desectorizing.

Without Desectorizing, as in Fig. 3, when more and more changes are made to the program, the program less and less resembles its original form and thus becomes continually more difficult to debug. With Desectorizing, program changes are made to a program written as originally conceived by the programmer; thus, symbolic addresses remain unchanged and the general character of the program is preserved. Any changes required in the address linkage are automatically handled by the Desectorizing logic.

As shown in Fig. 5. the same program in relocatable mode has been loaded so that the last location (X3) overlaps into sector 3. In the center column is the address portion of the extended object code plus the relocation factor (2762). The right-hand column shows the program as it appears in memory. Note that the reference to X3 (location 2773) requires the generation of an address link. This link appears in the sector 0 linkage table. Of course, if a sector boundary had not been crossed, no linkage would have been generated in sector 0. This example serves to illustrate how the Desectorizing loader is able to load relocatable programs and that, as in absolute programs, the requirement for an indirect address link is determined at load time rather than assembly time.

experience with desectorizing

Desectorizing has been in use with the DDP-116 as-assembly program (and with the FORTRAN IV compiler) for several months. Experience has shown that certain programming techniques tend to minimize the number of links developed by the loader. The normally good programming practice of dividing a program into relatively small logical modules has been found to be one of the most beneficial methods of minimizing address links. Another is to keep variables close to where they are used rather than placing them all either at the end or at the beginning of the program. Fully relocatable FORTRAN IV programs occupying nearly 16K of memory when loaded with their subroutines have been loaded successfully without overflowing sector 0 with the linkage table. This indicates that having \( \frac{1}{2} \) of memory available for address linkage appears to be adequate, at least from our experience to date.

Variations of the Desectorizing logic which first try to place links in the sector that the instruction is in before resorting to sector 0 are now being investigated in case \( \frac{1}{2} \) of memory proves to be insufficient when loading large programs. Many other variations based on Desectorizing are possible, such as pooling all literals in sector 0 to minimize execution time of the program and the development of various assembly-directing pseudo operations which guide the loader in making more efficient use of storage.

One such pseudo operation currently in use causes the loader to load relocatable programs smaller than a sector wholly within a sector and without requiring any indirect linkage to be generated within that program. This is particularly beneficial when loading programs that have a high use rate (such as arithmetic packages that are used in tight loops, etc.) in that execution time of the program is not increased by the introduction of indirect address links. This may also be important in the development of real-time programs where the programmer is interested in saving every microsecond possible. As more and more experience is gained with Desectorizing, many improvements are certain to be developed, but to date it has proved to be a very effective way of making a computer having a non-continuously addressable memory appear to the programmer as a contiguously addressable memory and to provide a capability for truly efficient relocation programs.
Managements across the country are combining the talents of the computer with modern communication techniques to achieve more efficient operations, improved use of corporate resources, tighter control and coordination of operating elements, and faster response to transactions. However, these benefits, and the potential cost savings associated with them, can come only to those managements that have carefully evaluated the response requirements of their data processing operations and have made these major considerations in the choice of a data communication system. This report indicates opportunities for effective and economical data communication, discusses requirements for an “on-time” system, and summarizes the equipment and services available to Honeywell Series 200 users.
DATA COMMUNICATION ADDS REACH TO YOUR COMPUTER

The ability of a data communication system to link computers, or to extend the power of a central computer to remote locations, has tremendous potential for business, industry and government. More specifically, some of the basic functions or activities that are benefitting from this capability are:

- **Customer Order Entry** — where the nature of the product or the market necessitates immediate response as to order status.
- **Control of Irreversible Transactions** — where complex analyses of information to support such actions as the granting of loans and credit are required for management decisions.
- **Data Collection** — where volume, tendency for human error, and extent of processing require greater discipline in collection methods.
- **Control of Interdependent Operations** — where involved and complex operations such as job scheduling and production control can benefit from faster exchange and processing of data.
- **File Interrogation** — where dynamically changing information such as stock price quotations must be constantly available for quick decision.
- **Customer Service** — where response to customer queries within limited waiting time is desired, as in a hospital admission or savings bank system.
- **Information Retrieval** — where provision for high-speed insertion, deletion, and access to large volumes of textual material is a requirement.

Although each of these application areas is distinguished by its particular response requirements, there is an "on-time" attribute common to all. "On-time" in one instance may mean instantaneously, or in real time. In another case "on-time" might well be within an hour, a day, or even a week. Since the cost of a system increases rapidly as the response time of the system decreases, the "on-time" requirement of an application becomes an important economic consideration.

THE ON-TIME SYSTEM

A significant feature of the communication-based on-time system is that it places a heavy demand on the computer manufacturer to provide system elements which can function in a wide range of on-time situations. The following sampling of Honeywell data communication applications indicates the flexibility that can be achieved when a product line is geared to this design goal.

- A large distributor handles 3,000 orders per day on an inventory of 20,000 items by linking two Honeywell computers at the home office to several warehouses via teletypewriter. Upon receipt of a warehouse order, the computer runs a credit check, computes quantity, brand, size, and price, and transmits the totalled invoice back to the warehouse in only minutes.
- A large manufacturer uses a Honeywell computer to control message switching for a nation-wide network of 100 teletypewriter stations concurrently with data processing. The computer receives the message from the sending station, stores it, and forwards it to the receiving station upon availability of an outgoing line.
- A racing association system uses two Honeywell computers which, in conjunction with ticket-issuing machines, record all types of pari-mutuel bets and compute odds and payoffs instantaneously.
- A Honeywell system handles some 300,000 inquiries per day for a national credit bureau. All credit inquiries are answered within 24 hours.
- A trucking firm uses a Honeywell data communication system in which several freight terminals can be linked with the home office. Among other things, the computer calculates charges and transmits final freight bills to the destination terminal before the arrival of the trucks.
- A telephone company uses a matched pair of Honeywell computers to provide long-distance operators with split-second voice response to their queries on rate information. The system handles 5,000 inquiries per hour from operators throughout a five-state region. Formerly, it took operators using a rate book 45 seconds or longer to determine the rates.

HARNESSING TWO TECHNOLOGIES

The foregoing examples illustrate the diversity of applications and organizations now using data communication. This diversity will multiply in the near future as data communication developments continue to occur at a rapid pace. Already, central processors have made significant advances in their ability to control large-scale inquiry, data collection and message-switching systems. A greater range of more economical and sophisticated terminals is appearing in the marketplace. Systems design is maturing as evidenced, for example, by more efficient joint voice-data use of telephone services. Communications facilities, services and tariffs offer more flexibility than ever before.
Since the computer is the hub of the data communication system, it is up to the computer manufacturer to provide facilities that will fully exploit the systems design flexibility offered by proliferating developments in communications technology.

**DIMENSIONAL DATA COMMUNICATION**

Dimensional data communication is one facet of the "dimensional data processing" concept underlying the design of Honeywell Series 200 systems. Under this concept, Series 200 capabilities are available in small increments making it possible to tailor a Series 200 system to meet both the functional and capacity requirements of a user's job. He needn't be saddled with oversized and costly capabilities which he does not need. Furthermore as his workload increases, capabilities can be added or expanded, gradually and economically. Inasmuch as data communications involve both a computer and communications facilities, here's how the dimensional concept applies to both of these.

**COMMUNICATION FACILITIES**

Most of the elements in a communication system — such as terminals, data sets, and communication lines — are available in a wide variety of types and capabilities and thus offer ample flexibility for precisely tailored systems, initially and as the user grows. However, in order for a computer to communicate over a particular line and with a particular terminal, the computer manufacturer must provide a communication interface designed to handle that specific line-terminal combination. The interface is therefore the key to flexibility and the cornerstone to economical systems design. The greater the variety of communication facilities that the computer can handle, the greater the chances for a system of optimum design.

Honeywell Series 200 systems are available with a full range of communication interfaces providing an extremely broad selection of line-terminal combinations (see accompanying table). Furthermore, the number as well as the variety of lines and terminals that can be combined in a single system are sufficient to fill the requirements of any application.

The Series 200 interface capability includes both single-line and multiline communication controls. Both controls are available with either character-by-character or message modes of operation. The single-line controls can send and receive data at the high speeds available through TELPAK, and still faster units can be provided on special order. The multiline controls can handle transmissions over as many as 63 lines simultaneously. It can accept varied combinations of remote terminals and can handle lines with speeds up to 300 characters per second and a total of 7,000 characters per second for all lines, a rate exceeding the requirements even of high-volume, 63-line message-switching systems.

In addition to the wide range of non-Honeywell devices that it can accommodate, Honeywell's Series 200 includes its own excellent terminals. These include CRT display devices and the Data Station, a multipurpose remote terminal. The Data Station features several optional capabilities including direct keyboarding, printing, card reading, paper tape reading and punching, and optical bar code reading — a unique capability for on-line or off-line handling of returnable documents such as insurance premiums and utility bills.

### A Partial Listing of Communication Facilities That Can be Incorporated in a Honeywell Series 200 System

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Service &amp; Line</th>
<th>Data Set</th>
<th>Transmission Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATASPEED Z</td>
<td>Voice-Grade Private Line</td>
<td>202D</td>
<td>105 cps</td>
</tr>
<tr>
<td>DATASPEED 5 RECEIVERS</td>
<td>Voice-Grade Private Line</td>
<td>402C</td>
<td>75 cps</td>
</tr>
<tr>
<td>DATASPEED 5 SEND UNITS</td>
<td>Voice-Grade Private Line</td>
<td>402D</td>
<td>75 cps</td>
</tr>
<tr>
<td>DIGITRONICS DIAL-O-VERTEER</td>
<td>Voice-Grade Private Line</td>
<td>202D</td>
<td>150 cps</td>
</tr>
<tr>
<td>DIGITRONICS TYPE I DIAL-O-VERTEER</td>
<td>Voice-Grade Private Line</td>
<td>201B</td>
<td>250 cps</td>
</tr>
<tr>
<td>FRIDEN COLLECTADAT A 30</td>
<td>Voice-Grade Private Line</td>
<td>103F</td>
<td>30 cps</td>
</tr>
<tr>
<td>Honeywell Series 200 Computers</td>
<td>Voice-Grade Private Line</td>
<td>201B</td>
<td>300 cps</td>
</tr>
<tr>
<td></td>
<td></td>
<td>201A</td>
<td>250 cps</td>
</tr>
<tr>
<td>Honeywell Data Station</td>
<td>Voice-Grade Private Line</td>
<td>201B</td>
<td>5100 cps</td>
</tr>
<tr>
<td>IBM 1050</td>
<td>Voice-Grade Private Line</td>
<td>1101A</td>
<td>103F</td>
</tr>
<tr>
<td>IBM Standard STR Series (702, 1013, 1085, etc.)</td>
<td>Voice-Grade Private Line</td>
<td>103B</td>
<td>103A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>103A</td>
<td>14.8 cps</td>
</tr>
<tr>
<td>TTY 15, 19, 28</td>
<td>5-Level TTY Circuit</td>
<td>301B</td>
<td>2020</td>
</tr>
<tr>
<td>TTY 33, 35, 37 Model 1</td>
<td>Voice-Grade Private Line</td>
<td>103F</td>
<td>100 wpm</td>
</tr>
<tr>
<td>TTY 33, 35, 37 Model 1</td>
<td>W.U. Telex</td>
<td>103F</td>
<td>100 wpm</td>
</tr>
<tr>
<td>UNIVAC 1004/DLT2</td>
<td>Voice-Grade Private Line</td>
<td>201B</td>
<td>2020</td>
</tr>
<tr>
<td></td>
<td></td>
<td>201A</td>
<td>300 cps</td>
</tr>
<tr>
<td></td>
<td></td>
<td>201A</td>
<td>250 cps</td>
</tr>
<tr>
<td>W.U. TELEX</td>
<td>W.U. Telex</td>
<td>301B</td>
<td>5100 cps</td>
</tr>
</tbody>
</table>

*Trademark of American Telephone and Telegraph Co.
†Trademark of Digital Data Corp.
‡Trademark of Friden, Inc.
*This capability handled by single-line control only
†This capability handled by multiline control only
THE COMPUTER

All Series 200 processors are program compatible. This and the fact that Series 200 encompasses a variety of input/output devices, all of which are available in many levels of capability, enable the user to tailor his system to the exact dimensions of his data communication job.

As an example of the Series 200's modularity, memory for the Model 200 starts at 4K characters and can be enlarged in 4K increments up to 32K and, from there, in increments of 8K up to 65K characters. Similarly, memory cycle times in the Series 200 start at 3 microseconds per character, then drop to 2, 1.5, 1, 188 nanoseconds, and 94 nanoseconds. Hence, the appropriate processor speed and memory size can be selected to meet both conventional and communication loads.

A unique input/output scheme and a hardware interrupt capability enable Series 200 systems to handle communications while simultaneously providing high production rates on conventional data processing applications. All Series 200 systems can handle multiple input/output data transfers simultaneously with computing; thus, they can send and receive messages over communication lines at the same time that input/output devices engaged in regular production runs are running at high speeds.

Series 200 also offers a wide range of peripheral capabilities for both real time and batched processing needs. There are 13 magnetic tape units ranging in data transfer rates from 7,200 characters per second to 96,000 characters per second. Honeywell's new Mass Memory File is available in three models, offering a range of on-line storage capacities up to 2.4 billion characters per control unit and random access times as low as 95 milliseconds. For faster access when storage requirements are less, a control/drum subsystem holding up to 20-million characters provides access to any record in an average time of 27.5 milliseconds.

A full complement of software is provided to handle communications for any type of application. This software includes those routines for interrupt handling, real-time input analysis, output stacking, random access storage, line utilization and determination of line availability, and data protection. All communication software may perform in conjunction with Series 200 Operating Systems.

MAKE YOUR OWN COMPARISON

The following table lists important characteristics in a data communication system. Honeywell's capabilities can be compared with those of any other system by filling in the appropriate data in the blank column provided.

<table>
<thead>
<tr>
<th>Check List of Data Communication Features</th>
<th>Honeywell</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CENTRAL PROCESSOR</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simultaneous production and communications?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>I/O interrupt?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Memory protection features?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Program compatibility for backup?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Small-unit modularity?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>INTERFACE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single- and multiline interfaces?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>No. of lines per multiline interface?</td>
<td>Up to 63</td>
<td></td>
</tr>
<tr>
<td>Character and message modes?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Maximum line speeds: Single-line</td>
<td>5100 cps*</td>
<td>300/7,000 cps</td>
</tr>
<tr>
<td>Multiline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gradually expandable line-handling ability?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Automatic switching for backup?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>SOFTWARE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication-handling routines for:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interrupt?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Real-time input analysis?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Output stacking and interfacing?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Random access storage and retrieval?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Line status?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Data protection?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Choice of operating system control?</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

*Higher speeds on special order

WRITE FOR MORE ON HONEYWELL COMMUNICATION DATA CAPABILITIES

Honeywell's concept of dimensional data communication insures an exceptional opportunity to control costs by fashioning your system to the dimensions of your workload. For more detailed information on Honeywell communication capabilities, complete and mail the accompanying coupon.

Honeywell
ELECTRONIC DATA PROCESSING
DATA COMPRESSION

by WARE MYERS, MICHAEL TOWNSEND and TIMOTHY TOWNSEND

Modern data acquisition systems are capable of producing digital data at high rates, in the tens, or even hundreds of thousands of samples per second. In logging applications, they are operated around the clock for weeks at a time. As a result, enormous volumes of digital data are obtained.

Data compression eliminates redundant data and retains useful data, simplifying the operations which follow digital data acquisition. These operations are recording, transmission, and data reduction, all expensive to various degrees. Also, each operation faces technical limits. For example, in the case of magnetic tape recording, there is a limit, in the form of tape speed and packing density, to how much data can be recorded in real time. Transmission, especially over a great distance, is limited by bandwidth. Data reduction is limited by the capacity of the computer, and this limit is particularly pertinent in on-line installations.

Activities which may profit from the use of data compression include test operations, process control, and scientific experiments.

Test operations are of two kinds: relatively low-speed, long-term tests such as those performed in environmental and space-simulation chambers; and high-speed, short-run tests such as firing a rocket engine. Even in long-term tests, certain parameters may exhibit transient, high-frequency behavior at intervals, separated by long periods of inactivity.

In process control, it is common to log many parameters on a 24-hour-a-day basis. One problem results—what to do with all the data? If the data is compressed first and then logged, the volume of data which must be examined by the plant operators is greatly reduced. Chemical processes, petroleum refineries, steel mills, utilities, and dry-process plants may profit from data compression.

When experiments are conducted in space or other inaccessible locations, the telemetering of data back to the experimenter may be seriously restricted by bandwidth limitations. The compression of the data, prior to transmission, can greatly increase the proportion of useful data.

It should be noted that the quantity of samples taken cannot be reduced simply by sampling less often. The reason is that the sampling rate is directly related to the frequency of the analog signal. Sampling theory dictates that a signal must be sampled several times faster than the highest frequency component of interest. Thus, the sampling rate must accommodate the maximum frequency that is expected to occur on each channel during a run. Yet, as a matter of practical experience, it is known that many of the data sources in typical instrumentation systems remain quiet a good part of the time.

The periods of inactivity during which the signal is unchanged thus constitute unnecessary or redundant data. In general, this redundant data is eliminated by electronically comparing each successive data value with a criterion, rejecting those which fail, and recording or processing those which pass. The data which survives has been compressed. Compressed data can better meet the quantity limitations of transmission systems, recorders, and digital computers. Compressed data, too, can be processed through smaller, less expensive systems and can be handled in less time.

Before resorting to data compression, as described here, several other means to cope with excessive data should be utilized, if possible. For example, by careful analysis of engineering requirements, it may be possible to eliminate some measurements altogether.

Types of data compression

Two types of data compression may be distinguished: one where the criterion is a limit, and the other where the criterion is a tolerance. The idea of a limit is illustrated in Fig. 1. (p. 40) Each digital value is compared with an upper limit and a lower limit. If the sample is between the limits, it is discarded. If the sample exceeds the upper limit or falls below the lower limit, it is passed to storage.

In the diagram, small circles indicate the significant samples. The tolerance concept is illustrated in Fig. 2 (p. 40). Here the rule is: if a new digital value varies by more than a predetermined amount, or tolerance, from the last value, the new sample is significant and is passed to storage; if the difference is less than the tolerance, the new sample is not.

Ware Myers is a writer-editor at SDS Data Systems, producing engineering bulletins to explain the operation of the company's digital data acquisition systems, and a part-time lecturer in engineering at UCLA. He has also been a systems engineer and supervisor of technical publications and has an engineering degree from Case Institute of Technology and MS in Administration from USC.

This term and others that may be unfamiliar to readers are defined in a brief glossary at the end of this article.
DATA COMPRESSION

passed. Small circles identify the samples which are out of tolerance. Note that the tolerance band is shifted each time a significant sample occurs.

These two diagrams show a single channel and a single value of the limits or the tolerance. When more than one channel is involved, it may be necessary to use different values of the limits or tolerance for different channels or groups of channels. For example, measurements using the same type of transducer and signal conditioning equipment may be compared against the same criterion, but measurements from different sensors may require a different criterion.

As the conditions of operation change, the location of the limits may be changed and the width of the tolerance band may be varied. The source of change commands may be either the operator or an on-line computer.

Elapsed time may be used as a factor in the determination of redundancy. With this technique, the tolerance to be applied is continually decreased as the time elapsed between the last time a sample was recorded and the current instant increases.

The limit concept may also be used for alarm purposes. In this application, the limits are usually set farther out than in data compression alone. When a sample falls outside these limits, the sample may be displayed and printed out, the printout may be flagged to call attention to it, and contact to an external alarm is activated.

implementation

A data compressor to implement the tolerance concept consists essentially of a memory, an arithmetic unit, a comparator, and logic circuits. The memory is used to store the last significant digital value—termed the reference value—and the tolerance. The arithmetic unit forms the absolute difference between the current sample value and the reference value. The comparator determines whether this difference is greater than or equal to the tolerance. From this comparison, the logic circuits either pass the current sample or discard it.

Implementation of the limits concept requires a memory, a decoding network, a limits storage-device, several comparators, and logic circuits. The memory is used to store—

for each channel of the data system—an address which designates one of a number of pairs of limits, contained in the limits storage-device. The decoding network, given one of the addresses, selects one of the pairs of limits. This pair is applied to the comparators where the current sample value is compared with the upper limit and the lower limit. If the sample falls outside the limits, the logic circuits pass the sample value.

It is evident that both types of data compression utilize a series of functions which may be found in a general-purpose digital computer or may be specially designed for a particular application from digital logic circuits.

hardware approach—tolerance method

To meet the requirements for processing data generated by the Mark I Aerospace Systems Environmental Cham-

Michael J. Townsend is an associate systems engineer in the Digital Systems Department of SDS Data Systems. He was responsible for the design of the 200,000-sample-per-second data compressor described in this article and was project engineer on the entire data processing system. He graduated from California Institute of Technology.
limits speed of the tape recorder to overall compression factor must average at least 53.1. In this unit is capable of receiving and compressing channels. Since the compression output rate is limited by the speed of the tape recorder to 3750 samples per second, the overall compression factor must average at least 53.1. In other words, for every significant data value recorded, at least 53 redundant readings must be discarded.

The data samples entering the data compressor (Fig. 3) have been commutated and digitized and are in parallel 11-bit binary form. Also entering the data compressor are channel numbers in binary form. At the beginning of the data-compression cycle, the channel number is applied to the channel-number hold register and the corresponding data sample is applied to the data-value hold register. The contents of the channel-number hold register are next applied to the address input of the data-compressor memory. This memory is a random-access device, and since the channel number is in binary form, one memory location is related to each channel number.

Stored in the data-compressor memory are three numbers, each in binary form. The reference number is the last significant data value. The tolerance determines whether the next sample value will be found to be significant. The bypass number, a single binary bit, simply provides a known condition, on or off, to be used for bypass purposes.

When the memory is interrogated at the location specified by the channel number, these three numbers—reference, tolerance, and bypass, appear in the memory's output registers. The reference value is applied to the arithmetic unit along with the present data value from the data-value hold register. The arithmetic unit forms the absolute binary difference—present sample value minus reference value.

This difference is applied to the comparator, along with the tolerance from memory. The comparator determines whether the difference is greater than or equal to the tolerance. If the sample is within the tolerance, the present data value is redundant and is discarded. The three numbers, reference, tolerance, and bypass, are then returned to memory and the data compressor waits for the next sample and channel number. If the difference is greater than or equal to the tolerance, the present data value is significant. Logic circuits act to replace the reference with the new sample value in memory, restore the tolerance to memory, and pass the present data value on to the recorder.

This series of actions constitutes the basic steps of data compression. Prior to a data run, however, the memory is programmed with the appropriate tolerances. Since each tolerance may range in size from zero to the maximum available to the data sample itself (that is, full scale), and since the resolution of the tolerance is the same as the data value, a tolerance can be found to specify any degree of redundancy. Also, since there is a position reserved in memory for each channel, each channel may therefore be assigned the tolerance appropriate to it and it only.

At the very beginning of a data run, there is, of course, no reference value stored in the data-compressor memory. One sample of each channel is passed, both to be placed in memory as reference and to be recorded on tape for data-reduction use.

The bypass signal is used to record a single sample from each channel periodically, regardless of the result of the comparisons. The bypass procedure enables the system to avoid long intervals with no samples. The bypass signal, selected by a rotary switch, is a clock signal. At the beginning of the selected time period, a transition occurs on the bypass line and triggers the recording process. Bypass time can be established at any intervals desired. In the present system, seven intervals were provided, ranging from five seconds to thirty minutes.

Bypass capability is also useful in checking the performance of the compressor since the bypassed readings may be compared to the edited readings. It is significant to note that the data compressor is not interrupted during the bypass. Both operations are carried on simultaneously. Furthermore, on operator command, the compressor may be set to bypass all data. Any particular channel may also be bypassed, in effect, by setting the tolerance at zero.

It is necessary for a data-acquisition system to record time along with data samples, since the time at which the value occurred is itself a significant datum in subsequent data reduction. Yet, during periods of no data recording, time recording should be inhibited also. This is the function of the time editor.

The time editor accepts two logic inputs: the record signal, indicating that a new data value is ready to be recorded; and a time-code change signal. When both of these signals are present, the time editor emits a signal enabling the time code to be recorded on the output tape.

It is important to note that the data compressor passes samples on what may be termed a random basis. That is, different channels are passed through the data compressor on the basis of amplitude variations which are entirely unrelated to sampling rate or to scanning sequence. As a direct consequence, each data sample recorded must be fully identified, both by channel number and by time. Therefore, all of this information—data, channel, and time—must be accumulated and organized in a storage buffer.

If the data compressor passes information faster than the maximum recording rate, the buffer fills to capacity. It rejects further incoming data until output provides space in the buffer. Recovery from this condition is automatic when the input rate decreases. All data recorded is valid; however, the rejected readings are lost for real-time consideration. In this system, however, a wideband analog recorder holds the analog signals and the rejected data can be recovered later.

If buffer fill occurs, the condition is indicated by a flag on the digital tape. The time of this flag can be used as a target to search the analog tape.

**Hardware Approach—Limits Method**

A design using upper and lower limits as the criteria of data compression is diagrammed in Fig. 4. As in the tolerance data compressor, the channel number and the new data sample, in binary form, are entered into hold registers. The contents of the channel-number hold registers are applied to the address input of memory. Stored
DATA COMPRESSION

in memory is a single three-bit binary number for each channel. This number is the address of one of eight pairs of limits.

Each pair of limits originates in a pair of digital thumb-wheel switches, located on a control panel. The digit-switches may be set at any decimal number within a four-digit range. Each of these eight low limits and eight high limits may be established at any value from minus full scale to plus full scale with the same resolution as the data sample. Although manual input to the digit-switches is in decimal digits, output is in binary form.

The binary outputs of the digit-switches selected by the three-bit address, representing high limit and low limit, are applied to two comparators. At the same time, the new data sample is entered into the comparators. If the sample exceeds the high limit or falls below the low limit, a data-record signal is produced by the corresponding comparator. This signal, together with the time-record signal

(derived in the same way as in the tolerance data compressor), then produces a record signal which enables data sample, channel number, and time code to be recorded.

When the tolerance concept and the limits concept are both employed in the same application, the hold registers and memory can be used jointly, realizing some economies in hardware.

computer approach

The use of a digital computer on-line with a data acquisition system to compress data is demonstrated in a system built to instrument a months-long operational test of a nuclear reactor. This system accepts 500 channels but samples them at a fairly slow rate, one sample per channel per second. A program flow chart for data compression alone is contained in Fig. 5. In the actual system other functions—calibration, linearization, conversion to engineering units, alarm check, and diagnostic monitoring—are included in the complete program flow chart.

Referring to Fig. 5, the interrupt which begins this subroutine is given every four milliseconds by a time-of-day clock. The interrupt causes the computer to output in parallel to the data system either two or three addresses, depending upon the cycling sequence. If the sequence is at the beginning of a new scan, the computer transfers three coded addresses calling for time, constant 1, and constant 2. These numbers are stored in memory, pending output to digital tape if the data value with which they are associated turns out to be significant.

Meantime, if the sequence is beyond the beginning of the scan, the computer transfers two coded addresses calling for data values from two channels. The choice of the data addresses is determined by the information supplied to the computer on paper tape by the operator during the initialization program. Two data values are transferred in parallel to the computer memory and placed in an input table. The first data scan, of course, is always recorded and is also stored in an output table in memory, identified on the flow chart as the reference data scan. Each data sample in the reference scan is subtracted from the corresponding data sample in each new data scan, forming the absolute difference.

This difference is compared with the tolerance values for each channel, also stored in memory. In this instance, the same tolerance value is used for all channels. If the difference falls outside the tolerance value, then the sample is significant. The computer tests for end-of-scan. If the sequence is at end-of-scan, the computer resets an output flag and starts outputting time, constants, and data for the entire scan from memory to digital tape. If the sequence is not at end-of-scan, the computer sets the output flag. On the other hand, if all the data samples are within tolerance at the end-of-scan, as revealed by whether the output flag is set, the computer tests for tenth scan. Every tenth scan is recorded even if all the data values in this scan are within tolerance.

The foregoing is a particular example of data compres-

<table>
<thead>
<tr>
<th>CHANNEL NUMBER</th>
<th>HOLD REGISTER</th>
<th>HOLD REGISTER</th>
<th>MEMORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIMITS ADDRESSES (0-7)</td>
<td>LIMITS THRESHOLDS</td>
<td>LIMITS THRESHOLDS</td>
<td>LIMITS THRESHOLDS</td>
</tr>
<tr>
<td>COMPARATOR $S_1$</td>
<td>COMPARATOR $S_2$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIME CODE CHANGE</td>
<td>DATA RECORD SIGNAL</td>
<td>TIME CODE CHANGE</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 4 Simplified Block Diagram of Principles of Operation of Limits-Type Data Compressor

Fig. 5 Program Flow Chart for Data Compression

---

42 DATAMATION
sion by programming a general-purpose computer. General-purpose programming, of course, is highly flexible, permitting other variations of data compression to be easily programmed.

**computer or special hardware**

As we have seen, both special-purpose digital units and general-purpose computers may be used to accomplish data compression. In the examples given, a specially designed data compressor was employed to handle a very high sample rate—200,000 samples per second. On the other hand, when the sample rate was only 500 per second, data compression was performed by the on-line computer along with a number of other computational and logical functions. The question arises of when to use a computer and when to use a special unit.

For either approach, it is evident that there must be core-memory capacity (or the equivalent in some other form of high-speed memory) to hold the new digital samples, the reference samples, and the tolerances. There must be input registers and an output buyer to format the data for recording. The cost of memory for a special-purpose compressor and the cost of adding memory to an expandable computer memory are comparable. The cost of registers and buffers is similar in either case. The differential cost, in the case of the specially-designed unit, lies in arithmetic, comparator and logic circuits, and in system design. Excess cost, in the case of the computer, lies in features and capabilities not needed for data compression.

Now, if an on-line computer is going to be employed for other functions anyway, and if the computer will have time left in the computation cycle to perform data compression, then certainly it is economical to employ this computer for data compression. For example in the 500-sample-per-second system already referred to, an on-line SDS 910 computer was required to perform the following operations on two data samples every four milliseconds.

The time required to process the two data samples, worst case, was estimated to be as follows:

<table>
<thead>
<tr>
<th>Operation</th>
<th>Time (us)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output two addresses to system</td>
<td>200</td>
</tr>
<tr>
<td>Input two data samples to computer memory</td>
<td>200</td>
</tr>
<tr>
<td>Linearize, convert to engineering units, and alarm check</td>
<td>1300</td>
</tr>
<tr>
<td>Set alarm contacts</td>
<td>100</td>
</tr>
<tr>
<td>Format output table</td>
<td>100</td>
</tr>
<tr>
<td>Data compression</td>
<td>200</td>
</tr>
<tr>
<td>Typewriters and displays</td>
<td>200</td>
</tr>
<tr>
<td>Write magnetic tape</td>
<td>400</td>
</tr>
<tr>
<td><strong>Total time</strong></td>
<td><strong>2700</strong></td>
</tr>
</tbody>
</table>

This processing time, 2700 microseconds, left 1300 microseconds in each computation cycle, an idle time of 32%. In this situation, it is apparent that data compression can be accomplished at no additional cost.

On the other hand, if the system sampling rate is very high, then an on-line computer may not have sufficient capacity to perform data compression in real time, let alone accomplish other functions as well. For example, if the system speed is 200,000 samples per second and data compression takes 100 microseconds per sample, the time to compress 200,000 samples would come to 20 seconds, far exceeding the one second available in real time. Thus, it is clear that data compression, at a sufficiently high sample rate, can be more economically performed by special-purpose equipment.

The 200,000-sample-per-second system employs both a computer (SDS 910) and special data-compression hardware. The computer controls many functions of the data compressor: it can modify tolerances; it can specify which channels are to be sent to the computer; and it can initiate bypass periods. Then, following these manipulations, the computer has time to reduce the compressed data on line.

In this system, the data compressor may be thought of as an extension of the power of the computer, particularly since the normal operation of the data compressor requires no computer time (other than input time for compressed data). So, in this sense, there is an argument, and an application; for both a computer and a hardware data compressor in a large-scale, high-speed data system.

In any proposed application, it is necessary to consider a number of factors before deciding which approach to pursue. What is the sample rate—which in turn depends upon the number of measurements and the frequency characteristics of the analog signals? What is the expected ratio of raw data to compressed data? How many bits precision are necessary? What on-line data reduction operations are required? What is the limiting rate of recording or transmission in the proposed system?

Once these design parameters are approximated, the capabilities of specific computers can be evaluated against the requirements. If available computers fall short, then data compression can be assigned to hard-wired equipment. With the program wired in, a data compressor can achieve a higher speed of operation than a general-purpose computer employing the same level of technology. In the intermediate area, where both approaches are technically possible, the decision rests on economic factors.

**DEFINITION OF TERMS**

**Bypass**: a secondary channel permitting a data sample to be routed around the data compressor, regardless of the sample’s value, at intervals selected by the operator.

**Comparator**: an electronic circuit which compares the absolute difference (between the current data sample and the last sample passed) with a redundancy criterion (which may be a tolerance or a limit), and determines whether this difference is greater than, or equal to, the criterion.

**Data Compression**: the process of reducing the number of digital data samples, which are recorded or transmitted, by excluding redundant samples.

**Decoding Network**: an electronic circuit which, when a particular combination of inputs is on, produces an output on one of a number of output lines.

**Initialization**: the process of supplying information (memory locations for data and results, tolerances, limits, etc.) to a computer prior to running a program.

**Redundant Data**: a data sample close enough in value to the preceding sample from the same source as to be of no interest in connection with subsequent analysis of the experiment or test, except the fact that the data sample is redundant.

**Sampling Theory**: the sampling theorem (developed by Nyquist in 1928) states that two samples per cycle will completely characterize a band-limited signal; that is, the sampling rate must be twice the highest frequency component. In practice, the sampling rate is ordinarily from five to ten times the highest frequency.

**Subcommutation**: the act of connecting one data source to a sampled-data system less frequently than other data sources.

**Supercommutation**: the act of connecting one data source to a sampled-data system more frequently than other data sources.

**Time Edit**: to exclude the time code from being recorded or transmitted during periods when data samples are not being passed; or conversely, to record or transmit the time code with each data sample passed.
How can Potter offer a chain printer priced so low?

This new Potter printer provides the combined benefits of high reliability and lowest cost of any line printer now available. Potter made it all possible by taking a completely fresh approach to printer design and construction... producing a 600-line-per-minute unit with only a fraction of the parts used in a conventional drum printer.

Take a look at these features:
- Speed to 600 lines-per-minute; up to 192 characters in 80 to 132 columns
- Precise vertical registration
- Sharp character definition—up to six copies
- Integrated circuit electronics
- Minimum maintenance—fewer parts to replace or service
The answer's a radical new design starting with the chain.

The chain? It's completely different from any you've ever seen. A continuous rotating belt with individually attached, easily removable type slugs.

This newest of line printers is available to you at an unbelievably low price. So send this coupon today. Or better yet, phone or wire us for complete specs and price. You'll be glad you did.

See it at SJCC—Boston, April 26, 27, 28.
If you’re looking for a new approach to cutting costs.

RELAX!

ADDRESSOGRAPH® PRESENTS THE NEW 4000

A versatile, high quality data writing machine with automated features never before available in this price range. (Lease it for as little as $2.19 per day.)

- Increases Employee Productivity
- Adapts to Hundreds of Writing Jobs
- Simplifies Paper Work Handling
- Gets Work Out On Time

With Addressograph Master Records and the new 4000, you have a self-writing reference file of important business data. Specific groups can be selected automatically from the master file—without disturbing file sequence. Data is written ten to fifty times faster than manual methods and with 100 per cent accuracy.

For complete information on the new Addressograph 4000, call your Addressograph representative (he's in the Yellow Pages). Or write Addressograph Multigraph Corporation, 1200 Babbitt Road, Cleveland, Ohio 44117.
ON-LINE BRANCH BANKING

by ELMER C. MIETHANER

Why install an on-line data processing system? At Western Savings, we heard criticism that ranged from the naive to the philosophical position that on-line teller systems could not be justified in terms of speed. Today's on-line systems are sophisticated and reliable. We believe that the philosophical critics have failed to take into account that speed, or time-saving, is not just a matter of cost per hour. At our bank, as at many others, there is also the nebulous but vital consideration of customer service.

In our system and other on-line installations the computer is always aware of the current status of every account. This means not only speed and better customer service, but electronic control as well. Any depositor can count. This means not only speed and better customer interest and "no-book" transactions are entered in his passbook automatically.

Western Savings was the first bank to initiate service with an on-line NCR 315 system, beginning March 27, 1964. Since then, the time required to process a typical transaction has been cut by 25%. Again, this time is more important to the customer than it is to the bank; lines seldom form, and when they do, they are short. We make no more telephone calls and no reference to ledger files while the customer stands and waits.

equipment

The teller's machine used in the system is the NCR 42-501, incorporating alphabetic display indicators and an audit tape printer for communication with the teller. The basic machine was designed by bankers for banking requirements, and can operate very satisfactorily without any computer connection. Posting-print speed is 40 characters per second.

The teller's machines are linked through a single cable to a remote controller in the same office. (Controller capacity: 16 teller's machines). The controller recognizes an active window machine, generates accuracy checks on input and analyzes the validity of all data transmissions on output. We are currently using 15 machines in our main office and two branches.

Signals are adapted for transmission over full duplex telephone lines using Dataphone subsets. The use of these lines reduces data communication (turnaround) time and increases the throughput of each transaction. The data flows between the teller's console and the computer at the rate of 2,000 bits (1,500 bits out) per second.

To send the messages over the voice line, the controller converts the bits from parallel to serial mode. When receiving, the conversion is from serial to parallel mode. A parity bit is generated and validated on each character and a longitudinal bit sum check is performed on each segment sent to and received from the processing facility.

The controller scans each line at the rate of 500 microseconds per line (each window machine can be scanned up to 7,500 times per minute). Upon recognition of transmission failure, the controller independently and automatically attempts three retransmissions before alerting the teller of any communication difficulties.

On returning output messages from the computer, the controller analyzes routing codes, and channels the data to the appropriate window machines.

The 315, located one floor above our main office, has a 10K memory and three CRAM units, served by a central buffer connected to the remote controllers. Input lines are continuously scanned for data. When a message is in buffer, the processor is signaled and the message is taken into memory. Similarly, when the processor has data for a remote location, the data is placed into the buffer, and the processor is released. An unbuffered printer and a card reader complete the system.

on-line processing

Approximately 110,000 accounts are spread over 308 CRAM cards in two separate decks, called the on-line balance file. After an incoming transaction is validated, the appropriate CRAM record is selected, and a teller audit performed. The on-line balance file is updated, and the transaction is assigned a chronological sequence number and stored. Control totals are also maintained.

Window transactions are proved by stripping the transactions from the on-line balance file at the end of the day. A new balance file is written for tomorrow's on-line processing. The daily transactions are then sorted to chronological order by window machine for comparison with the window machine proof run. After proof, this file is sorted to account number sequence prior to reformating for further processing.

The window machine proof run accumulates and balances teller totals, listing them only if an out-of-balance condition exists. This list is then compared with the computer's detail chronological transaction list.

software philosophy

On-line systems in general are similar in mechanics and cost. In choosing our system, we were particularly im-

Mr. Miethaner is comptroller of Western Savings Bank, Buffalo, N.Y., and is responsible for the institution's methods, systems and procedures, and accounting department operations. A past president of the Niagara Frontier chapter of the Institute of Internal Auditors, he has also served on the board of the American Institute of Banking and is currently president of the local chapter of the National Assn. of Bank Auditors & Comptrollers.

April 1966
Voltage variations cause computers to make mistakes...

Voltage surges cause damage to component parts, p.c. cards. Voltage dips cause memory loss, digit drops, loss of parity.

Voltage variations outside the limits of your equipment cause costly mistakes. Elevators, motors, plant equipment and other voltage-demanding equipment surrounding your plant or building are the culprits.

Protect your equipment and data with the Solatron® voltage regulator. Special 3-phase computer models provide ± 1% voltage regulation, correction begins in first ½ cycle.


ON-LINE BANKING...

pressed with the philosophy of software packages applied to the system. We believe that the design and sophistication of these packages provides, in the first place, the same performance and efficiency for the small user as for the large user, and, in the second place, unique flexibility.

The program has been designed in two sub-packages, an executive package and an application package. The former includes all hardware oriented and communication functions, while the latter is concerned with the updating of accounts, processing of transactions, control of holds, and other general bank functions.

This division places functions that will generally remain fixed in the executive package, and functions related to institution policy in the application package. If the user should desire to implement certain operations in a different fashion, the programmers need to concern themselves only with the application package. Areas where changes might be desired have been anticipated, and the package is designed so that many changes can be implemented within the logical structure provided.

**data communications**

The executive package in general covers all peripheral unit communication, including all reading of the inquiry buffer, input message assembly, output message control, retry situations, all CRAM read and write, account number look-up, and console typewriter communications. In addition to the symbolic code for the application, the variable information for the executive is specified. A separate program generates autocode based on these specifications.

Messages from window machines are received in segments (usually two or three segments per message) which must be stored and chained together. The general message area accommodates four categories of data: input messages, output messages, CRAM cards waiting to drop, and available spaces. This area consists of a number of six-slab segments. Each unit of data (a complete input or output message) consists of some number of segments associated by a chain slab (high order one of the six). Each segment of the unit directs us to the next segment (if any) via this chain slab. Available space is considered a single item and its segments are similarly chained.

An active window machine directs us to its associated message via the relative address slab of its file table entry. As segments are added to messages during input, the amount of storage increases and the available space decreases. When segments are no longer needed as is the case when outputting, and are deleted from storage, the amount of storage used decreases and the available space increases.

The executive package assembles messages as the segments arrive. When a complete message is received (indicated by the receipt of the account number), the CRAM will be accessed, the account found, and control is turned over to the application package.

Output is delivered to the executive package in blocks of complete edited segments, which are sent to the window machine. When multiple segments are transmitted to a single window machine, other data can be either sent or received between segments, so that a heavy load on one machine does not reflect on the rest of the system.

Balance file records are variable in length, providing for expansion or contraction of the record number of slabs as provided by the executive package. The application package edits the desired items to be inserted or deleted as indicated by the processing. This information is communicated to the executive package by means of the
length slab and an index register. Insertion or deletion is done at the end of the record.

The transaction file is on the same CRAM track as the balance file. As each transaction is created, it is recorded at the end of the balance file record on which its respective balance file record is located. The application package assigns a serial number to each transaction so that the chronological sequence may be determined for later audit trails.

If a given track becomes full (as a result of new accounts or no-book operation), the adjacent track is utilized. Where the immediately adjacent track is also full, the next track is utilized, and so on. Transaction overflow is to the pure transaction file.

Totals from each window machine are recorded on a separate card reserved for data not related to a given account. This area, the pure transaction file, is also used for teller checks and money orders.

typical transaction

When the teller machine is connected to the 315 and ready to process transactions, the indicators read ON and READY. To process a transaction, the depositor fills out a deposit or withdrawal slip and presents it with his passbook to a teller. If necessary, the teller can compare the signature by placing the passbook under the machine’s black light, revealing the passbook’s invisible signature.

The teller then enters the old balance from the passbook, the amount and type of transaction from the slip, and the depositor’s account number. The indicator lights now read PARTIAL MESSAGE until the account number (always the last item) is entered. The information is transferred through telephone lines to the 315, which checks it for accuracy.

The computer usually processes the transaction in less than a second, while the processor control light is lit. The 315 updates its CRAM records, and transmits the posting information. As the teller machine makes the updating entries, the ON and READY lights go on again.

Other signals on the teller machines include ERROR, ENTRY ERROR (error in information entered by teller; for example, balance and account number do not agree with what is stored in the computer), SEND ERROR, RECEIVE ERROR, REFER (teller to review printed audit tape), ERROR UPDATE, and OVERDRAFT. The ERROR UPDATE signal, informing the teller that the computer is correcting an error that was discovered after the last transaction on the account was processed, is reinforced by an audio signal. Usually, the bank sends a letter to the depositor informing him of the discovered error. When the teller returns his passbook, he points out that the error has been corrected.

A bank may select any six messages for the bottom screen of indicators on the machines, and may also define the conditions under which the computer will turn them on. We chose two, HOLD and UNCOLLECT. HOLD indicates that a withdrawal violates a hold condition on the account. UNCOLLECT indicates a withdrawal includes funds currently in float. In each hold condition, the computer locks the teller’s console until the appropriate action is taken.

If messages conveyed by the indicators need amplification, the 315 provides more detailed information by causing the journal tape printer to print a code number visible to the teller. Each teller has a chart of code definitions for reference.

The system enables the bank to establish three levels of override on conditions that may arise in processing transactions. At the lowest level, the teller may depress the “override” key. The intermediate level requires supervisor
ON-LINE BANKING...

Account inquiry

The teller's console can be used to query the computer files. Indexing an account number on the machine, a teller can interrogate the 315 and receive a printout of account number, holds, date of last transaction, passbook balance, current balance, available balance, and amount in float, as a convenience to depositors. The teller may also inquire as to the number of checks in float, and the number of days in float for each.

The system assures that computer records and passbook are in agreement. The teller is able to operate without leaving the window, even for signature verification, and errors caused by incorrect account numbers and incorrect old balance pickups are automatically detected and prohibited. The computer monitors every teller operation.

One of the primary control features of the system is that a complete audit trail is established at the point of original entry for all input-output transactions. Stops, holds, and uncollected funds are automatically under supervisory control, and dormant or inactive accounts are kept in strict control.

Customer convenience is increased by the ability to handle transactions at any window of any branch, and the tellers' machines provide complete validation on deposit or withdrawal slip as well as printing the passbook and audit trail, simultaneously, and in original print. These abilities are available on- or off-line.

Off-line processing

In daily off-line processing, a series of programs organize the information accumulated during the day. Reformatted transactions in account number sequence are combined with sorted adjustments, net deposits, withdrawals and corrections to update a master account file with today's transactions, and create a daily journal file printout. Intermediate steps in this processing include creation of a sorted adjustments file, a combined transaction file, and a net transaction file. The computation of net transaction not only simplifies interest computation, but also permits the depositor to withdraw and redeposit money on the same day without sacrificing interest. Printouts include an adjustment list of totals, a daily transaction list, and a transfers from list.

In the second run, the computer updates the off-line master file by incorporating the one net transaction on each active account. This master is more than a complete version of the on-line file, which includes only information for processing and describing current status.

As another result of the updating run, the bank gets new control figures by branch and by date, a total on the interest credited for the year to date, and the anticipated interest for the current quarter.

The daily journal file is combined with the payroll savings bond issue list and recap, and a new listing and recap is printed. The daily journal is also printed, listing net transactions on all active accounts. This list provides the account numbers in sequence, the date of the previous transaction (to provide an audit trail), the type of net transaction, the net transaction amount, and the post-transaction balance.

The daily journal listing also provides group totals including the number of new accounts opened during the day, the total amount deposited in the new accounts, the number of transfer accounts, the number of accounts closed, and the total amount withdrawn from the closed accounts. It lists for each branch the total deposits, total withdrawals, the total of all open accounts and the loss or gain for the day.

Weekly, monthly, and quarterly transaction files are also created and printed when necessary. Interest is posted quarterly to the master account file, creating an interest transaction file and simultaneously calculating new anticipated interest. The on-line balance file is updated from the interest transaction file. A yearly closed account file is also created and held for year-end reporting.

Year-end tax reporting programs provide for combining the master account file with a name and address file, and printing 1099's for active and closed accounts. Interest is also cleared for the year to date from the master account records to create a new master account file for the new year's first off-line processing run.

In the near future, we expect to extend programming to include 19,000 mortgages. Home improvement loans are now on the computer.

Our experience with the teller machines in the system has shown that the depositor usually leaves the window within one minute after his arrival. The average savings transaction, including passbook posting, takes four seconds on-line. If the entire system is to be justified with respect to customer service alone, disregarding the system advantages to the bank, its cost would represent about one dollar per account per year at present. Naturally, we expect our accounts to grow, but even at the present figures, we consider the cost to be justifiable and the convenience vital.

We did not have to develop a new account numbering system or add a check digit. Even the most accurate check-digit systems are only about 90% dependable, but by requiring that the account number and the passbook balance entered by the teller agree with the same information stored in memory, our on-line system reduces the possibility of error to a small fraction of 1%. Because the account numbers have not changed, our depositors continue to use their old passbooks.

In event of a line breakdown or other trouble, the tellers simply process the transactions off-line, as they did before their window machines were connected to a computer. When the system is back on the air, the tellers re-enter and off-line transactions at their convenience from the journal tapes. In our experience, down time has been only about 1½% per year. NCR provides full back-up for the system.

We have found that the teller's job at the end of the day has been reduced to clearing the machine and counting the cash. The tellers usually leave within a half hour after closing.

Because the period between installation and system startup was short, tellers at our Delaware Park office had an average of two hours training before processing live work. Nevertheless, the transition posed no problems. We found that two tellers can easily share a machine. We are currently using four on-line machines for six windows in each office. Between March and June, tellers from the other offices were assigned for a day or so to Delaware Park for training on actual work.
Think of a number between 1 and 6,000.

That’s how many lines per minute the MC 4000 can print.

Monroe Datalog®’s MC 4000 ultra high speed optical printer records 6000 lines per minute, or any speed less that your application requires. Truly synchronous or asynchronous. Completely silent. Absolutely reliable—only two moving parts. Available in numeric or alphanumeric models—both 32 columns wide. Any 4 or 6 line code with any logic level.

Features: character serial input, bit parallel. 6 microseconds per character data transfer time. Exceptional compactness—$10\frac{1}{2}$" x $10\frac{3}{4}$" x $21\frac{1}{4}$". All solid state. Cathode ray tube with fiber optics.

Permanent copy option available.
And a full year’s warranty. Price: $5650 for numeric model; $5850 for alphanumeric model.

For information, contact Monroe Datalog Division of Litton Industries, 343 Sansome St., San Francisco 94104. (415) 397-2813.

MONROE DATALOG
DIVISION OF LITTON INDUSTRIES
In our jet-propelled business world, decisions often have to be made now—not later when information finally filters through the usual channels. Yet, how can you get current sales and inventory information in time to set up accurate production schedules or determine raw material needs without committing more money than is necessary?

The answer is data communications.

**Data When You Need It** Most business information needs can be solved easily with a data communications system using Teletype terminal equipment—like Telespeed 750 (high-speed tape-to-tape) sets. This enables you to get information where you need it, when you need it. You are able to make better informed, more timely decisions that could spell the difference between profit and loss.

**On-Line, Real-Time Operation** A basic advantage of Teletype Model 33, 35, and Telespeed equipment is that they operate on the same permutation code (ASCII) approved by the American Standards Association for information interchange. This is the same language used by many computers and other business machines.

Consequently, you can use Teletype sets to link your branches and departments to a central real-time computer, feeding administrative data and engineering problems on-line into the computer from distant locations almost simultaneously.

In addition, the Model 33 and 35 sets have typewriter-like 4-row keyboards that make them simple for any typist to use.

**Improves Decision-Making** A major producer of heating units uses Teletype Model 35 ASR (automatic send-receive) sets to link distributing facilities in New Jersey and Ohio directly with its home office computer center. This company not only has cut as much as four days off its order processing cycle, but also supplies its management with up-to-date reports on company activities.

According to the marketing vice president, "this system enables better decision-making capabilities, permitting greater flexibility in dealing with customer demands."

**Improves Management Control** Data communications systems have helped solve many information problems, resulting in improved management efficiency and control. That's why this Teletype equipment is made for the Bell System and others who require dependable, low cost communications.

For more about applications of Teletype equipment, write for our new brochure, "WHAT DATA COMMUNICATIONS CAN DO FOR YOU." Teletype Corporation, Dept. 81D, 5555 Touhy Avenue, Skokie, Illinois 60076.
The computer is fast becoming a useful tool for biomedical research. With this tool, as with others before it, potential users have the right to ask: how will it do my job better and how much will it cost? With these questions in mind the computer system to be described was developed to increase the ease with which certain kinds of biomedical research can be performed and minimize the cost and time for both the investigator and computer.

Some specific problems which arise in applying computers to biomedical research are: 1) the need for sampling of biological data over extended periods of time or sampling at very high rates for short intervals, 2) the separation of computer and experimental site, and 3) the need for continual rewriting of research programs as the form of the experiment is changed to accommodate a change in the mathematical model of the biological system. To solve these problems most efficiently a multiple remote station system has been developed. Each station can communicate with a central processor and is able to run experiments in conjunction with one to six other stations, one of which is the card reader and printer at the central processor. The system can process data from several experiments simultaneously as well as perform the more routine card and tape oriented data processing and computing. In most cases the monitoring of experiments takes relatively little computer time from the more conventional computer processing. A time-sharing monitor has been written to accomplish this. The hardware and software of the system, along with several applications, are described in this paper.

Fig. 1 is a diagram of the computer system at the Latter-day Saints Hospital. The system consists of a CDC 3200 computer with five I/O channels and 32,768 24-bit words of memory, and the following peripheral equipment: a high speed line printer connected to computer I/O channel 0, three tape drives and two IBM 1311 disc pack units on channel 1, an analog-to-digital converter connected to channel 2, a digital-to-analog converter on channel 3 and a 1200-card-per-minute card reader on channel 4. Channel assignment was based on job function in order to keep the channels as independent from each other as possible for maximal efficiency of the buffered I/O during simultaneous use of these peripheral devices. An analog computer is available for hybrid computations. It is connected to the central processor using one or more of the analog-to-digital, digital-to-analog channels.

Conversion equipment

The analog-to-digital (A-to-D) converter is an 8-bit unit with a maximum conversion rate of 100,000 samples per second. At present there are 16 analog input channels and 16 digital input channels. The digital inputs are 12-bit binary words which are gated directly into the computer. Selection of the analog or digital channel to be used for a particular program is under program control. Various modes of operation are available to the programmer in.

Mr. Pryor received his BS from Long Beach State College and his MS from the University of Utah. He is presently systems director of the digital computer facility at the Latter-day Saints Hospital and assistant research professor of the Department of Biophysics and Bioengineering at the Univ. of Utah.

Supported by a grant from the National Institutes of Health, United States Public Health Service, No. 5 PO7 FR-00012.

FOR WILSON JONES CIRCLE 25 ON READER CARD→ DATAMATION
COLOR TELLS YOU FASTER
Get the right "tab" report in the right hands with color-coded nylon post binders by WILSON JONES

10 Most Popular Sizes
For Burst and Unburst Sheets
NOW... 8 sizes in 8 colors 2 sizes in 9 colors WILSON JONES GENUINE PRESSBOARD NYLON POST BINDERS

- For fast distinction among E.D.P. reports
- For Burst and Unburst Sheets
- For Unburst Sheets with one or both margins stripped off
- For sheets and forms of various sizes
- For easy conversion to Top and Bottom Loading

Now you can color code your marginal-punched sheets as fast as you bind them! Just pick a different color binder for each kind of "tab" record: sales, payroll, receivables inventory, you-name-it! Choice of 9 separate, instantly-distinguishable colors.

14-LINE NYLON POST BINDER SIZES AND COLORS

<table>
<thead>
<tr>
<th>For Unburst Sheets</th>
<th>For Burst Sheets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>Number</td>
</tr>
<tr>
<td>11¾x8½ *</td>
<td>14-128</td>
</tr>
<tr>
<td>8½x11 *</td>
<td>14-811</td>
</tr>
<tr>
<td>10⅛x11 *</td>
<td>14-1011</td>
</tr>
<tr>
<td>13⅛x11 *</td>
<td>14-1311</td>
</tr>
<tr>
<td>14⅝x11</td>
<td>14-1411</td>
</tr>
</tbody>
</table>

* Available in all colors listed except Black

Call your Wilson Jones office supply dealer or tabulating supply source for a demonstration... or send for Catalog DP-266 C1.
including interrupt modes which allow the A-to-D converter to send to the computer an external interrupt when data is ready to be transferred to the computer. Sampling rates of the A-to-D converter can be controlled both internally by the computer or externally through a pulse or sine wave fed directly to the A-to-D converter. In this external sync mode, data will be transferred to the computer only when the A-to-D converter is ready and some other external sync pulse has been supplied. There is also a hold-off feature which restricts sampling and transferring of data from the converter into the computer until an external hold-off pulse has been received by the A-to-D converter. After this pulse has been received, the converter will transfer data in either the internal or external sync mode. Connected with each digital input channel is a four-digit thumbwheel octal switch through which an operator is able to transfer digital information to the computer.

The digital-to-analog (D-to-A) converter has a maximum rate of 100,000 conversions per second and will convert the low-order 8 bits of a 12-bit digital word to an analog voltage varying between 0 and +10 volts. The present system consists of eight analog channels connected to the D-to-A converter. The first two of these channels are hard-wired directly into six Tektronix memory scopes located in the different laboratories. All information displayed on these scopes comes via these two analog channels. The erasing and blanking of any scope is controlled by the program through the use of three banks of relays available on the D-to-A converter. Thus, although data is transferred to all the memory scopes, it will, by use of the relays to control blanking, be visible only on the particular scope whose station has requested the information. The relays not only control the erasing and blanking of the scopes but also control the internal and external sync modes of both converters.

The investigator communicates with the computer through remote stations. Each of these (see Fig. 2) consists of a computer interrupt push button, a digital input dial, a memory scope, and eight small indicator lights. These lights indicate the status of the computer, i.e., which areas of core memory contain active programs and the priority of programs in core or waiting on disc to be run. By pressing the interrupt button with an appropriate code word in the digital input dial, the investigator may request his program be brought into memory. Once in memory the program normally writes on the scope in the laboratory of the investigator the sequence he is to follow. Subsequent interrupts from his station then allow him to communicate with his program and to start and stop the flow of information through the converters.

At locations remote from the hospital the data is transferred to the central processing area via telephone lines.

Fig. 2 A remote station consisting of memory oscilloscope, octal switch, indicator lights and interrupt button.

Here the investigator, instead of feeding his data directly into the A-to-D converter, feeds his analog data into the voltage controlled oscillators and a frequency multiplexer. The FM carriers are then transmitted via a private telephone line to the central processing location. Here the FM signals are demodulated and fed into the A-to-D converter for input into the computer. The results of the experiment are in turn relayed back to him using a similar system over another telephone line.

**basic programs**

Because an investigator may need repeated access to the computer during a long experiment, a monitor program has been developed to control the use of the computer and allow simultaneous experimentation from more than one remote station. Programs written to communicate with the remote stations are written in assembly language. These programs may, however, act as subroutines for a FORTRAN program. Where extensive computation is required on the real-time data, the computational portion of the program is written in FORTRAN and the communication with the A-to-D, D-to-A and remote stations in assembly language.

All user programs are stored on one of the disc packs. When a program is requested, the monitor brings it into core for execution. Through a program priority system, it is possible for one program to be interrupted during execution and another program of higher priority to be initiated. At this time the program of lower priority is...
Now Cheaper by the Billion.
Introducing the Bryant Series 4000-2A real time mass memory system. It can store 3.8 billion bits. The largest single unit disc file capacity in the world. And by far the lowest costing random access system available today. All data is on-line, available within an average of 100 milliseconds. A basic cabinet offers modular growth to capacity. Environmental control reduces maintenance to a minimum. Dual access option offers increased throughput. The 2A joins 190 Series 4000 files operating all over the world. Deliveries begin in November, 1966. But don't wait till then. Call your nearby Bryant Application Engineer now or write: 850 Ladd Road, Walled Lake, Michigan 48088.
stored in a temporary area on disc to be completed later.

A central print driver has been written to prevent the printed results of one program from being intermixed with another on the line printer. Output from every program, as well as compiled listings, is placed on the disc. At the end of execution of a given program the monitor initiates the disc-to-print program, which then prints in an interrupt mode the entire results of that program. After completion of one print job, the system looks to see if other programs have been completed and require some listing. If so, it initiates the listing of that program. Only FORTRAN programs are allowed to have printed output. The output of the assembly language programs will be to the scopes.

Access to the disc is via a central disc driver. This is to eliminate the moving of the disc arms by many programs causing a loss of data.

Programs written in FORTRAN are compiled into the lower 16K of core. Since they require so much core even for a relatively short program, a priority scheme was developed to use this portion of core most effectively. Priority three was given to FORTRAN-compiled programs which require more than five minutes to run while priority two programs run in less than five minutes. A FORTRAN-compiled program is priority one if it is linked with upper core to one of the assembly language programs. These require highest priority since they use data in real-time from some experiment in progress. This option requires that the program be accessible to the investigator within two seconds in order to insure no loss of data. Although these programs are of highest priority they are swapped on the disc during times of no activity from the station using the high priority program.

Above this first 16K area the next 12K is set aside for assembly language programs which handle real-time data from the laboratories. These programs are designated real-time programs. These programs are relocatable in this area and upon execution are brought into some part of this 12K area. They remain in core, however, until the experiment is finished or the investigator sends an appropriate code to the computer. All programs in this area are called from the remote stations by depressing the interrupt button after dialing 7XXX in the octal switch, where XXX is the program number. The monitor interprets this as the beginning of program XXX, reads it from the disc into memory and transfers control to the program.

Again, the main function of these upper core programs is to communicate with the experimenter and do the actual transferring of data to and from the computer. For example, these programs may write a control message on a memory scope (Fig. 3) to tell the experimenter to connect his input to certain analog channels or to specify a program option desired. Upon completing these functions the experimenter then presses the interrupt button telling the computer that he has performed the function and is ready to proceed with his experiment. This two-way communication proceeds with the operator controlling the flow of information from the experiment to the computer and the computer asking for data and options in the proper sequence and finally displaying results on the oscilloscope as alphanumeric characters and/or graphs. A more detailed description of several of the programs will be given further on in the paper. The monitor can control A-to-D and D-to-A operations for six such programs in memory at any one time.

The upper 4K words of memory contains the monitor and several special-purpose subroutines which are accessed by all of the real-time programs. One such program is the subroutine to write alphanumeric information on a scope.

Multiplexing between the programs in memory may take place as a result of an interrupt from a remote station or from the real-time clock within the computer. The clock interrupts are normally used to control sampling rates. Each program specifies to the monitor the desired interval between successive samples of its analog input/output. This interval is added to the reading of a 10KC internal clock and placed in an interrupt mask table to switch control to that program when the next sample is due. If in any program there is a time delay for operator intervention or for the next sample to be ready, control is returned to the monitor which then tests whether there are other programs to be serviced.

**transfer interrupts**

Since each of the real-time programs generates so many interrupts requesting that control be transferred to its program, it has been found that there need be no scheduled cycling through the programs by the monitor. The only program not generating interrupts is the FORTRAN program in the lower 16K; but since only one such program is allowed to be executed at any time there is no need to interrupt it periodically to look for other similar programs in core since they do not exist. When a FORTRAN program has been interrupted by some real-time program it takes from 0.1 to 50 milliseconds for the computer to complete the function required by the real-time program and return to the FORTRAN program. There is a small probability of a real-time program being interrupted at a time in the program when it is no longer generating interrupts by an interrupt which initiated a FORTRAN program, thus causing a long delay before returning to complete the real-time program. It has been found through experience, however, that the probability of this happening is negligible. For this reason, cycling periodically through the various programs to determine if they require servicing would only reduce computer efficiency.

FORTRAN-compiled programs are debugged in the normal manner using the compiler diagnostics and a sufficient number of print-outs in the program to inform the programmer of his errors. Debugging the real-time assembly language programs is accomplished on-line through the use of a special debug program. This program uses a memory scope and the on-line typewriter to communicate with the programmer and his program. It permits the programmer to execute a single instruction, read and write in core and execute specified portions of his program without actually stopping the machine or interfering with other experiments.

Fig. 3 A message written on a memory oscilloscope giving procedural instructions to the user.
Diploma earned

Before you enroll any make of incremental recorder in your data processing operation, a little homework may be in order. Though any one of several incremental on the market can make passing grades the first semester, it's important that you be able to tell the potential dropouts from the honor students before you come up with the tuition.

Recommended reading should include all catalogs, literature, and specification data.

You might also study the maintenance manuals, parts lists, and engineering drawings. Be sure to include the historical background. And though we're not asking you to simply take our word for it, we have every reason to believe you'll conclude that PI stands at the head of the class.

And for good reason. PI has studied longer and harder, starting in 1962 with the introduction of the first incremental recorder. Today, PI incrementals are widely known for their skill in reading and writing up to 300 precisely spaced characters per second, in computer compatible formats.

PI incremental recorders get straight A's because they're disciplined. For example, they use optical control of pulse spacing to insulate more precise packing of digits on the tape. They have fewer mechanical parts, and

no clutches or gear trains to misbehave, so their attention span is longer, their reliability greater.

For your first increment of recommended reading, send us your name today. We'll forward a transcript on the complete line of PI-1100 incremental recorders. Write to us at 3170 Porter Drive, Palo Alto, California. Or contact any of our sales engineering representatives ... we're worldwide.

- bit by bit

CIRCLE 27 ON READER CARD
in progress. All options available at the computer console are available to the programmer at the typewriter. At each breakpoint in the program all registers are displayed to the programmer and some option requested. This on-line debugging is considered a necessity if the system is to be a true time-sharing system.

A few programs are not compatible with this time-sharing mode of multiple simultaneous program servicing in that they use an extremely high analog data sampling rate, or special A-to-D synchronizing schemes. An example of such a program will be described later. These programs occupy the computer for only a few seconds and can be scheduled at specific times during the day. To illustrate the use of this system, some programs will be described here which use various features of the system and demonstrate the flexibility which is available at the present time.

examples of users' programs

The first example of a program involves solution of a mathematical model developed to describe the transfer function of pressure receptors in the wall of an artery. The input to these receptors is the pressure in the artery and the output is in the form of nerve spikes or action potentials on the nerve going from the organ to the brain. To test this model, arterial pressure and frequency of nerve firing are sampled from an anesthetized animal. This data is then compared with the frequency of nerve firing generated by the mathematical model. To obtain the data, two programs have been written. The first determines the number of nerve fibers which are being detected by the pick-up electrodes. This is accomplished by sampling 1000 action potentials and then returning to the investigator an oscilloscope plot of a histogram of the spike amplitudes. It has been shown that a single fiber fires at essentially a constant amplitude. Amplitudes will vary between fibers due to differences in electrode contact with the fiber. However, because of noise in the recording system, the amplitude histogram of a single fiber has the form of a normal distribution. Upon receiving a histogram, the investigator makes a judgment as to whether there is one or more fibers being recorded. If there are more than one, he continues to dissect the nerve until he obtains a histogram which is unimodal. Here the computer serves as a valuable tool for real-time work. The output of the nerve should easily be stored on magnetic tape and processed at a later date but if due to some error the correct data was not recorded, the experimenter has lost both time and information. With the computer available to him during the experiment, he advances to each new step with the results of the last step already verified.

To obtain the histogram described above, the output of the recording electrodes is fed into a digital logic system which is set to trigger on a given threshold. When a nerve action potential crosses this threshold, it triggers a 500μsec duration pulse. The computer meanwhile has requested an input of 25 samples from the A-to-D with the converter set in the external sync mode. A sine wave is “anded” with the output of the digital logic system and is fed into the A-to-D converter only during the 500μsec when the nerve spike is above the threshold. The 55KC sine wave is allowed to synchronize the input of analog data into the computer during this time. The computer is programmed to interrupt when the 25-word input buffer is full. This will occur in slightly less than the 500μsec. The

maximum amplitude of the action potential will then be determined from these samples and stored for later display in the form of an amplitude histogram. Since the input/output of the computer is buffered, the computer is able to service only those other programs which do not use the A-to-D converter while waiting for a nerve firing. After 1000 action potentials have been so processed, the program calculates an amplitude histogram and displays this via the D-to-A converter as a plot on a memory scope at the investigators station.

Once the investigator is satisfied that he is recording from a single nerve fiber, he calls a second program. This program samples the input to this organ, the arterial pressure, at a rate of 100 samples per second. As it reads in the pressure wave it determines the beginning and ending of each heart cycle. Corresponding points on each succeeding pulse are added and the resulting average waveform is then stored in memory. At the same time the voltage from the nerve is fed through another digital logic system which causes an external interrupt to the computer each time the nerve potential crosses a set threshold. Upon receiving these external interrupts the program reads the real-time clock to determine the frequency of firing at that instant of the heart cycle. Thus, for each averaged point on the pressure wave, an averaged frequency of firing at that point in the cycle is also calculated. Simultaneously with these calculations the averaged pressure wave and frequency of firing are displayed on an oscilloscope at the investigator's station 50 times every second. This, then, enables the investigator to follow the build-up of these averages. When displayed averages become stable the investigator generates a manual interrupt via his station which causes the computer to write the averaged data on a digital tape. At the end of an experiment, the investigator may call a FORTRAN program which tests a mathematical model of the organ. This program predicts the time-course of frequency of nerve firing from the time-course of arterial pressure. This predicted frequency of nerve firing is then compared with the actual frequency of nerve firing obtained from the animal as a measure of the validity of the model.

The first two programs described here may either be run on-line real-time, that is, feeding the data from the animal directly into the computer, or the data may be run from analog tape. Since the histogram program uses a special synchronizing scheme with the A-to-D, it must be run at a time when no other real-time programs are being processed. This does not mean that another program cannot be run during the complete experiment, but only during those few seconds that the program is sampling data.

analog processing

In many instances in the formulating of a mathematical model for some biological system, it is more convenient to program the mathematical model on an analog computer. The investigator tries to match by empirical adjustment of equation parameters the output of the model on the analog computer with actual data which has been recorded from an animal. This process becomes quite time consuming since the investigator must test the model against data obtained under a variety of physiologic states before he can be confident that it is an adequate description of the system. From the raw data, such as blood flow and pressure, many variables must be calculated, such as heart rate, cardiac output, stroke volume, resistance and mean arterial pressure. The time-sharing system allows the digital computer to do much of the work that would normally be done by the investigator at small expense to the computer. A program to do this has been written in two sections. The first part inputs from an analog tape or
directly from the animal the raw data and calculates the derived variables for a time interval specified by the investigator. It then logs this data on a digital tape for replay later. When the investigator has programmed his model on the analog computer he is then able to call the second portion of the program which reads these variables from the digital tape. With each sweep of the oscilloscope a clamp pulse is generated which initiates the solution in the analog computer and acts as an interrupt to the digital computer. The digital computer outputs these variables through the D-to-A, some acting as forcing functions for the analog computer model and others being displayed on an oscilloscope for comparison with the corresponding variables being predicted by the analog computer model. The output from the digital computer may be at any multiple of real time requested via the digital switch. It would be difficult to justify this mode of operation were it not for time-sharing and multiple-station operation because of the inefficient use of the 3200 by this single program. However, under the multiple-station processing mode, this becomes an effective use of machine time as well as the investigator's own time in developing his mathematical model.

Continuous monitoring of various parameters from an experimental animal is another task readily accomplished by the multiple-station, time-sharing approach. An example of a program to do this is the pressure pulse stroke volume program which provides a means for estimating the amount of blood ejected by the heart on each beat from the contour of the pressure wave recorded in the aorta.  

Fig. 4 Comparison of stroke volume determination by pressure pulse method and flowmeter method.

Within ten milliseconds after the end of each heart cycle, an analog voltage is generated to represent each of five variables calculated from the pressure waveform and the input of data can continue indefinitely. The method is based on the fact that the aorta is distensible and acts as a capacitor. Part of the blood that is ejected by the heart

---

in each cycle is stored in this distensible tube during the ejection phase; then, during diastole, when the heart is not contracting the stored blood runs out of the arteries as the pressure wave decays. The program consists primarily of a scheme for recognizing the onset of systole and the end of systole or dicrotic notch. The difference in pressure as a function of distance down the aorta at these two points in time is estimated and this pressure difference is related to the difference in volume of the aorta at these same two points in time. The ratio of flow out of the system during systole to flow out of the system during diastole is considered to be proportional to the ratio of the time integrals of pressure over these two periods in time. Then by estimating a single constant which relates stroke volume as measured by the flowmeter to stroke volume as estimated by the pressure pulse method with the dog in a resting state, subsequent beat-by-beat estimates of stroke volume can be made under a variety of physiologic states.

Fig. 4 shows a cross-plot of beat-by-beat estimates of cardiac output made by the pressure pulse method against the measured stroke volume obtained by integrating the output of the flowmeter curve. The correlation between the two methods varies from .92 to .98 under a wide variety of physiologic states including exercise and the infusion of drugs which raise and lower blood pressure and raise and lower heart rate. This continuous monitoring in humans of five important variables in the circulation from a single pressure input is done by using only a small amount of the computer time since other programs are being processed at the same time but still insures accurate pattern recognition of the pressure and flow curves.

At one of the remote stations a typewriter and memory oscilloscope are available for on-line use with the computer. A standard use of the typewriter is entering parameters in mathematical models of various biological systems. The time-course of any variable may be displayed as a function of time on the memory scope and compared with a previous solution. The FORTRAN portion of the model is swapped in and out of memory by a small control program which resides in upper core and controls the communication with the typewriter and the oscilloscope. Thus, the FORTRAN area of core memory is available for other programs except when a new solution of the model is requested. Variables and parameters in the FORTRAN program are referenced through indirect addressing in the control program. The program allows the operator to easily explore the effects of variations in each of the parameters on model performance and is an effective tool for designing experiments and interpreting results.

**system evolution**

Although this system has been in operation for about 18 months in this laboratory, it has undergone a gradual evolution over this period and will continue to evolve to meet the changing needs of the research community. The programming of the laboratory consists of two systems programmers. The rest of the programming is all done by individual researchers and graduate students. The system has recently been put into use on the 3200 system at the Mayo Clinic and will be made available to all 3200 users through Control Data; the company has accepted responsibility for system maintenance. The system is designed to fill a specific need for those engaged in biomedical data of the type generated in a physiology laboratory and is not meant to do all things for all people. Primarily because of this, the system runs efficiently and was implemented by a few people in a short time. An effort is now being made to make the system more readily available to a larger portion of the medical research community in Salt Lake City through expansion of the remote telephone terminal concept.
Why did IBM develop still another computer language?

Why did we develop PL/I—Programming Language/One? Why didn't we let well enough alone?

You have FORTRAN for the bulk of your present computing.
You have IBM Assembler Language to provide direct entry to every SYSTEM/360 feature.
So why PL/I?

Basically, to have one language that will provide the ease of programming you have long associated with FORTRAN, plus the increased machine efficiency you realize through the use of the Assembler.

Truly, PL/I reflects the better features of each of these languages.

And PL/I is user-oriented—developed in cooperation with many of our customers who suggested many of its features.

Use only what you need
You use PL/I according to your immediate needs.
If you're less familiar with computers and programming or your computing problems are less demanding, you learn and use only portions of PL/I—learning more only as your needs grow.
If you're more experienced in programming techniques or your computing problems demand maximum effort, then you can use the full power of PL/I immediately.

PL/I makes it easier to integrate data communications in your system. It complements the computing power of SYSTEM/360.

PL/I doesn't obsolete FORTRAN. FORTRAN will still be used and IBM will continue to fully support its growth.

PL/I is not the perfect solution to every problem. But it is better and quicker in solving many advanced applications like computer-aided experimentation, and simulation of continuous systems.

Once you start using PL/I, you'll be glad we didn't let well enough alone.

SYSTEM/360—The Computer with a Future.
If you want... a computer specifically designed to meet your system requirements — with such useful system features as MicroExec for sub μsec processing rates — independent CP memories for simultaneous operation — two memory access channels, 555 KC and 200 KC — 16 or 18 bit words — 1.8 μsec core memories, and 0 to 12 v. logic levels.

If you want... Input/Output flexibility, DATA/620 has six types of I/O facilities and up to sixty-four devices for simultaneous I/O rates of more than 500,000 words per DMA.

If you want... complete software, DATA/620 is equipped for FORTRAN in 4 K, Assembler, Aid, Maintain — all opened ended — and more than 100 machine commands.

If you want... a computer built for your system, the DATA/620 rack mounts in only 26¾ inches of space with front access, and offers highly reliable operation with 7,500 hours MTBF. And, DATA/620's low initial cost of $27,900 will not break your system budget.

If you want... 90 day delivery you can still have it — although 37 DATA/620s have been sold and 10 delivered.

There is a lot more we would like to tell you about the DATA/620 in a fact filled 36 page brochure. If you would like one, write to:

DATA MACHINES

1590 Monrovia Avenue, Newport Beach, California • Telephone (714) 646-9371 TWX (714) 642-1364 Division of DECISION Control, Inc.

See the DATA/620 at booth 1113 at the Spring Joint Computer Conference.
ARE SMALL, FREE-STANDING COMPUTERS HERE TO STAY?

by FRED GRUENBERGER

If one were to judge the current state of affairs in computing by the number of published lines per subject, then the world seems to be as follows:

The big, important jobs are done on big machines, run by professionals with the aid of ultra-sophisticated monitor systems.

The small jobs are done through time-sharing systems via remote consoles.

Little, if anything, in the literature today advocates the use of small, free-standing machines. The man who controls a lonely 1401 or 1620 or 160 and who plans to move up to an 1130 or 1700 or 360/30 may wonder whether he's on the right track. Should he, maybe, sign up now for one of the impending time-shared terminals?

In discussing such a subject, it seems to me vital to define a point in time and stick to it. One tends to confuse what we have now with what we are told to expect. For example, the language of time-sharing systems is one of the virtues currently touted. Now, language is a subject worth considering, but I'd like to cancel it out of this discussion. Therefore, I pick a point in time in which a conversational problem-solving language (like joss) is commercially available on some small computer. We can only guess when that time will be—perhaps early 1967.

I maintain that computing-power-per-dollar in small machines is increasing rapidly and will continue to do so. Some of the features now available only through time-sharing will become available on free-standing machines. When that occurs, and when the crossover point in costs is reached (i.e., when it costs the same either way), then attention will focus on the unique advantages of each system of operation.

more for the money

Let me try to bolster my first point—that computing-power-per-dollar is an increasing number. It is probably futile to try to quantify in a simple index a measure of computer-per-dollar, in the same sense that it is fatuous to measure a man's potential with a single number like I.Q. Any such index measures only what it measures, so to speak, but it can still be useful in making broad comparisons. I suggest the following:

\[ G = \frac{B(A + M)}{D(L)} \]

where

- \( B \) = number of bits in main core,
- \( A \) = additions per second,
- \( M \) = multiplications per second,
- \( D \) = dollars per month of CPU rental,
- \( L \) = instruction length in bits.

The term \( M \) is included to measure something other than addition speed. Some computers penalize (in both machine time and storage space) any multiplication at all, but especially multiple precision. On others, the hardware is such that multiplication comes almost as cheaply as addition. Similarly, the factor \( L \) attempts to measure inefficiencies due, for example, to decimal capability.

None of the five factors is wholly objective (\( D \) comes closest) and some (\( M \) and \( L \)) are extremely difficult even to estimate for some machines. In any event, an attempt was made to pinpoint these figures for all small computers, with results as shown in Fig. 1.

Fig. 1 shows the \( G \) index plotted on a log scale against time. This line is fitted to data points (by eye). As mentioned, the data going into the index is highly subjective. A further complication comes from attempting to assign a point in time to a given machine. Date of first delivery? Date of peak use? Date of announcement?

The value of the index, then, lies in showing a gross trend (as in Fig. 1) or as means of comparing two similar machines.

In any event, we have some basis for asserting that raw

---

Mr. Gruenberger is now a member of the senior staff at Informatics after many years of association with the RAND Corp. Author of several books on computing, he has a master's degree in mathematics from the Univ. of Wisconsin, where he also served as project supervisor in the Numerical Laboratory.
computer power per dollar for small computers has gone up by some three orders of magnitude in a decade. No existing evidence indicates when this trend might taper off. Whatever we're getting 800 of now, we might expect to get 8000 before 1970. And the thing we are getting is pertinent to a discussion of time-sharing. Any virtues espoused for time-sharing that relates only to computing power sooner or later can become available in the free-standing machine.

time-sharing advantages

What, then, are the unique virtues of time-sharing, i.e., that cannot be made available through the small local computer? Some things seem clear-cut; others less so.

1. Buy only what you need. Time-shared systems will probably require a base load (nuisance charge) of, say, an hour a day. Added to that is the (one-time) cost of installing the console, plus the monthly charge for the data set and the per-minute costs of telephone service. From that point on, charges could be entirely on an as-used basis. There need be no worries about keeping the device occupied. (The analogy to the use of electric power is strong.)

2. Access to powerful tools. I have postulated a point in time at which a good conversational language (as good as, or better than, JOS or TINT or MAC's time-sharing language) is available on a free-standing machine. Now, if the loading of that program into the computer is by disc (as on the IBM 1130), then conceivably one could have several languages at his disposal. However, one could always have a wider choice of more powerful languages through a time-shared system, since the processor can be very large and have access to a mass-storage system. The assumptions here are for equivalent cost. For whatever the cost-per-hour to operate a free-standing machine, the same cost-per-hour could hook the user into much greater computing power—and this will remain true for the foreseeable future.

3. Access to data banks. Along these same lines, the remote-terminal user can have access to mass storage for other purposes; viz., as a source of data. In a given data-processing situation, the need for computing power might be small (i.e., easily satisfied by a small machine) but the need for data files large, at least momentarily.

4. The use of a remote terminal has obvious advantages in space-saving and machine maintenance.

5. The remote terminal may offer lower pressure on the user. This may be more psychological than real. There is a feeling, in dealing with a free-standing machine, that dollars are going down the drain during head-scratching time. To some extent, that same feeling should apply to a time-shared terminal. The true situation depends on how the terminal is financed, and to what extent it is saturated.

6. Queueing problems and turn-around time. We are getting down to vague and tenuous advantages. It is often claimed that time-shared terminals eliminate queues and reduce turn-around time to zero—an "advantage" that could be attained as readily on a free-standing machine.

7. Red tape. Current time-shared systems cut red tape, to be sure, but they are being compared to current operating systems. I see no reason why red tape cannot also be cut for free-standing machines.

Two constants seem to be operating in this area. The cost of terminal gear (typewriters and consoles) will probably remain steady and high unless mass-produced. The cost of communications (i.e., telephone lines and data sets) will also remain fairly constant.

Two factors are variable and dynamic. The cost of free-standing small machines is decreasing rapidly. At the same time, of course, the cost of equipment suitable for central processors for time-sharing is coming down, and the programming for time-sharing may eventually be spread over many installations. There is a race going on.

I suspect that the situation will eventually simmer down to this: a free-standing machine hooked, for short bursts, to a large central facility. Thus, the future might bring us the best of both worlds.

free-standing machine advantages

A similar list can be made of the advantages (over time-sharing) of a free-standing machine.

1. Lower cost. If usage approaches one full shift, then the cost of a small computer (rented) approaches $5 per hour, or about half that of any existing or proposed time-sharing system.

   If usage will ever exceed one shift (say, for peak loads), then even greater savings can accrue. A small machine that is owned can be run around the clock, driving the cost-per-hour down to less than $2.

2. Reliability. If the time-sharing central processor or the data links break down, then 100 consoles are down, all at once. On the other hand, 100 free-standing machines are hardly likely to be out of commission all at once. One can argue that the overall reliability of equivalent computing power is higher when split 100 ways. Offsetting this is the concept of a duplexed central processor to guard against CPU failure. (What guards us against telephone failure? We have yet to accumulate experience from the existing systems.)

3. Safety. Suppose the computing power is being used to interact (in the sense of monitoring, but not in the sense of process control) with a physical experiment. The experimenter might feel more comfortable with an independent machine, and not have to worry about communication links or delays that time-sharing might cause.

4. Speed. The ratio of speeds of the large machines to the small ones is now of the order of 3 or 4 to 1. Some of the speed of a large machine (acting as the CPU for a time-shared system) must be dissipated in system overhead; the remainder is distributed among those consoles needing computation. The full attention of a small machine, operating for a single user, could reasonably lead to greater speed.

   A more interesting question is, where will this relationship be a few years from now? I conjecture that the ratio of speeds (large to small machines) will tend toward 1:1 and that the index of computing power for small machines will increase faster than for large machines. If this occurs, then the speed advantage for free-standing machines will accentuate.

5. Security. Obviously, classified information cannot be processed by a computer utility without elaborate cryptographic techniques. Even then, security officers would probably have qualms. The same situation would hold for privileged and company confidential information. In order to avoid leakage of such information, processing by a free-standing machine would seem preferable.

* The same analysis applied to large machines shows a growth rate of two orders of magnitudes in a decade.
Why did the Jet Propulsion Laboratory give us the Mars job?

Over 1,000 reels — approximately 2.5 million feet — of Audio Devices Computer Tape supported the photography and telemetry of the Mariner IV mission.

Why did JPL use Audio?

Real-time data acquisition demanded quality computer tape. Many brands were tested before the 7½ month flight. Audio was chosen.

Maybe it was the tests. Maybe they liked our references (21 out of the top 25 U.S. industrial companies buy computer tape from us). Maybe it's because we're tape specialists. In any case, isn't it time you consulted a specialist?

Get the picture? JPL did!

Audio Devices Inc. INSTRUMENTATION TAPE • COMPUTER TAPE • AUDIOTAPE
235 E. 42nd St., New York 10017. Offices in Chicago, Los Angeles and Washington, D.C.
If you want to be really hard-headed about efficiency when you buy a compiler, here’s how you might go about it:

First: Code up a small but representative set of test routines in the source language of the compiler, along with some test data for these routines. Opler discusses some of the characteristics to be desired in such test programs. Briefly, they should be designed with at least four purposes in mind:

To determine whether the compiler accepts the full source language.

To determine whether the object code generated by the compiler produces the correct results.

To determine the speed of the compiler.

To determine the efficiency of the object code produced by the compiler, in terms of its use of storage space and execution time.

This note discusses only this last purpose and, for this purpose, the test routines should include statements that reflect the kinds of applications for which the compiler will be used as well as statements that, based on experience with similar compilers, can be expected to produce the most troubling cases of inefficient object code.

Second: After the test routines have been written and debugged in the compiler language, recode them in the assembly language of the target computer. Assign a senior programmer to the task, preferably one with experience in programming for the target machine, and tell him to turn out the tightest code possible, using all the facilities the machine provides. (Questions of trade-offs between storage space and execution time that arise here should be resolved with the same criteria you would want used in your operational programs.) Since almost any code can be improved, you might want to repeat this step a few times, until you’re confident you’ve squeezed out all the fat in the assembly language routines. You will, of course, check these routines out with the test data to see that they too produce the desired results.

Third: These assembly language routines are then your standard of coding excellence, and you can specify that the compiler you’re buying turn out object code that averages no more than $x$ per cent more total instructions (and constants) and $y$ per cent more total execution time, using the same test data ($x$ and $y > 0$).

The question now naturally arises, what are reasonable values of $x$ and $y$ to ask for? Well, this answer depends on a lot of factors, not the least of which are the test routines themselves. But I wonder if some general answer isn’t possible, assuming that all you want is a reasonably efficient compiler, for a reasonably straightforward source language, on a reasonably ordinary machine, and at a reasonably competitive price. Under these assumptions, my guess, for $x$, would be from 20 to 30 per cent; for $y$, from 10 to 20 per cent.

Fourth: in checking the compiler to see if it meets your standards here, you can afford to allow the compiler builders to rewrite the source language versions of the test routines in an attempt to coax the best possible object code out of their compiler. Needless to say, the compiler-generated object code should do essentially the same computations and produce the same results from the test data as the hand-coded routines.

If the compiler writers do come up with a more efficient set of source routines, you should ask them to document the coding tricks they used to do this. Of course, they may just have discovered a better algorithm than did your assembly language programmer, and their compiler really turns out lousy code. More power to them; you’ll just have to grin and bear it.

Another objection I’ve heard to this scheme is that, if you choose your cases with care so they cover most of the problems that concern you, then this is exactly what you want them to do.

Mr. Shaw heads the information center on Information Processing at System Development Corp., Santa Monica, Calif., and is chairman of the Special Interest Group on Programming Languages of the L.A. chapter of the ACM and chairman of the Special Interest Committee of the ACM. He has participated in language standards work at both the national and international levels. A mathematician, he is a project leader of the Advanced Programming technical staff of SDC’s Research & Technology Div.


2 You could, in step two, go another route and try to obtain instead a standard of coding mediocrity. This would be harder to do, since it would entail averaging out the programs written by a representative sample of programmers. And it would not serve to measure object-code efficiency any better than would a standard of coding excellence. Furthermore, you couldn’t use this standard of coding mediocrity to determine the average efficiency of compiler-produced code unless you applied a similar sampling procedure to obtain a representative set of compiler-language routines.
New LINK Waveform Display/Analyzer—precision film reading and recording with one machine.

Here is a new graphic input/output device that can help reduce computer time and programming costs significantly. The Waveform Display/Analyzer allows real-time access to information and immediate updating and analysis. You can change the display with a light pen and keyboard and request further action from the computer without the assistance of a programmer. The light pen lets you alter, add and delete data. You can move, enlarge and reduce images, plot graphs, and label displayed information. Problems can be altered for further analysis. It is not only a problem-solving tool—it's a system for producing new designs. The light pen saves time and cost by eliminating the need for an output record, thereby cutting down on equipment and producing answers more quickly.

AND THESE OTHER FEATURES—
• Scan a film image or waveform and digitize the data.
• Display data and images on a high-resolution CRT.
• Store computer output data on film in black-and-white or a 16-level gray scale.
• Handle large amounts of information by film scanning—(1024 x 1024-bit matrix with 16,380 x 16,380 also available).
• Buffer system storage capacity 1024 words, 36 bits each.
• All solid-state circuitry.
• Utilizes interchangeable film transports making it possible to use 16mm, 35mm and 70mm film in both the read and record mode.

The Waveform Display/Analyzer can operate as a single unit with one small binary computer or as one of several time-shared units on a large host machine.

For an informative brochure, write to Advanced Product Sales, General Precision, Inc., Link Group, 1451 California Ave., Palo Alto, Cal.
How to design a total information system

In a previous Task Force Report it was pointed out that microfilm has no place in the recording of total information. Proper systems design, however, requires the study of several factors in designing any effective information system.

Prior to the selection of equipment, the microimage file form which will be used to establish central and satellite information files must be determined. Strangely enough, the cost per page recorded for assimilation into the system may be one of the least important factors in the selection of the microfilm.

In the table below, the cost per page converted for storage is tabulated for the most common microforms. The cost ranges shown, which reflect cost experience in efficiently planned operating systems, differ little from one form to another, when a given microform is being used most effectively.

It becomes apparent then that the selection of the microform and thus the equipment used in the system must be based on other considerations. Some of the considerations which relate to the ease of creating, duplicating and distributing the microform are also shown in the table. In general, that microform should be used which can best be adapted to the natural organization of the information store and which can handle the changes to the store.

Most commonly, aperture cards and microfiche are used to record units of information. Documents recorded on microfiche or aperture cards can be serially identified and simply added to the back of the existing file, or they may be identified as they relate to a segment of the file and interfiled in the proper place. With either of these microforms, replacing a superseded item in the file with a new document can be accomplished with ease.

Aperture cards help add new information instantly

Aperture cards, for example, have long been used by larger organizations for recording drawings and related documents in reproducible form. The primary or first generation cards are then replicated to duplicard decks at speeds up to 2000 cards per hour. This provides distribution of the information in compact, reproducible form to satellite files established to serve the various users of the design information.

The rate of change of drawings in many files required that a unit record microform, such as the aperture card, form the basis of the system. With the introduction of the 3M Processor-Camera with its capability to convert documents to microform on a document for document basis, systems based on the aperture card and duplicard could be designed for organizations generating as few as ten new and revised drawings per day.

Similarly, there are several systems in operation and many others under consideration in which the aperture card is used for technical reports, various other business records and published documents consisting essentially of letter-sized pages and ranging from one to sixteen pages in length.

**Microfiche as a micropublishing medium**

Within the past few years, microfiche has come into its own as a micropublishing medium for larger documents, those greater than thirty pages in length. The application of present and future technology and design capability will make microfiche an even more useful microform. For example, the equipment and time required to prepare master microfiche from input documents is such that microfiche can only be used economically for micropublishing.

This will change; work on the development of a microfiche camera and processing capability is under way. The objective of this development is equipment which would provide for the conversion of single documents to master microfiche.

**Roll film for information collections**

In general, two types of information collections may best be handled in roll form. Serial collections which change only by adding new documents to the end of the file, where there is either a broad distribution of document length or a very narrow range of short documents, and where there is a distribution of all of the contents of a roll to given files can most effectively be handled in roll form.

Conversely, for collections such as catalogs where there is frequent change which can be programmed to republication, roll film in cartridges finds excellent application. When the characteristics of the information collection are matched by the best attributes of roll microform, it can be the least costly, most compact form and the one with which there is the least concern for file integrity.

**“People” files**

Jackets find their best application in establishing unit or “people” files. These are files to which information must be added on some sporadic basis. Since one can add microimages to a jacket, it is the only microform which can be used effectively for this type of open-end file resulting in a unit film form entry.

However, the cost and control which must be exercised in making a series of very short additions to a series of jackets has precluded its use in many files. Until recently, it was difficult to prepare high quality, contact copy microforms from a jacket for distribution. The advent of the thinner jacket represents an improvement in this regard. However, the bi-axially oriented polyester films used in these jackets has some optical properties which may still adversely affect the quality of print through images from microimages filed in the jacket. From both this standpoint and with respect to the specifications which are being written by both the Federal Government and industry for microfiche, it is improbable that jackets will ever be totally satisfactory as masters for the preparation of microfiche. Jackets find their best application in establishing one central microfilm store of open-ended files.

For a more complete discussion of a total information management system, please write Dr. David R. Wolf, 3M Company, Building 209, Dept. FDJ-46, St. Paul, Minn. 55119.
THE FLIGHT TO TOKYO-1984 STYLE

by LT. DORIAN DE WIND

(Inspired by Ascher Opler's article in the January issue, Bon Voyage—1984 Style, Lt. de Wind of the Air Force offers this description of the flight to Tokyo taken by Lester P. Jonas on the advice of his UTSS counselor.)

It is 7:15 a.m. at San Francisco International Airport. The pilot of flight 597, Trans Sonic Airlines, steps into the cockpit of his shiny new Boeing 797 . . .

AIRBORNE

PILOT: Good morning. I have just received your flight plan from traffic control. If you desire to read it I'll print it out.

PILOT: Never mind, I'm running late. How is the aircraft?

COMPUTER: All pre-flight checks have been completed. The airplane is in perfect condition, except for a minor deviation error in the manual compass. Could possibly be an error in my check-out program. Would you like me to obtain a double-check from remote control?

PILOT: Negative, we won't be needing it any how, I'll let you do all the flying today . . . had a rough night. By the way, where are we going today?

COMPUTER: Our destination is Tokyo. I have just received indication that all passengers are aboard. We are ready to go; all seat belts are fastened except yours. Would you please sit down?

PILOT: O.K., what’s on the menu for today?

COMPUTER: Will print it out for you while taxiing. Am just receiving taxi and take-off instructions, also weather forecast. Looks like a smooth flight ahead. Will be using runway 27 . . . presently taxiing to take-off position, take-off time will be 07:31, estimated time en-route 3 hours and 17 minutes, flight altitude . . .

PILOT: Tell it to the passengers. The menu looks good. What time is breakfast?

COMPUTER: The master menu program was just checked; breakfast will be served in 30 minutes. Passengers have been briefed, take-off cameras have been programmed on, pressurization completed, final data transmission, ground, and airborne equipment checks all O.K. We are ready for take-off; if this is to be a computer controlled take-off press the “AUTO T/O” button . . . Understand. Take-off program and latest weather information have been read in. We are rolling.

PILOT: Congratulations! That was one of the smoothest take-offs I have seen you make yet.

COMPUTER: Thank you. I thought so myself, considering the strong cross wind . . . Take-off time was 7:31 on the dot. Am presently climbing under ground radar control. In-flight movie playing is the "The Moon Lovers." Landing gear is up. During take-off noticed a change in left yaw response rate of 15 microseconds, have modified the program to compensate for it on future flights. Also discovered a failure in the flight data recording system, switched over to the alternate system and recorded it on the mal-function log . . .

PILOT: We are level at 40,000 feet, all in-flight checks completed. We are now under Airways control, the weather in Tokyo is excellent; have been notified there will be five-minute hold in the traffic pattern over Tokyo International, then will land on runway 15 behind Pan American flight 885.

PILOT: Well, I think breakfast should be ready now. Let me know if you need me.

COMPUTER: Before you go, press the “AUTOMATIC MARGINAL CHECK” button so I can perform preventive maintenance checks on my circuitry, but leave the “MONITOR/-INTERRUPT” option on in case I need to go back to the flight program.

Two hours and fifty-two minutes later:

An alarm sounds in the cockpit.

COMPUTER: Sorry I had to wake you up, but we just landed at 18:48 Greenwich Mean Time. You will have to take over now, as you know it is against company policy to taxi under computer control on foreign airports.

PILOT: (Sleepy voice) Oh, O.K. Boy, these flights are getting more and more demanding every day!

Lt. de Wind is presently assigned to the Reno Air Defense Sector, where he is responsible for operation and maintenance of the SAGE AN/FSG-7 computer. He is a graduate of the Air Force Electronic Computer Maintenance Officer Course and intends to complete his studies for a degree in computer science through the Air Force Institute of Technology.

April 1966

73
MOORE PUTS TOTAL VALUE

Optical Character Recognition and Mark Reading represent a great advance in data processing, but the work the scanner does is no better than the forms fed into it.

We make precision forms so the scanning process will yield the speed, economy and accuracy expected of it.

This calls for the highest precision, for technical knowledge, production efficiency, a lot of research, and men trained in optical scanning techniques.

Our Research Engineering Departments have produced special manufacturing equipment and techniques for precision forms.

And working with the machine companies, Moore meets manufacturers' specifications on format and tolerances, involving also paper, carbons, margins, spacing, use of ink and colors and other factors.

Moore makes OCR and Mark Read documents for many uses—premium notices, utility bills, checks of all kinds, statements, invoices, library cards, coupons, membership cards, etc.

These are some of the things that give Moore forms Total Value. If you work with forms, we can show you how to make forms work for you.

MOORE BUSINESS FORMS INC

"The right business form for every form of business" • Niagara Falls, N.Y. • Park Ridge, Ill. • Denton, Texas • Emeryville, Calif. • Over 500 offices and factories in North America

CIRCLE 35 ON READER CARD

MARK READ FORMS are designed and manufactured by Moore with exact tolerances to make sure that they serve as accurate input documents.

MOORE'S MARK READ TESTER determines acceptability of documents for Mark Read applications, insuring form specifications that meet scanner requirements.

SELF-CHECK DIGITS are used to verify correctness of consecutive numbers. Many other features are available to save machine time and clerical labor.
Whether because winter is done and spring has sprung, or because manufacturers now see where IBM is committing itself, new computer announcements are being made with a rush and a fervor. Last month, Sigma 7 got the Klieg-light treatment from SDS (see March, p. 53). And if industry pundits can be believed, Univac will have a few words about a new machine in June.

Now it’s Burroughs’ turn. Continuing to produce decimal-oriented computers, the latest entries are the B2500 and B3500, which form part of the Burroughs 500 Systems. (Others in this program-incompatible series are the B5500 and B8500.) Functioning decimally all through the mainframe, including the addressing, the 2500 and 3500 take their place between, but overlap, both the B200 and B5500—but are not compatible with either. In the marketplace, they compete with the IBM 360/30 and 40, the RCA Spectra 70/35 and 45, and the 200, 1200 and 2200 from the Honeywell 200 series.

The new machines also speak for the company’s commitment to the latest technology. Monolithic integrated circuitry is used throughout the mainframe. Specifically, they’re Fairchild Semiconductor’s CTuL family.

With the new pair of 500’s, the company also emphasizes the use of higher-level languages. Available are both COBOL and FORTRAN IV. Reportedly “open-minded” about PL/I, the company is awaiting the specifications for this language. Some features of the new machines have even been designed to take advantage of COBOL. The adder, for example, operates from left to right (high-order to low-order position), and in comparing numeric fields the machine looks first at the high-order position.

In a further attempt to upgrade the dp operations of its users, Burroughs has drawn on its experience in multi-programming with the B5500 and added this capability. Several programs can occupy core simultaneously, under the aegis of the Master Control Program operating system; smaller configurations operate under the basic control program. A base register makes possible the use of relative addresses, program boundary (or limit) registers achieve memory protection by preventing the accidental overwriting of one program by another, and priority interrupt is on the basis of a fixed assignment. There’s also dynamic storage allocation and the automatic overlay of program segments.

The two computers differ only in internal speed, memory capacity, and the number of I/O channels. The B2500 has from 10,000 to 60,000 characters of core; two characters can be accessed in 2 usec. It can have up to six I/O channels, three of which can be of the high-speed variety. The larger B3500 can have up to 500,000 characters, two of which are accessible in 1 usec. There can be up to 20 I/O channels, 10 of them high-speed.

**internal organization**

As can be surmised from the memory access rate, the internal code is the 8-bit EBCDIC (Extended Binary Coded Decimal Interchange Code), used also in the 360 and Spectra 70. By means of a programatically-selectable mode switch, ASCII code can also be executed without
B2500 and B3500...

translation. Internally, the machines handle 4-bit digits, 8-bit characters, 16-bit words, and 24-bit syllables. Processor instructions, as distinguished from I/O instructions, are variable in length from one to four syllables; thus, instructions may contain from zero to three addresses.

There is a special case of numeric representation for floating-point operands (floating point is optional). These operands are in the 4-bit-digit format, but the mantissa can be of variable length—up to 100 digits.

Arithmetic speeds are perhaps best expressed by examples. In the B3500, it takes 32 usec to add two 5-digit numbers. This includes the time to fetch the instruction data from core, return the sum to core, and to pack and unpack mixed digit and character fields. The same operation in the 2500 requires 64 usec. The floating-point add takes 13.5 usec, plus the normal add times of the mantissas of the two operands.

Including the same operations, the 5 by 5 fixed-point decimal multiply times are 206 and 412 usec for the 3500 and 2500, respectively. Floating-point multiply takes 23.5 usec plus the normal decimal multiply times of the two mantissas.

An important part of the processor is the Address Memory, a 100-nanosecond register with from 24 to 120 words. Eight words are assigned to the processor, and two to each I/O channel. During execution, the processor addresses core memory with words from Address Memory. Thus, memory accesses are not required for information relative to the command itself during execution; that is, accesses during the execution phase are for data only. Peripheral control units use their associated words in Address Memory for data accesses during their I/O operations.

Input-output operations are independent of the processor and of each other, and any or all I/O channels may operate simultaneously. The I/O system time-shares core and the Address Memory with the processor, under control of the Central Control unit.

Still another register is the index register, three of which are available to each program in core. Indirect addressing and indirect field length are standard features of the system, and are allowable to any level.

microprograms & emulators

Available also is a read-only storage, a resistive-type memory, with a 100-nanosecond cycle time. This is used to store microprograms that initiate and control:

- Memory reads and writes for the processor
- Transmission of data from register to register within the processor
- Loading and unloading the processor's eight words of address memory
- Counting and setting of all the various registers
- The initiation of I/O operations

Microprograms are automatically initiated by the op codes of the program instructions as they are fetched from core. Additional read-only storage may be added, including emulators for the B200 series and the IBM 1400 series.

The system memory—for the storage of the software package, the user program library, and for working or general storage functions—is a single magnetic disc with a capacity of 1 or 2 million characters and an average access time of 17 msec. At least one of these units is required when operating with the Master Control Program. Although resident on disc, the MCP also requires 10K of core.

Other peripherals include the regular disc file expandable from 10 million to 2.5 billion characters. With a head-per-track design, the average access time is 20 msec, and the maximum transfer rate is 240 KB. In addition to stand-up tape drives, a new unit consists of a cluster of four drives in one cabinet. They operate at 45 ips, have transfer rates of 36 KC and 72 KC, and rent for approximately $1300 and $1700 per month. Also new are drum printers operating at up to 1,040 lpm.

In the area of communications, there are both single- and multiple-line controls. The latter enables the use of any mix of voice-grade lines. Communications can be with any other 2500 or 3500, the B493 typewriter inquiry station, a mod 33 or 35 Teletypewriter, IBM 1050, Univac 1004, and the Friden 30 On-Line System.

System prices begin at $208,610 ($4,165 per month) for a minimum tape-oriented B2500 and $230,690 ($4,780/month) for a minimum tape-centered 3500. The smallest 2500 with the MCP operating system goes for $5,575/month, and can be purchased for $274,850. A "typical" (but large) commercial B3500 system might include 90K of core, 100 million bytes on discs, eight 72KB tapes, floating point, and other peripherals. The system would rent for $20,720, and sell for $1,032,765.

Deliveries of the B2500 are scheduled to begin in January of 1967; first B3500's are slated for May 1967.
Click. Click. Click.

Your records are ready for data processing.

Now, your records don't have to be tied up when you convert to punch cards.

We come in and microfilm your company records on the spot.
Then, we make xerocopies of your records from the microfilm. And the xerocopies are used to set up your data processing unit record system.

We meet government security standards. So confidential material stays confidential. And you get back all existing copies, plus microfilm file, if desired.

No inconvenience. No delays. No records lost. No matter how big or complicated the job is.

Just the click, click, click of the microfilm camera.

Go ahead—clip it out. We'll send you all the details.

NAME ____________________________
TITLE ____________________________
COMPANY _________________________
ADDRESS __________________________
STATE __________________ ZIP __________

XEROX CORPORATION, ROCHESTER, NEW YORK 14603. BRANCH OFFICES IN PRINCIPAL U.S. CITIES. XEROX IS A TRADEMARK OF XEROX CORPORATION.
Now save 20% and more on computer maintenance

with no strings attached  If your company is “wedded” to unnecessary computer maintenance costs…or suffering from excessive downtime — you’ll do well to check into DATACOMP. Ours is the only FULL SERVICE COMPUTER MAINTENANCE ORGANIZATION. We lease, install and maintain computer systems…handle operation programming, system procedures and analysis engineering on all makes of computer equipment. The Armed Forces, leading universities, the GSA and many other large installations are currently saving 20% or more on computer maintenance through the services of DATACOMP. We can probably do the same for you.

Datacomp Service Corporation
“World Leader In Computer Services”
2011 Lemoine Avenue, Fort Lee, New Jersey

Engineering Opportunities at Datacomp! We are expanding rapidly. Engineers, Programmers and Computer Technicians who feel a like need to expand are invited to send resumes to Personnel Director.

“An Equal Opportunity Employer”

CIRCLE 37 ON READER CARD
The 1966 Spring Joint Computer Conference will be held in Boston April 26-28. It is my pleasure to invite everyone who is interested in the information processing field to attend this meeting. In keeping with the pattern of past conferences, a wide range of technical information will be presented. The breadth of the program is a reflection of new applications for computers that are being discovered and old ones that are being expanded in scope.

Information retrieval will receive increased emphasis at this conference. This attention is prompted by the growing concern of professional people who are trying to keep abreast of the large amount of technical information being published. One physicist calculated that if the Physical Review continued to grow at the rate it did from 1945 to 1960, it would weigh more than the earth in the next century. Although computers are playing an important role in the solution to these problems, the field is still in an early stage of development. The availability of mass memory devices and information utility concepts makes this a timely subject.

Our keynote speaker, Walter Finke, president of Honeywell EDP, will address the opening session on one phase of this broad subject in his talk, "Information: Dilemma or Deliverance." Our luncheon speaker, Dr. Isaac Asimov, noted science fiction author and speaker, will talk on the subject "Four Steps to Salvation." In addition, a panel discussion will be held on the topic of "The Evolving Library." Several members of a recent summer study group on this topic will be participants in this important panel.

A second area receiving special attention is the role that computers might play in the business transactions of individuals. This will be highlighted in a panel discussion session on the topic, "A Checkless—No Money Economy."

The rapidly evolving time-sharing concepts will be reported on in several technical papers, panel discussions and in tours to organizations in the Boston area.

An innovation in format for this conference will be the combining of a panel of technical leaders with most sessions of technical papers. An abbreviated presentation of the papers will be made so that a review and discussion of its contents may be carried on by the panel. This is part of continuing Joint Computer Conference effort to make the technical programs more interesting and useful to the attendees.

On the non-technical side, Boston is an interesting city to visit, and the conference steering committee has planned opportunities for attendees to participate in a wide spectrum of attractions ranging from the famed Freedom Trail of historical sites to a Boston pops concert.

On behalf of AFIPS, I welcome your attendance at the 1966 Spring Joint Computer Conference. Come and participate fully in the extensive program planned for your benefit.
conference particulars

From Las Vegas, where little is banned, to Boston...

Many in the Outside World think of the city as Old Boston, bound in historical and familial tradition ("where the Lowells speak only to Cahots..."), but the Chamber of Commerce talks of a New Boston with a modern architectural facade, and the New Yorker's Christopher Rand has written that the technological research and development occurring at local universities, laboratories, and firms have created a Boston in renaissance. The patron for the most part is the federal government, and a major object and instrument of the activity is the computer.

It is at the New Boston's favored landmarks, the Prudential Center and the Sheraton-Boston Hotel, that the Spring Joint Computer Conference will be held on April 26-28. The technical program available to the 4000 computerites expected has been kept to a small number of sessions, 16. Two or three will usually run in parallel, but only one is spotlighted Tuesday at 3:30—time-sharing, which, of course, has been a main focus of computer development in this region. IBM will be the sole manufacturer on the podium. A panel discussion on the meanings of time-sharing will follow Wednesday morning.

A unique feature of the program will be the panel of critics at most sessions, who will give pros and cons on the papers presented. In a session on pattern recognition, M. Minsky of MIT will play "devil's advocate," but we don't know if his MIT computer-controlled "hand" will be used to hook any speakers who may give a bad paper.

The implications of computers will be discussed by keynoter Walter Finke, president of Honeywell EDP, in his speech, "Information: Dilemma or Deliverance?" If "Four Steps to Salvation" sounds like an interesting lunch-eon talk, its deliverer makes it more intriguing: Isaac Asimov, science and science-fiction writer and associate professor of biochemistry at the Boston University School of Medicine. (For the ultimate in miniaturization, read his latest, Fantastic Voyage.) Also at the Wednesday luncheon, the W.W. McDowell award for outstanding contribution in the computer field will be presented to Fernando J. Corbató of MIT for his work in large-scale timesharing systems.

With no advance registration, the sign-up will begin Monday, April 25, at 6:30 p.m. The fees, which include the Proceedings, are $10 for members, $20 for non-members. AFIPS sponsoring societies for sjcc are the Assn. for Computing Machinery, IEEE Computing Group, American Documentation Institute, Simulation Councils Inc., and the Assn. for Machine Translation and Computational Linguistics. On Friday, after the conference, each of these groups will have sessions on such topics as real-time system design, interactive computation, optical scanning, and natural language processing.

About 90 firms will show products and services in War Memorial Auditorium. Expect a packed exhibit area: at time of writing the chairmen were still looking for corners to put more booths. Hours: Tuesday, 11:30-5; Wednesday, 10-8; Thursday, 10-5.

Other conference features include tours of government and university laboratories and manufacturing facilities in the area. Invited students and teachers will have a chance to trade ideas about the use of typewriter and graphic terminals with Richard Warren of MIT and Anthony Oettinger of Harvard. Also on the agenda are 41 computer sciences films (including "The Living Machine") on implications, applications, experiments, and tomorrowland; an amusing clip should be IBM's satire on the evolution of programming. The ladies' program will include a historical tour, visits to the Gardner Museum of antiquities and art, the Botanical Museum at Harvard, and the Heritage Center, and a little wine-tasting at Anthony's Pier 4.

Although there won't be a final summary at the conference, the panels of critics at the sessions, and indeed, the specialists who will be available to the general press and others to discuss the meaning of the session topics, could help make this sjcc one of the better conferences for perspective and information.
the exhibitors

Exhibitors are categorized according to the products they will be showing.

COMPONENTS & EXPENDABLES

- keyboards and control panels
  - Ohr-Tronics, Inc.
  - Royal Typewriter Co., Div. of Litton Industries
- logic modules
  - Brogan Associates, Inc.
  - Computer Control Co., Inc.
  - Decision Control Inc.
  - DI/AN Controls, Inc.
  - Digital Equipment Corp.
  - Raytheon Computer
  - Scientific Data Systems
  - Vermont Research Corp.
- mag tape and accessories
  - Ampex Corp.
  - Computron Corp.
  - U. S. Magnetic Tape Co.
- memory equipment and systems
  - Ampex Corp.
  - Computer Control Co.
  - Decision Control Inc.
  - DI/AN Controls, Inc.
  - Electronic Associates, Inc.
  - Electronic Memories, Inc.
  - Fabri-Tek, Inc.
  - Fairchild Memory Products
  - Ferroxcube Corp.
  - General Precision, Inc., librascope Group
  - Indiana General Corp.
  - Lockheed Electronics Co.
  - Magne-Head, Div. of General Instruments Co.
  - RCA Electronic Components & Devices
  - Raytheon Computer
  - Tech-Met, Inc.
  - Vermont Research Corp.
- Other
  - Corning Glass Works
  - Digital Equipment Corp.
  - ELCO Corp.
  - Electronic Associates, Inc.
  - Fabri-Tek, Inc.
  - Ferroxcube Corp.
  - Sylvania Lighting Products Div.

booth numbers

- 913A
- 1009-1012
- 206
- 913A
- 611-612, 703-704
- 324-325
- 1202-1203
- 207
- 330
- 805-808
- 1315
- 206
- 913A
- 611-612, 703-704
- 326-327
- 1312-1313
- 333
- 810-812
- 319-323
- 1315
- 1013-1016, 1101-1104
- 109
- 611-612, 703-704
- 326-327
- 613-615
- 310-313, 310A, 313A, 406-409
- 330
- 805-808
- 1315
- 1001-1004
- 414-418, 414A, 501-505
- 913A
- 903-904
- 1312-1313
- 207
- 310-313, 310A, 313A, 406-409
- 1009-1012
- 214-218, 214A, 301-305
- 713-716, 713A, 716A, 801-804
- 1001-1004
- 414-418, 414A, 501-505
- 1317
- 611-612, 703-704
- 912, 912A, 1005
- 319A, 328
- 310-313, 310A, 313A, 406-409
the
exhibitors

Mathatronics, Inc.  608
Olivetti-Underwood Corp.  1301-1302

mag tape transports

Ampex Corp.  319-323
Brogan Associates, Inc.  207
California Computer Products, Inc.  101-105
Control Data Corp.  1010-1301, 310A, 313A, 310-313, 310A, 313A, 406-409
Dartex, Inc.  330
Datamec, Div. of Hewlett-Packard  805-808
Kennedy Company  206
Midwestern Instruments, Inc.  705-707
Potter Instrument Co., Inc.  333
Texas Instruments, Industrial Products Group

microfilm systems

Benson-Lehner Corp.  905-907
National Cash Register Co.  1013-1016, 1101-1104

plotters

Auto-Trol Corp.  334-335
Brogan Associates, Inc.  905-907
Brogan Associates, Inc.  207
California Computer Products, Inc.  101-105
Electronic Associates, Inc.  214-218, 214A, 301-305

printers

Anelex Corp.  212-213, 213A, 306-307
Brogan Associates, Inc.  3108
Datamark, Inc.  1205-1208
Data Products Corp.  324-325
DII Controls, Inc.  710-712
Monroe Datalog, Div. of Litton Industries
Potter Instrument Co., Inc.  705-707
Teletype Corp.  310-333

punch & read equipment

(card, paper tape)

Datamec, Div. of Hewlett-Packard  805-808
Data Machines, Inc.  1113, 1113A, 1204
Digitronics Corp.  331-332
National Cash Register Co.  1013-1016, 1101-1104
Ohr-Tronics, Inc.  913A
Omni-Data, Div. of Borg-Warner Corp.  1114-1115
Photocircuits Corp.  331-332
Remex/Rheem Electronics  1213, 1214
Royal Typewriter Co., Div. of Litton Industries
Soroban Engineering, Inc.  603-604
Tally Corp.  903-904
Teletype Corp.  1312-1313

random access memory systems

(disks, drums, etc.)

Anelex Corp.  212-213, 213A, 306-307
Brogan Associates, Inc.  207
Computer Accessories Corp.  1109A
Data Products Corp.  1205-1208
DI/AN Controls, Inc.  324-325
Electronics Memories, Inc.  410-411, 410A
General Precision, Inc., Librascope Group  913-916
Honeywell, EDP Div.  1001-1004
Magne-Head, Div. of General Instruments Co.  208-209
Potter Instrument Co., Inc.  705-707
Tech-Met, Inc.  613A
Vermont Research Corp.  602

other

Auto-Trol Corp.  334-335
Brogan Associates, Inc.  207
Digitronics Corp.  916A
General Computers, Inc.  709A
Redcor Corp.  326-327
Texas Instruments, Industrial Products Div.  333

COMPUTERS

analog

Applied Dynamics, Inc.  511-513
Beckman Instruments, Systems Div.  412-413, 413A, 506-507
Comcor Inc.  1303-1306
Computer Products, Inc.  509
Electronic Associates, Inc.  214-218, 214A, 301-305
Milgo Electronic Corp.  815-816, 901-902
Reeves Instrument Co.  1109-1112

digital

Computer Control Company, Inc.  201-205
Control Data Corp.  310-313, 310A, 313A, 406-409
Data Machines Inc.  1113, 1113A, 1204
Digital Equipment Corp.  1009-1012
Electronic Associates, Inc.  214-218, 214A, 301-305
General Electric Computer  713-716, 713A, 716A, 801-804
IBM Corp.  414-418, 414A, 401-505
Raytheon Computer  611-612, 703-704
Radio Corp. of America EDP  609-610, 701-702
Scientific Data Systems  314-318, 314A, 401-405
Texas Instruments, Industrial Products Group  333
Univac, Div. of Sperry Rand Corp.  210-211, 210A, 308-309

hybrid

Adage, Inc.  810-812
Applied Dynamics, Inc.  511-513
Beckman Instruments Inc., Systems Div.  412-413, 413A, 506-507
Comcor Inc.  1303-1306
Computer Products, Inc.  509
Electronic Associates, Inc.  214-218, 214A, 301-305
A product preview

what they're showing that's new

ANELEX CORP.
Boston, Massachusetts

Among products being shown are the model 81 disc file, the model 4000 printer being fed data via Dataphone, and the 2610 print station. From the product line of subsidiary Franklin Electronics, there will be model 120A and 2200 digital strip printers.

APPLIED DATA RESEARCH INC.
Princeton, New Jersey

The recently-announced, proprietary software system, AUTOFLOW, for producing flowcharts on a line printer, is being shown. Accepting assembly and higher-level languages, the software performs the allocation of symbols, editing, code rearrangement, column and page allocation, and the drawing of connecting lines. The system is leased to users, and is available for the IBM 1401, 1410, and the 360's, Honeywell 200 series, and RCA Spectra 70's and 501.

AUTO-TROL
Arvada, Colorado

The model 8030 is an all-digital machine tool director for use with existing machine tools and positioning tables. Input can be from cards, paper and mag tapes; the unit can also be operated manually. Incremental motions as small as 0.0001 inch can be accomplished. A visual display is provided for $x$ and $y$ value registers.

BENSON-LEHNER CORP.
Van Nuys, California

Newly-developed is a card-input Delta Incremental Plotter. The off-line unit includes the plotter, table, and card reader, and reportedly allows up to 100 steps in $x$ and/or $y$ from one computer command. The control unit is also compatible with all on-line plotters for reducing computer write time or to convert from on- to off-line. Another new product is the STE off-line mag tape plotter. It operates from 200- or 556-bpi 7-track tapes with either the gapped or gapless format. It can also be outfitted to run from 556- or 800-bpi tapes, and can be field-modified for 9-track tapes.

CALIFORNIA COMPUTER PRODUCTS INC.
Anaheim, California

The model 835 being introduced is a CRT/microfilm plotting system for any computer output that can be converted to graphic form. It is a digital incre-
SEE THESE DEVICES OPERATING IN OUR EXHIBIT AT THE S.J.C.C.
To computer users who are looking ahead:

Sharpen your peripheral vision

Wall-to-wall peripherals: look at them. Look closely. Beside those you might expect to find, there are some surprises. A unit that optically reads numbers, letters, punctuation. People-oriented devices that answer questions in plain language by video screen. Data collection stations to help you with labor distribution, order location, inventory control and other management functions. A remote calculator that lets mathematicians tap the world's most powerful computer—the CONTROL DATA® 6600—by phone line, so that many people in an organization can share one central system simultaneously. Of course, different users want output in different ways. This also is fully provided for. Today, a typical computer system is largely peripheral equipment. So, peripherals get attention in depth at Control Data! We've supplied thousands of peripherals for our systems throughout the world; won a reputation for performance second to none. Good to know your equipment investment is so thoroughly underwritten! Ask for information on our complete line of computer systems and peripheral equipment by getting in touch with your nearest Control Data representative. Or write direct to our Minneapolis address, Department H-46.


the biggest computers for the biggest installations come from CONTROL DATA CORPORATION

8100 34TH AVE. SO., MINNEAPOLIS, MINN. 55440

April 1966

CIRCLE 38 ON READER CARD
Either positive or negative transparencies are produced for direct viewing or photographic printing.

DATAMARK INC.  
Westbury, New York

New line of printers to be exhibited is the 300 Series, designed for communications terminal and small-scale computer output applications. Worst-case print speed is 300 lpm with a 64 character font; also available is a 96-character font. Frame sizes are available for 80 and 132 columns, the former mountable in a 19-inch relay rack.

DECISION CONTROL INC.  
Newport Beach, California

Being announced is a new line of more than 20 digital logic modules, the Micro VersaLOGIC series. Included are universal flip-flops, delay multivibrators, clock drivers, variety of gating configurations, and a number of pre-connected arrays: binary counters, shift registers, etc. They operate to 5 MC with logic levels ranging from 3.8 to 6 volts (true) and 0 to 0.5 volts (false) with noise rejections of over 1 volt.

DI/AN CONTROLS INC.  
Boston, Massachusetts

Three new products are being shown: a computer typesetting system (shown), a field-programmable aerospace magnetic timer, and a lister/printer. The typesetting system, model LC-3, uses a special-purpose computer to perform hyphenation, justification, and error correction before the paper tape is punched. In the error correction, one keystroke is used to erase either one letter, a word or an entire line, obviating the production of idiot tape.

The timer provides discrete timing and interval stepping for 12 sequential events, and can be field-programmed for all 12 intervals. It uses core transistor logic elements and magnetic commutator elements to perform all logic and control functions.

The data printer has 16 columns, prints 40 lines of numeric data per second or 20 lines/second of alphanumeric information. The series DL has an ink-roller with inking capacity of more than 10 million lines.

A unidirectional paper-tape handler, the model 6011 handles 5 to 8-level tapes of 1/24, 3/4 and 1-inch widths, interchangeably. No adjustment is required when changing from one width to another. Spooling speed is 30 ips and rewound speed is 40 ips.

A new core memory system with a cycle time of 650 nanoseconds is the NANOMEMORY 650. It has a capacity of 16K (84-bit) words and an access time of 300 nsec. Features are silicon circuitry, 2-D-D organization, and 20-mil cores.

Entry of the firm into the core memory business will be featured. Shown will be a model of a microcircuit unit with a memory cell using a 16-bit version of the 36-bit cell, in addition to possibly a 2-D-D memory system.

The recently-announced line of 10-use memory systems for the commercial/industrial market is being shown. First system in the line, the FX-12, is a small memory with a maximum of 512 (8-bit) words, designed primarily for code or format conversions and speed buffering applications. Featuring all-silicon, cord-wood construction, it measures 15 x 5 x 9 inches.
product preview

HEWLETT-PACKARD CO.
DATAMEC/DYMEC DIV.
Mountain View, California

An optical mark reader being introduced is a desk-top unit that performs alphanumeric reading with a variable card format. It is compatible with communication modems such as Dataphone, as well as mag tape and Teletypewriter devices and computers. Speed is variable according to output requirements.

CIRCLE 183 ON READER CARD

KENNEDY CO.
Pasadena, California

A new incremental recorder, the model 1500 produces 7-channel mag tape at from zero to 400 steps/second. Features include front access to circuit cards, binary zero to BCD 10 conversion, straight-through threading, and quick-lock reel hubs. The reels are 10%-inches.

CIRCLE 184 ON READER CARD

LOCKHEED ELECTRONICS CO.
Los Angeles, California

Two core memory systems are getting their first public showing. The CD 50 has a read-write cycle time of 750 nanoseconds and an access time of 300 nsec. It uses the 2½-D memory organization, has a capacity of 64K (80-bit) words. The model CI-300 is the second unit. Designed for extreme environmental conditions, it has a cycle time of 3 usec and an access time of 800 nsec. Capacity is 16K (32-bit) words.

CIRCLE 185 ON READER CARD

OHR-TRONICS INC.
New York, New York

The System 128 being shown is a complete tape preparation system. It can prepare paper tape from a keyboard (from 18 to 64 keys can be incorporated) with or without parity check, can duplicate tape, compare two tapes and stop on an error character, can compare and duplicate, and can verify in which a previously-punched tape is compared against key entries and a second verified tape produced.

CIRCLE 186 ON READER CARD

REDCOR CORP.
Canoga Park, California

Being shown is a new series of integrated-circuit hybrid computer linkage systems. Features include simultaneous sample-and-hold, 15-bit ADC capability, input and output transformer coupling, double buffer D-A register, and 100-volt output.

CIRCLE 187 ON READER CARD

ROYAL TYPEWRITER, ROYTRON DIV.
Hartford, Connecticut

Being shown are new punched-tape reader and punch mechanisms. The model 250 is a pin-sensing, wire-contact reader that operates at 17 cps asynchronously and 23 cps synchronously. It also comes as an integrated reader station. Operating at the same speeds is the model 200, which punches in accordance with the recommended American standard. This also is available as an integrated station.

CIRCLE 188 ON READER CARD

TALLY CORP.
Seattle, Washington

Paper tape communications systems being shown are the System 111 transmitter and 211 receiver. The 111 features a retransmit capability for error control, and transmits at 120 cps. It operates with the Bell 202 C-2, or equivalent, data set, and handles 5- or 8-level tapes. The 211 receives at the same speed, checks for correct parity after it is punched, and can instruct the retransmission of an incorrect block of data. Unattended operation is another feature.

CIRCLE 189 ON READER CARD
LOSING TIME IN REAL TIME?

You say Real-Time Reilly waltzed you out the door with the wrong specs from the start? Then everything went downhill fast, right? The programmers said one computer and a set of a/d converters would do the job beautifully. But five months later your design consultants added on enough instrument packages to fill Yankee Stadium? Of course, your Project Manager should never have used a Mickey Mouse watch for the central timing system. Now you just got word that your entire Proposal Staff will have to testify before Congress to help explain why the only parts of your system that ever got on the air were the bugs in it. Well, isn’t that the name of the game in real time? Difficult verging on the impossible. But no need to flutter your Fixed Price as long as there’s IDC. Who’s IDC? Let’s take it from the top.

First, IDC is one company to put on your bid list whenever you want to save time and money with top programming and systems design talent. The best way to tell an IDC program is that it has all the elements you admire in well-designed hardware: simplicity, modularity, and efficiency. In other words, the finished product looks easy precisely where others turn out to be masterpieces of complexity. Whenever you think of IDC, remember that the staff is all hand-picked for outstanding accomplishments in telemetry, display, hybrid systems, automatic checkout, closed-loop batch processing, seismic data handling, and many other real time areas. But in real time or anytime, from scientific software and operating systems to compilers and management information systems, IDC tells you at once the requirements of getting a job done, based on an uncommon ability to define the problem, relating the hardware environment to a set of software specifications that they’ll stake their FIXED PRICE on. For an improved perspective on your software management problem, contact IDC now. 1621 East 17th Street, Santa Ana, California. Phone: (714) 547-8861.
The technical program for the 1966 Spring Joint Computer Conference has been planned to represent the diversified scope of the computer field with no specific overall theme. The program was designed under the assumption that this is a general meeting where good papers on topics of relatively general interest to the information processing community should be considered and that specialized papers should be submitted to one of the journals or a smaller, more specialized meeting. Hopefully, the program will serve the interests of a major cross-section of conference attendees.

No attempt was made to fix the number of papers in a single session. Session chairmen were asked to select only those papers which they felt merited presentation; therefore, there is considerable variation in session length. In order to eliminate schedule conflicts, the afternoon has been divided into two periods. This practice proved to be successful at the 1965 FJCC.

Sixteen sessions are planned; 10 are made up of presentations of formal papers published in the conference proceedings. The formal papers were selected from those submitted in response to the call for papers, and those encouraged by session chairmen. One of the 10 sessions, Coherent Optical Information Processing, is intended to be tutorial; its aim is to familiarize computer specialists with some new techniques available in optical technology. In most sessions, a group of panelists will present a critique of the papers and attempt to place them in proper perspective. This panel will also lead the audience discussion following the papers.

The remaining six sessions are informal (no papers are published in the Proceedings). The format of the session, Display Application Research, is somewhat experimental. Each speaker will present a review of his current research, which will include a movie or TV monitor display in order to provide a realistic picture of the work. The aim is to give an attendee up-to-the-minute results such as he would receive on a personal visit to a particular laboratory. In addition, there will be panel discussions on the meanings of time-sharing, design of large computing systems, computers and a "checkless" economy, hybrid computation, and on the role of computers in present and future libraries.

Tuesday, 1 p.m.
Grand Ballroom
Display Applications and Techniques
A Panel Discussion
Chairman:
Dr. D. C. Engelbart
Stanford Research Institute
Menlo Park, California

The goals and developments in any area are influenced considerably by the image that people have of the possibilities and needs associated with the area. I happen to feel that the generally-held images relative both to the possibilities for harnessing computer-display working aids and to the corresponding needs associated with pursuing these possibilities, are much more conservative and less challenging than is merited by the current state and potential of our technology. My purpose in selecting the participants and establishing the specifications on their presentations was to do as much as possible for "expanding" the generally-held images as to possibilities and needs.

Two important features about on-line computer-display systems are: (1) the computer operations available for the user to call, and (2) the speed, flexibility, and smoothness with which these operations may be called by a
the sessions

practiced user. The former may be appreciated quite well by reading a descriptive paper. However, the latter aspects of the system are not so easy to communicate by writing, and their composite effect upon the usability and effectiveness of the system is quite significant.

This session is organized to bring out both of these aspects for six research projects that are exploring utilization of computer-display tools for real-life problem solving. To bring out the characteristics of speed, flexibility, and smoothness, each presentation will include either a movie or an actual real-time demonstration with TV monitor displays in the session auditorium. It was specified to each participant that the movie should be made up especially for this presentation, as a representation of the actual state of his research. Also, to communicate most realistically the "user feel," the various delays in computer operation or user actions involved in the demonstrated processes are to be shown in their real speeds, or clearly indicated otherwise.

Since it is not too difficult to dummy up demonstration operations that can show a flashy succession of amazing display images, I want to emphasize that the presentations will show the things that can be done in line of realistic, purposeful constructive work. In other words, each speaker will be presenting serious working tools—if not usable now in a coordinated working system, at least being represented by him as serious candidates for same in a purposeful, exploratory research effort.

W. R. Sutherland, Lincoln Laboratories.
W. H. Ninke, Bell Telephone Labs.
Cyrus Levinthal, Mit Project MAC.
G. J. Culler, Univ. of California, Santa Barbara.

Tuesday, 1 p.m.
Babbage Room

Optical Processing Techniques

Chairman:
David A. Berkowitz
The MITRE Corporation
Bedford, Massachusetts

The vigorous renewal of interest in optical and electro-optical information processing occurred within the present decade. Already practical applications have been found for many of the newer techniques in input-output and peripheral computer equipments and in special purpose computers. The coherent optical techniques form a special class within the larger field of novel optical information processing techniques and they will receive special attention in this session. The coherent techniques have been used for various off-line computations, and they give promise of new storage and memory access schemes. In addition, there are developments aimed at on-line coherent optical processing which could ultimately lead to another approach to adaptive image processing.

This session will not have the panel format, but rather we will have the more customary organization better suited to a descriptive and tutorial exposition of a relatively unfamiliar field.

The first paper will explore the entire field of optical and electro-optical information processing in very practical terms: what tasks can be, have been, performed and what is promising in the future. In language meaningful to the computer man, the present capabilities will be described, and the capabilities peculiar to the coherent techniques more clearly set aside.

This paper will be followed by a mathematical and tutorial paper which presents an inquiry into the nature of coherent optical systems and how they differ from non-coherent systems. It also describes, in mathematical terms, how the development of the laser has made these systems more practical.

The third paper will discuss the optical processing of information that can be represented by two-dimensional diagrams, transparencies, etc.
the sessions

stimulated new concepts of peripheral hardware and software to match the human eye, ear, and hand. Equally important are languages oriented toward problem terminology and the specialist's mode of expression. However, additional dividends which are less well known but perhaps even more significant have come from these experiments. One is the "memory-centered" philosophy, which recognizes the importance of file systems to serve as software archives. These systems must play the role of both a public library and a private file cabinet, and techniques have been developed which permit just this. Adequately indexed and protected file systems are a significant step toward permanent and evolving software repositories and data banks. The new file organizations promise that, for the first time, users effectively can "stand on the shoulders" of earlier programmers.

Time-sharing experiments have pointed to the vital role of multiprogramming and multiprocessing in advanced computer system design. The former contributes efficiency through full utilization and the latter yields adequate capacity and high reliability. These techniques are basic to versatile hardware-software systems which can supply each user and task with the appropriate service; console interaction for those desiring it and production capacity with guaranteed completion time for the routine requiring that.

Hardware designs are feeling the impact of time-sharing, too. Special processors and large, fast secondary memory modules are being tailored for time-shared systems. The reality of computing systems which will be all things to all users is still ahead of us, but that goal is not nearly as remote as it once seemed. The massive hardware-software systems now being created under the catch-all phrase "time-sharing" will represent considerable progress in this direction. The performance of these systems will hinge upon thoughtful strategies for such functions as dynamic memory allocation, memory relocation, scheduling, and file organization, among others. Thus models, simulations, and performance data to provide insight into the properties of various schemes are a topical subject. This time-sharing session presents work toward this objective.

Time-Sharing in the IBM System 360, Model 67, by Charles T. Gibson.
An Optimization Model for Time-Sharing, by Dennis W. Fife.

Wednesday, 9 a.m.
Auditorium

The Meanings of Computer Time-Sharing
A Panel Discussion

Chairman:
Charles W. Adams
Adams Associates, Inc. and KEYDATA Corp.
Cambridge, Massachusetts

Almost every newsletter, press release and trade journal makes glowing reference to the implications of new developments in computer time-sharing technology. But they tend to ignore the fact that "time-sharing" is a broad term with a variety of meanings, ranging from the small computer used in the morning by the Physics Dept. and in the afternoon by the School of Engineering to the sophisticated message processing and page turning of the general-purpose business or scientific computer utility.

The first meaning that comes to the mind of the computer professional, perhaps, is the one first defined at MIT, in which a large-scale computing capability is put at the disposal of independent users, each treating his remotely-located Teletypewriter as if it were the console of the central facility. Through it he enters and corrects programs, supplies data and receives results without knowledge of, or concern for, the fact that the same machine is being concurrently used by others. Out of MIT's efforts, which date back seven years or more, have come highly encouraging operating experience, new software techniques, and the guidelines for new hardware developments such as now appear in the GE 645 and IBM 360/67.

During the past few years, groups at RAND, SDC and elsewhere have demonstrated impressive time-sharing accomplishments, in many cases using quite small computing systems such as Dartmouth College's Basic system, which is implemented on relatively modest GE equipment. Profit-oriented entries into the field have appeared not only under such established banners as GE, IBM, CER, and Bolt, Beranek & Newman, but also under new names like Allen-Babcock Computing, Inc. And the Advanced Research Projects Agency, sponsor of fast-moving Project MAC at MIT, has continued to expand its leadership by sponsoring a study of interconnected networks of time-shared systems, the development of advanced digital graphical techniques, and the like.

Important as these developments have been, they represent only one aspect of computer time-sharing. Specialized systems built around the need for multiple remote access to a centralized file have undergone extensive development since the early days of American Airlines Reservisor and the SAGE air defense system. Closely related to the sophisticated successors of these early systems are the store-and-forward message switching networks now in use not only by the military and the airlines but by several large corporations as well. Increasingly are the messages not only switched but also processed and responded to, a development typified by the Telecomputing Center of Westinghouse Electric Corp. An increasing number of other specialized systems, like the one operated by Bolt, Beranek & Newman for the Massachusetts General Hospital, fall into this general category.

Yet another form of time-sharing is that in which a variety of different services, tailored to the needs of individual subscribers but not programmed by them, are provided from a central computer facility. The business data processing services offered by KEYDATA Corp. are representative of such applications. In this case the centralized processing and file storage primarily serve an economic function, to the small user it is of little consequence if the processing is done by a local device or through time-sharing. As National Cash Register, among others, well realizes, questions of convenience, reliability and price will determine...
whether the needs of the small businessman can best be met by centralized off-line processing of data collected at the point of sale, by small free-standing computers with random access files of a few hundred thousand characters, or by time-shared on-line processing from a central facility.

As times goes on and techniques of forecasting, simulation and strategy evaluation are improved, time-shared processors will come into their own by providing business management with the powerful tool that electronic data processing has long promised but not yet fulfilled. Exploratory work being done at Westinghouse and at IBM's Education Center, for example, sheds light on the nature and complexity of this problem.

This panel is made up of expert, vocal representatives of several of these different applications of time-sharing. Its objective is both to delineate and establish some measure of the potential significance of each of the many meanings of computer time-sharing—a purposeful task at a time when an increasing number of people are finding such definitions needed but lacking.

James D. Babcock, Allen-Babcock Computing Inc.

L. R. Hague, Westinghouse Electric Corp.

Dr. Thomas E. Kurtz, Dartmouth College.

K. F. Powell, IBM Education Center

Dr. Ivan E. Sutherland, ARPA, Dept. of Defense.


Wednesday, 9 a.m.

Babbage Room

Simulation and Model Building

Chairman:

Geoffrey Gordon

IBM Corporation

Armonk, New York

It is virtually impossible to discuss the programming of simulation problems without talking about models. The close association of these two topics reflects the fact that the task of applying digital computers to simulation consists essentially of two parts. One part is to build a model representing the problem to be studied, and the other is programming the model.

It is, of course, highly desirable to simplify the programming, particularly when the ultimate user of a simulation program is not likely to be a skilled programmer. Many developments have been aimed at easing this problem. Of particular interest are the programming systems that embody general-purpose languages specifically designed for simulation. Each such language has a certain set of concepts that must be used to build models with that language. The questions of how general purpose the concepts can be or whether there will ultimately be one or more standard sets of modeling concepts accepted by simulation users are interesting and will, no doubt, be the subject of much more programming research and development in the future. In the set of papers to be presented in this session, we will see how varied the model building concepts that users need can be. We will also hear about some of the characteristics users are looking for in simulation programming systems to simplify the use of models in the solution of problems.

The first three papers take over modeling concepts that were established first in fields other than that of digital computers. The paper by Syn and Linebarger describes a language that allows models to be described in the manner of an analog computer. This concept has, of course, been introduced before. The paper, however, describes a powerful integration of digital programming techniques with analog concepts, indicating that this type of language will be used in its own right for model building and not just as a means of transferring studies from analog to digital methods of simulation. The paper by Bartee and Lewis similarly describes a method of integrating a digital computer with the concepts of a differential analyzer. Here, however, an actual differential analyzer has been coupled with a digital computer to produce an on-line system, giving the user an unusual degree of control for running and observing the simulation. A third paper by Chang and George builds upon Boolean algebra techniques to develop a language for the analysis of logic networks.

The method described in the paper by Katz illustrates the use of SIMSCRIPT, one of the most widely used general-purpose simulation languages, used here to build a very comprehensive model of a multiprocessing computer system. In contrast, the paper by Wallace and Rosenberg treats the same subject in a different manner. Their paper makes use of Markov chains as a means of simulating systems. The paper's presence in this session may be a trifle odd since the authors offer this approach as an alternative to simulation. They show how a considerable amount of information can be gained about a complex system by applying numerical computation techniques to models of this nature without following the detailed performance of the system. Leaving aside the question of what precisely is and is not simulation, the paper serves to show how a well-chosen set of modeling concepts can derive the essential facts about a problem directly.

The paper by Jacoby et al illustrates another interesting approach to the problem of providing simulation users with useful modeling tools. Here, a relatively small amount of programming, built onto a general purpose simulation language, cess, derives a simple program for a particular type of problem at considerably less effort than would be required to develop a compiler for a problem-oriented language designed for the type of program.

Finally the paper by Jacobson discusses some of the problems involved in applying simulation to the study of problems irrespective of the language being used. Altogether, the group of papers should be a review of simulation techniques of interest not only to users of simulation but also to individuals interested in the development of general-purpose simulation languages.
Digitek is about to deliver the world's first full-language PL/1 compiler. This, in itself, is not startling when you consider the source.
Ferrite core memories come in various wiring schemes which have inspired such nicknames as “3D”, “2D”, or “2½D”. Manufacturing costs, memory speed and capacity, memory access requirements, and other circuitry considerations are factors which determine the “dimension” selected for a particular memory design.

This brief explanation of five typical memory types makes basic comparisons only. Each particular type fits specific applications efficiently if properly matched to cost and operation criteria.

The most simple form of core memory is the two-wire (“2D”) scheme. This form is used for so-called linear-select, word-organized memories. It requires one drive line and one electronic switch for each and every word or word group in the memory and a shared digit-sense line for each and every bit of every word. It can be exceptionally fast. Another version of “2D” uses separate sense and digit lines.

The familiar and versatile four-wire coincident-current system is called “3D” and allows a broad range of memory sizes and speeds to be economically fabricated, and is also very efficient in its use of electronics.

“3D” coincident-current selection can be achieved with 3 wires by sharing sense and inhibit functions on one line.

The “2½D” configuration combines some of the circuit advantages of “3D” with economies of “2D” stack construction.

One “2½D” configuration adds a separate sense line to the 2-wire scheme for a total of three wires.

Another method of achieving “2½D” with two wires through a core, time-shares the ½ read current, the sensing, and the digit writing process on one line.

To intelligently select one of the above memory types for a particular application, the computer engineer must weigh many factors carefully. Individually considered, certain features of each are appealing, such as high speed, economy, reliability, and versatility. The final result of the “trade-offs” necessary to best match a memory to an EDP situation must be lowest ultimate cost, with every element of memory economy considered from initial design to long term maintenance.

This is the fifth in a series of six brief discussions on the basic principles of memory systems. If you would like the complete series in booklet form, please circle 61 on reader card.
The lowest ultimate cost results when the many variables of memory type selection are carefully weighed. The scale is easily tipped in the wrong direction by missing a subtle economic factor.

Fabri-Tek's 20-million-bit mass core memory uses 2-wire, 2½-0 for coincident-current versatility with 2-wire economy. Any memory selection type is available from Fabri-Tek to match any system need with the lowest ultimate cost.

Fabri-Tek's memory designers take maximum advantage of the information storage techniques described here. Let us help you select the type of system that gives you the lowest ultimate cost with maximum usability. Write Fabri-Tek Incorporated, Amery, Wisconsin; or call 715-268-7155; or TWX 510-376-1710.

FABRI-TEK LEADS IN MEMORY TECHNOLOGY

Check with Fabri-Tek for rewarding engineering opportunities!
$14,800
4,096 WORDS (12 BIT) — MORE COMPUTER FOR LESS

BARRIERS SMASHED: LOW PRICE & 60 DAY DELIVERY

COMPUTER POWER

Sixteen Basic Commands Powerful command structure for add, subtract, jumping and shifting

Microinstructions Over 100 commands which can execute four non-memory instructions in a single cycle

Literal Instructions Allow high speed, one character arithmetic or logical operations

Direct Memory Access Permits high speed data transfer between memory and external devices

Memory Protect Allows reading but inhibits writing in the protected area

Hardware Index Register Provides address modification for memory reference instructions

Flexible Subroutine Linkages A single instruction executes a transfer to a subroutine in any core bank and provides the mechanism for a single instruction return to the calling program

Four Addressing Modes Indirect, direct, relative or indexed

Priority Interrupt Channels A priority facility is included to allow external devices to command computer to transfer to specific subroutines

Memory Cycle Time 2 microseconds

Large Memory Capacity Expandable to 32,768 words in 4,096 word increments

Fully Parallel Operation All arithmetic and logical operations are completed in parallel

Functional Control Console Addressable registers continuously displayed

Other computers available are 24 bit word (SCC 660 or SCC 670) with 2 or 5 μsec memory cycle time.

Literature available.

complete systems by

SCIENTIFIC CONTROL CORPORATION
14008 Distribution Way Dallas, Texas 75234 214 — 241-2111

CIRCLE 40 ON READER SERVICE CARD
the sessions

Yao Nan Chong and Oliver M. George.
Simulation of a Multiprocessor Compu-
ter System, by Jesse H. Katz.
Markovian Models and Numerical
Analysis of Computer Systems Behavior,
by Victor L. Wallace and Richard S.
Rosenberg.
SMPS—A Tool Box for Military Commu-
nications Staffs, by Kathe Jacoby, Di-
ana Fackenthal and Arno Cassel.
Digital Simulation of Large-Scale Sys-
tems, by Robert V. Jacobson.

Wednesday, 1:30 p.m.
Auditorium
Processing Large Files
Chairman:
John A. Gosden
Auerbach Corporation
Arlington, Virginia
This session cannot and will not begin
to cover the area embraced by the
title. The full title of this session should
be: "A selection of three interesting
projects that are only related in that
each involves large masses of data,
describes a technique that reduces the
size of one of the problems involved,
has been implemented, and should
stimulate a useful and interesting dis-
cussion." The three techniques are:
the automatic correction of errors in
large masses of a restricted class of
data, the investigation of the behavior
of large-scale data systems, and the
sifting of literature by professionals for
interesting or relevant documents.
All three papers cover topics that
should provide an interesting base for
discussion. The full papers will be
printed in the proceedings and the
speakers will only be allowed a brief
period to discuss highlights of their
subjects. The discussion will be stimu-
lated by a panelist reviewing the paper
before questions and comments are
entertained. It is hoped that in this way
there will be time to ask questions and
discuss problems. The panelists will
help to ensure that the questions are
pertinent and followed up.
The first paper discusses a technique
to automate the correction of errors in
large volumes of data. Errors in input
data have been and will continue to
be a source of irritation and a bottle-
neck when human correction is re-
quired. The techniques to be discussed
rely upon some common pattern in the
data. The successes reported with
Christian names are encouraging.
The second paper is concerned with
the problem of assisting in the design
and evaluation of the design of large
data handling systems. Such systems
contain large files. It provides a means
to test alternative design plans for
feasibility and simulate on-line multi-
access situations for timing. All of
those responsible for large systems
should evaluate the payoff of this kind
of technique.
The third paper is a report on the
design and experience of a system to
provide people in the edp field with
literature scanning facilities. It is a
case of the doctor taking his own med-
icine. This project is something that
everyone who has to keep up with his

field should be interested in, apart
from the techniques of implementa-
tion.
At first thought, everyone who can
justify coming to the conference in
order to "keep up" should be interest-
ed, and decide if he needs such a serv-
vice for himself. All three papers are
practical, and of importance. The au-
thors will discuss results as well as
techniques.

Techniques for Replacing Characters
that are Garbled upon Input, by Gary
Carlson.

ADAM—A Generalized Data Manage-
ment System, by T. L. Connors.
The Engineer-Scientist and an Informa-
tion Retrieval System, by C. Allen Mer-
ritt and Paul J. Nelson.

Wednesday, 1:30 p.m.
Babbage Room
Waveform Processing
Chairman:

Dr. Bernard Gold
MIT
Cambridge, Massachusetts
In certain scientific and technological
problems, information about the physi-
cal phenomenon is available as a wave-
form, or intensity vs time signal de-
rived from the same phenomenon by
means of a transducer. For example,
a voice microphone output serves as
the input to a speech communication
system.
A digital computer can be helpful in
providing to the scientist useful
information about the waveform. This
utility derives from the simulation abil-
ity of the computer. As an example, a
computer can be programmed to sim-
ulate a spectrum analyzer. It can also
be programmed to simulate an entire
speech communication system.
Until recently, the use of digital
computers for waveform processing
was severely limited because the tech-
niques for digital simulation of linear
systems, such as filters and spectrum
analyzers, involved lengthy execution
times. Typically, the simulation of a
simple band pass filter to process one
second of a speech signal would take
50 to 100 seconds of running time.
This limitation has, to a large ex-
tent been overcome by the develop-
ment of new techniques. With the
z-transform as a mathematical basis,
a field of digital network and filter
theory, whose possibilities are just be-
ginning to be exploited, appears to be
emerging.

Digital processing of signals has
been applied to the study of at least
three important physical phenomena: speech, seismic signals and brain
waves. Experience in these three areas
has shown that the success of such
processing is highly dependent not only
on the programming techniques but
also on the nature of the computer
facility. For example, it seems that
long on-line sessions, direct running of
the machine by the research worker,
large random access tape memories
and flexible input-output control can
enhance the signal processing capabil-
ities of a digital computer.
In certain instances, especially when
the input signals are at very low fre-
quencies, such as occur in the study of
earthquakes, the processing equip-
ment may consist largely of general
purpose digital computers. Thus the
computer goes beyond simulation of
the hardware; it becomes the hard-
ware. In other problems—for example,
automatic recognition of spoken words
—the accumulation of much data on
variations among individual speakers
may require that a real-time analog
spectrum analyzer pre-process the
The chip above (center) is Spectra 70's integrated circuit, actual size.

You think you can outgrow this tiny RCA computer circuit?

Try.

It's 1/20th of an inch square, actual size. But when you measure results, Spectra 70's integrated circuit is all business and a yard wide. As the first true third-generation circuit, it gives you the most computing power for the price anywhere. It packs in its pinhead area the equivalent of 15 transistors and 13 resistors. And because of this RCA circuit's tiny size, impulses have less distance to go. Result: more speed for you. Its simplicity means extra economy, extra reliability. We built that in for RCA space satellites. (Where they were going, the repairman wasn't.) Think as big as you like. Spectra 70's circuitry will grow right with you, right into the '70's. So will our computer series' hardware, software, communications, system support, service. Finally, a here-and-now fact. We're getting Spectra 70's on the job as promised. On time. Even ahead of time. Why not get all of the facts from your RCA Spectra 70 representative. Or just drop a few lines to RCA Electronic Data Processing, Camden, N.J. 08101.
speech before entry to the computer.

What the above remarks imply is that the problems of computer processing of waveforms can be subdivided into three aspects: a) the design and use of a computer facility especially suitable for signal processing, b) the development of a theory of digital networks, and c) applications to various fields. Of these three aspects, the second seems most likely to develop as a distinct discipline.

Of the three papers listed below to be presented at this first session on the subject of Waveform Processing, two are on aspects of the programming techniques and one is on the application to the design of the data handling equipment used for the Large Aperture Seismic Array (LASA). There will also be a panel discussion on the basic design of a computer for signal processing.

Effects of Quantization Noise in Digital Filters, by B. Gold and C. M. Rader.


High-Speed Convolution and Correlation, by T. G. Stockham, Jr.

Wednesday, 3:45 p.m.
Auditorium

Programming Languages

Chairman:
Thomas Cheatham
Computer Associates
Wakefield, Massachusetts

This session will offer a most interesting and varied collection of papers and will feature a panel discussion of the ideas and issues presented through these papers.

The first paper, by Sassaman, describes a program which translates from IBM 7000 series machine language into FORTRAN. The whole subject area of machine to machine translation has, of course, received a great deal of attention over the past several years (and is receiving particular attention at this point in time when so many installations are converting to 360 and Spectra 70 machines). The paper presents the specific, and encouraging, results achieved by the author, and discusses the many issues and difficulties inherent in such translations.

The second paper, by Metze and Seshu, presents a proposal for a language and compiler for describing computers, rather than the programs to run on computers. Again, there is considerable current interest in the area of such language systems and the present paper should provide a substantial contribution to this rapidly-developing field.

The third and final paper, by Iturriaga, Standish, Krutar and Earley, is concerned with the development of the Formula Algol Compiler using the FSL Compiler Writing System. The "compiler-compiler" problem has received a good deal of attention, and this very well constructed report on the authors' experience in using such a system for the development of a compiler for a quite advanced language will be of interest to all those who are involved in the development of compilers as well as those who are interested in programming language development and extension.

The speakers and chairman will be joined by J. W. Smith of the Rand Corporation and M. Douglas McIlroy of Bell Telephone Laboratories for an informal panel discussion following the formal presentations. I am sure that these gentlemen will provide a stimulating and refreshing conclusion to the session.

A Proposal for a Computer Compiler, by Gernot Metze and Sandaram Seshu.

A Computer Program to Translate Machine Language into FORTRAN, by William A. Sassaman.

Techniques and Advantages of Using the Formal Compiler Writing System FSL to Implement a Formula Algol Compiler, by Renato Iturriaga, Thomas A. Standish, Rudolph A. Krutar, and James C. Earley.

Wednesday, 3:45 p.m.
Babbage Room

Business Applications

Chairman:
F. W. McFarlan
Harvard Business School
Boston, Massachusetts

Successful computer-based management information systems usually require extensive systems development activity which is often of a quite technical nature. Unfortunately, however, the results of even the most careful design may be highly unsatisfactory unless the attendant problems associated with its implementation and integration into the firm's operations are recognized in advance and effectively

New Acme Visual Control Panels

mastermind electric brains

at Department of Defense
doublewide general supply center

Have you a tough problem of production programming, sales quota policing, budgeting, contract coordinating? Then see how swiftly and efficiently two new Acme Visual Control Panels help Uncle Sam do a kindred job of appalling proportions. Computers at the Defense General Supply Center receive punch card data on daily transactions from every supply depot. From these, they prepare a complete inventory of assigned general supply items to the Armed Forces.

And that's just one of 150 jobs these machines must do. Yet the work flows smoothly, 24-hours a day, thanks to just two Acme Control Panels that mastermind these electric brains. Let an Acme representative show you exactly how these remarkable control panels, with their movable tapes, sliding signals and calibrated frames, can help you stay on top of almost any program...at a glance! Meantime, send the coupon for complete facts on new Acme Visual Control Panels.

New Acme Visual Control Panels

ACME VISIBLE

ACME VISIBLE RECORDS, Inc.
7904 West Allview Drive, Crozet, Va.
Please let me have full details on new Acme Visual Control Panels.

Name:

Company:

Address:

City Zone State

CIRCLE 42 ON READER CARD

99
See here Mr. Businessman...

There are some things you should know

... about the major advantages Sanders 720 Communicator System offers over conventional displays.

For instance, the 720 is the only fully modular desk-top display system: you buy just the capabilities you need. 256, 512, or 1024 character systems, with or without full editing, single or double keyboards per display console... all are typical options available in the Communicator.

The full-editing Communicator lets you insert or delete letters, words or sentences in the text already displayed on the screen. You can also hold portions of displayed data, e.g. prevent accidental erasure of computer-generated forms by separating them from the fill-ins.

Then there is the low cost control unit which handles from three (1024 character) to twelve (256 character) displays. Furthermore, with its microcircuit logic, it is small enough to fit in a standard rack, a desk or in a closet — with no special cooling required.

The 720 has an unbelievably quiet, solid state keyboard that uses no switches, contacts or linkages.

Because the 720 does not count spaces as characters, it will display up to 50 per cent more data per message than systems of equivalent character memory capacity. And even with 256 character systems, you can use the entire vertical 7½” x 9” message area.

Naturally, you can interface with modern computers via numerous data transmission methods.

And as for the price — it’s lower than many systems with far fewer capabilities.

All the details are in our brochure. Write for a copy, or better still, write and tell us about your specific needs. Sanders Associates, Inc., Data Systems Marketing, Nashua, New Hampshire 03060.

*T.M., Sanders Associates, Inc.

SANDERS ASSOCIATES, INC.
Creating New Directions in Electronics
Micro VersaLOGIC is a complete new line of 5 M.C. general purpose integrated circuit modules designed to provide the systems engineer with all the necessary building blocks for an integrated circuit digital system.

Micro VersaLOGIC incorporates many of the features of the proven VersaLOGIC line, such as NAND, NOR logic with wired OR capability at the collector. Over twenty types of μVL modules are available including universal flip flops, delay multi-vibrators, clock drivers, efficient 2, 3, and 4 input expandable gates, and pre-connected arrays such as dual binary counters, dual decade counters and dual shift registers. Interfacing modules for PNP to NPN conversion and power driving are also available.

Perfected for system use, and based on proven DTL circuits, Micro VersaLOGIC operates to 5 M.C. with 5 v. logic levels, and has excellent noise rejection of over 1 v. Micro VersaLOGIC modules are capable of driving high systems capacitances. The modules operate from 0° C. to plus 70° C. and require a single 5 v. power supply. Highly reliable, well proven connectors are used throughout. Mounting hardware, including card files, and card drawers, is also available.

Micro VersaLOGIC’s high packing density results in more functions per card and a lower cost per function. Plan Micro VersaLOGIC into your next system — we’ll be happy to show you how easy and economical it is. In the meantime, write for our new Micro VersaLOGIC brochure.

DECISION CONTROL, INC.
1590 Monrovia Avenue, Newport Beach, California
Telephone (714) 646-9371 • TWX (714) 642-1364

See the new Micro VersaLOGIC and our VersaSTORE memory systems at booth 1204 at the S.J.C.C.
PLOTTING FOR FUTURE PROFITS

...new concept in digital incremental plotting
THF BENSON-LEHNER DELTA PLOTTING SYSTEM

- featuring the exclusive B/L Delta Control Unit and Format
- providing up to 100 steps in X and/or Y from one computer command
- accepts either punch card or magnetic tape input
- makes your present on-line plotter more efficient for multiplexing
- converts on-line plotters into a fast off-line system

Unique programming format of the exclusive B/L Delta Control Unit can slash valuable computer time from 10 to 50 times for most plotting applications. Consider the time-and-command comparisons for the following sample plot.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Using Delta Format</th>
<th>Using Single-Character Incremental Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>plotter control</td>
<td>245 sec</td>
<td>10 min</td>
</tr>
<tr>
<td>computer write time</td>
<td>265 ms</td>
<td>179 ms</td>
</tr>
</tbody>
</table>

(360 software now available)

Why not ask for more complete information concerning how the new Delta Control Unit can revolutionize your plotting system.

ON DISPLAY AT SJCC BOOTH 905-907

the sessions

planned for. Three papers will be presented which describe how modern information technology has been applied to specific industrial problems. The technical aspects of the systems designs presented in these papers will be of general interest. A second dimension of these papers is a description of the actual and anticipated problems incurred in making each systems operational. This topic will be developed further in the panel discussion following the presentation of the papers.

The session will start with a paper by James Gatto which describes the design of a direct mail system, whose logic is based on information retrieval concepts, and which is used to disseminate promotional material and product information to subscribers on a selective basis. Topics discussed include: structure of problem; actual organization of system; maintenance of system; and problems of implementing the system.

Use of an automatically backed-up computer system to provide a real-time audio response to telephone operators who handle toll calls in a 5-state area is the subject of a paper by Bruce Dale. Following an identification of the problem’s nature, Mr. Dale describes the structure of the system’s backup features, design of the system monitor, capacity for system’s growth and the project’s implementation strategy.

George Duffy and William Timberlake next will describe a business-oriented time-sharing system currently in operation. A description of the system’s structure, planning and training prior to its actual introduction, and indication of its principal applications will be included, together with a presentation of the peculiar systems problems inherent in its implementation.


“Never-Fail” Audio Response System, by Bruce D. Dale.

Thursday, 9 a.m.
Auditorium

The Evolving Library
Chairman:
Frank E. Heart
MIT Lincoln Laboratory
Lexington, Massachusetts
For some years it has been an article of faith that the digital computer will play a central role in recasting the information paths between people that are served by libraries. Developments in time-sharing technology seem to strengthen this faith. However, the proper mechanism and timing of this library evolution are still quite unclear.
As a market for the data processing industry, the library still remains a potential rather than a reality. This session will provide a perspective view of the computer in library evolution and will highlight some avenues of progress. The discussion will include a review of recent research, a description of a specific evolving library system, and some projections about information paths of the near future. The discussion will also include a report on the research suggestions to MIT which were made by a recent major interdisciplinary conference on information transfer.


Coordinated Information Processing in Three Medical Libraries, by Frederick G. Kilgour.

Plans for Information Transfer Experiments at MIT, by Dr. Carl F. J. Overhage.

On-Line Information Networks, by Dr. J. C. R. Licklider.

Thursday, 9 a.m.
Babbage Room

Current Developments in Peripheral Hardware
Chairman:
Rudolph Klein
Univac Engineering Center
Blue Bell, Pennsylvania
Electro-mechanical peripheral hardware has always been an important part of "electronic" computing systems. At first this hardware was largely borrowed from other fields as main development emphasis was concentrated on new processor and memory techniques. As the computer field matures, however, the inadequacy of
the sessions

some of the borrowed approaches is apparent in terms of high manufacturing and maintenance costs, and poor long-term reliability in customer service. These factors have an important effect on sales and profitability.

Bulk data storage can still be accomplished most economically by elec-
tromechanical devices—i.e., magnetic tape, drums and discs. Tab cards remain extremely popular in customer applications associated with nearly all commercial installations. The importance of hardware to perform computer peripheral functions is now paramount as many modern systems contain large quantities of this gear used as communications terminals and for on-line mass storage, in addition to the conventional input/output devices. Well over half of system cost can often be attributed to peripherals.

The realities of the present-day computer business demand electromechanical gear of not only improved functional capacity, but also lower maintenance cost and extreme reliabil-
ity. This session is intended to cover the type of design philosophy now emerging in the industry, as well as examples of new developments with improved functional characteristics. Papers covering new tab card devices, a high-performance incrementing tape transport, and a giant capacity random access storage unit will be presented. Session emphasis is on the engineering design decisions made and solutions to problems encountered during development of these new devices which are intended to meet the stringent demands placed on modern computer peripherals.

A New Look in Peripheral Equipment Design Approach, by Earl Masterson.


IBM 2560 Multi-Function Card Machine, by C. E. Spurrier.


IBM 2321 Data Cell Drive, by Allan F. Shugart.

Thursday, 9 a.m.
Grand Ballroom
Analog/Hybrid Techniques
Chairman:
Mark E. Connelly
MIT Electronic Systems Lab.
Cambridge, Massachusetts

The analog/hybrid session this year indicates clearly the growing maturity, sophistication, and scope of combined analog and digital computation tech-
niques. Successful hybrid applications will be described, based on such dis-
verse topics as a nuclear reactor, a helicopter, a distillation column, a free piston engine, displays, and the data processing of seismic, sonar, and biomedical signals. Very evident in all of the papers is an increased emphasis on the high-speed, iterative capabilities of analog equipment. The continuing search for analog-digital combinations that most efficiently meet the require-
ments of various classes of problems is likewise evident.

The utilization of simulation tech-
niques to provide intellectual leverage in a broad range of scientific and tech-
ological investigations is gratifying, but such diversity also has its draw-

---

Write it Right!

(With Sanders new PHOTOPEN*
Light Sensing System)

MARK
CORRECT
COPY
ERASE
ADD
TRANSFER

Make any information changes on the face of any CRT . . . it takes only 2 mi-
icroseconds when you use Sanders new push button PHOTOPEN System.
Simple, convenient and easy to use, an illuminated finder circle precisely en-
closes the area to be changed, regardless of how you hold the pen unit.

Designed to provide greater display versatility, you can use the PHOTO-
OPEN System to write last minute changes right on the screen of any vis-
ual information display . . . quickly, accurately and directly with push but-
ton convenience. No other input device is required.

The product of advanced display editing technology, Sanders new PHOTO-
OPEN System is extra versatile. It senses the presence of light from below the human visual threshold to above the level for comfortable viewing.

Completely reliable, the PHOTO-
PEN System eliminates false or mul-
tiple triggering on long persistence phosphors, ambient lighting and reflec-
tions from CRT face or implosion shield.

Sanders new PHOTOPEN System puts you in close control with any vis-

---

 Sanders Associates, Inc.
 Microw ave Division
 Creating New Directions in Electronics

CIRCLE 47 ON READER CARD
backs. Genuine contributions to simulation technology itself are often obscured by the specialized language and models employed by specific disciplines. The 1966 Analog/Hybrid session will provide an interesting measure of whatever mutual incomprehensibility already exists between separate branches of the simulation fraternity.

The next benchmark in the evolution of hybrid simulation facilities is most probably a single digital computer interfaced to service several analog real-time problems simultaneously. The United Aircraft Research Laboratories, which has already put such a facility into operation, will report on its organization and performance in a very timely paper.

How many software firms can claim they've implemented the following compilers?

- ALGOL
- COBOL
- FORTRAN
- PANTRAN

We can't. Programmatics has never implemented PANTRAN. We've done all the others, though. And many more, including ACT, ATOLL, METAPLAN, NELIAC, and SIMSCRIPT.

We would like to write your next compiler. If you have a special application, we'll help design the language.

What's so special about a Programmatics compiler?
Nothing much. Only the speed, price, and delivery. And we do give a lifetime warranty.

Hybrid Simulation of a Free Piston Engine, by R. E. Gagne and E. J. Wright.


Hybrid Simulation of a Reacting Distillation Column, by R. Ruszky and E. E. L. Mitchell.


Thursday, 1 p.m.
Auditorium

Resource Allocation
A Panel Discussion
Chairman:
Peter G. Neumann
Bell Telephone Labs.
Murray Hill, New Jersey

A multiprogrammed multiprocessor computing facility may be viewed as a pool of resources containing processors, diverse storage media, and input-output equipment. In the past, many of these resources have been managed independently of one another. In order to obtain flexibility and efficiency in the use of multiprocessor systems, however, it is becoming increasingly essential that all resources be managed in a completely coordinated way. The burden must thus fall on a set of utility programs (i.e., a supervisor) and not on the average programmer. The starting point for this panel discussion is the notion of an integrated approach to the allocation and general management of all computer resources. Particular aims are to examine the significance of the interactions among resources, to explore possible useful ap-
Here’s how we designed our small, real-time control computer—
the H21

**FIRST IN A SERIES**—

**WORD LENGTH** — small, scientific computer manufacturing costs are almost linearly proportional to word length. What is the optimum word length? Here are the critical considerations: accuracy and efficiency of data representation; a desirable instruction repertoire; efficient and simplified programming that goes with a directly addressable memory; and suitable architecture for supporting advanced software.

We chose an 18-bit word for our H21 real-time control computer. It gives a data resolution of one part in 262,000—and packs three alphanumeric characters into each word. The extra bits provide for a larger, more powerful instruction set. And a single word instruction directly addresses a full 8192 word core bank making programming straightforward and efficient... no cumbersome, memory wasting addressing schemes, such as paging, double word instruction modes, relative addressing, etc. are necessary.

**MEMORY GUARD**—a new concept in real-time systems. This feature allows critical system programs (executives, monitors, etc.) to be guarded. Once guarded, a program is protected against accidental modification by un-debbuged, unguarded programs. Since each word carries its own guard bit, we now have a 20-bit word length... and a new dimension in system utility and reliability.

**HARDWARE INDEXING**—everything an index register can do, programmers can simulate with subroutines. But the tedious and time-consuming programming effort, and the extra memory required, result in false economy. Who cares how much extra memory you have to buy after you've bought the machine? We care... we include a “full use” hardware index register to ensure program efficiency.

**BULK MEMORY**—a moving head disc file is cheaper than a head per track. And less reliable. And slower... (moving head disc files have long access times, normally 10 times that of fixed-head discs or drums). In high-performance, real-time systems, fast bulk memory is desirable to simplify system programming. Also core memory requirements are reduced since fewer programs have to reside permanently in core.

**COMPUTER INTERFACE**—manufacturing costs could have been pared by building a minimal interface—singular I-O connector, low power bus drivers, etc. But this only defers the cost, multiplied several times, to the user at the time of system tie-in. Therefore, we include multiple I-O connections, husky bus drivers (75ma) and a generous set of clocking and control signals. The H21 interface even packs and unpacks characters into or from memory. The results... simple and economic interfaces for real-time systems.

**PRICE**—the lowest for computers with this capability. For just $21,000 you can get a central processor with 2K memory, and an I-O typewriter with tape punch and reader. An 8K system (that's 8192 words) costs only $32,000. And the delivery is good... try us.

If you'd like to get immediate information and complete H21 specifications, call or write to Control Computer Department, Honeywell Inc., Fort Washington, Pa. 215-643-1300.

Honeywell
the sessions

proaches to the overall problem of resource management, and to evaluate the hardware and software implications of these approaches.

A partial example is provided by the storage resources, for which an integrated approach is already beginning to emerge. In particular, consider all those storage devices (e.g., core, on-line secondary and certain off-line devices such as tapes used to extend the on-line secondary) for which storage may be allocated by the supervisor. In general, it is desirable that the actual residence of any piece of information on such a device should be totally unknown to any program outside of the supervisor. This is, in fact, achievable by designing hardware that permits the separation of the notion of residence from the notion of address. In such a design, the non-supervisory program is aware of only a logical address, which the supervisor then converts to a physical address known only to itself.

The complete coordination of all storage management is a step in the desired direction. A second and similar step is the complete coordination of all input and output management. However, these steps are fairly small in comparison to the effort of coordinat- ing all resources at once. The real difficulty is that storage allocation, input-output allocation and processor allocation (more commonly called scheduling) all interact strongly with one another. This is especially true in a dynamically-mixed environment with interactive and noninteractive users, some of whom have by pre-arrangement been guaranteed special services.

A simple example should suffice to introduce the nature of the difficulty. Consider a program which requires six tape drives and enormous core buffers in order to run, and which in addition requires vast amounts of processor time. If all the necessary resources were allocated at some particular time, would system performance for other users remain adequate? If so, might system performance be unduly degraded at some subsequent time? Suppose that the program eventually requires four more tape drives and more core buffers. Can the system afford to satisfy this new request? Can it afford not to satisfy the request, in view of the resources already committed which must thus remain unavailable to other users? This example gives only an inkling of the problems involved.

In summary, the subject of the panel discussion is what might be called the generalized multi-resource scheduling problem. Although this problem is still somewhat ill-defined, it is of rapidly growing significance.

Charles R. Blair, Dept. of Defense.
Edward L. Glaser, MIT Project MAC.
Theodore Kallner, IBM.
Victor A. Nyssotsky, Bell Telephone Labs.

Thursday, 1 p.m.
Babbage Room

Computer Techniques in Pattern Recognition
Chairman: Oliver G. Selfridge
MIT Lincoln Laboratory
Lexington, Massachusetts

This session describes a broad spectrum of current work in automatic or machine-aided pattern recognition. The emphasis has been on programs that actually are in operational status, and preferably are of actual assistance to someone whose primary concern is not

NEW!

ROBINS® BULK TAPE ERASER FOR MAGNETIC TAPE

ERASE FULL REELS OF TAPE IN SECONDS!

No longer worry about incomplete erasures when tape is used on different drives. Robins model DME-120 erases the full width of complete tape reels in seconds. 1" wide tapes on reels up to 17" can be erased in one operation. A built-in fan allows for longer operation without heat build-up. Thermostatic control turns on overheat warning light. Erasure is 50-90 db below saturation minimum. 115 V, 50-60 cy. A.C. IBM and N.A.B. adaptors are available for the standard 5/16" spindle. For tapes up to 2" wide. For further information on this item write: Dept. DE

ROBINS DATA DEVICES, INC.
Subsidiary of Robins Industries Corp.
15-58 127th Street, Flushing, N. Y. 11356

CPFF or FP

DESIGNING/PROGRAMMING/DOCUMENTATION/CHECK OUT

MESA ALGOL COMPILERS

PLANNING RESEARCH CORPORATION
Including the merged capabilities of Mesa Scientific Corporation
Home office: 1100 Glendon Avenue, Los Angeles, California 90024
BECKMAN SOFTWARE—
ANSWER TO THE HYBRID RIDDLE

For thousands of years, hybrids have puzzled men. The Greek Sphinx, for example, destroyed those who couldn’t answer her riddle.* Beckman resolves the enigma of today’s complex hybrid computers with its comprehensive software library.

Beckman’s leadership in computer programs has been developed by personnel familiar with the vital relationship between hybrid computers and software. With Beckman systems you receive complete field-proven program packages providing ease of man-machine communication.

You no longer have to develop costly specialized programs for your specific applications. Your only concern is with the simulation problem.

Let Beckman software answer your hybrid riddle. A detailed description of our programs is available. Write for our new brochure, “To Harness a Hybrid”.

*What walks on four legs in the morning, on two at noon, and on three in the evening?

Beckman INSTRUMENTS, INC.
SYSTEMS DIVISION/
COMPUTER OPERATIONS
RICHMOND, CALIFORNIA • 94804

INTERNATIONAL SUBSIDIARIES: GENEVA; MUNICH; GLENROTHES, SCOTLAND; TOKYO; PARIS; CAPE TOWN; LONDON

CIRCLE 53 ON READER CARD
the sessions

the computer; another general requirement on the papers is that results have been obtained instead of hopes or plans or promises. As a result, the level of sophistication of the programs is less than many of the discussions of the past decade. But the programs provide one thing that discussion cannot, and that is a certain amount of feedback from experience on real problems. One may get a feeling that there is no universal symbolic approach to the problems of machine pattern recognition, so differing do the techniques seem to be. The first four papers are treated critically by a devil's advocate in the fifth paper.


A Chess Mating Combinations Program, by George W. Baylor and Herbert A. Simon.

Multidimensional Correlation Lattices as an Aid to Three-Dimensional Pattern Reconstruction, by Samuel J. Penny and James H. Burkhard


Review: The Devil's Advocate, by Marvin L. Minsky.

Thursday, 3:30 p.m.
Auditorium
Development of a "Checkless"—"No Money" Economy
A Panel Discussion
Chairman:
Dale L. Reistad
The American Bankers Assn.
New York, New York

One of the favorite topics of the "blue sky" philosophers in recent years has been the gradual evolution of a "checkless" or "no money" economy. This checkless economy they envisage would be built around a network of ultra-sophisticated computers linked in an on-line/real-time system for all types of financial, credit information, and retail institutions in the country.

As happens so often these days, "blue sky" systems of the past (such as those of Neil J. Dean of Booz, Allen & Hamilton, Inc., dating back to 1957) have become feasible as a result of technological developments. Today all of the major parts of the "checkless" economy system are in being, although they are still not connected in a manner which could replace the check writing operation that we have grown accustomed to. A major New York bank, for example, has completed a two-year study on the non-return of checks which proves that it is not necessary to return checks to custo-

mers. A Delaware bank, working closely with IBM and AT&T, has designed a system in which their customers can charge items or transfer cash by using a plastic identification card and a Card Dialer Touch-Tone telephone connected to the bank's computer. Several large credit bureaus are now either completely computerized or are in the

---

Revolutionary Electronic Calculator

- Unmatched speed, versatility
- Simple to operate
- Single keystrokes provide all these functions

+ - × ÷ √ x² eˣ log₁₀ x

- Two independent accumulators for random data entry and retrieval
- LOW PRICE — FROM $1690 to $2095
  Additional keyboard units from $450
- Time sharing units also available

Write for complete details

WANG LABORATORIES, INC.
DEPT. FF-4, 836 NORTH ST., Tewksbury, Mass. 01876
TEL. (617) 951-7311

CIRCLE 55 ON READER CARD

April 1966

CPFF or FP
DESIGNING/PROGRAMMING/DOCUMENTATION/CHECK OUT

PRC JOVIAL COMPILERS
PLANNING RESEARCH CORPORATION
Including the merged capabilities of Mesa Scientific Corporation
Home office: 1100 Glendon Avenue, Los Angeles, California 90024

CIRCLE 54 ON READER CARD
We scoured the country... and didn’t find a load cell good enough for precision uses.

So we designed one ourselves. (It’s available to you)

Most load cells behave themselves nicely under ideal conditions.

But conditions are seldom ideal.

Getting down to cases, you almost always face one or more of several problems. Barometric pressure changes. Side load forces. Overloads. Dynamic temperature changes.

In working with load cells for automatic batching systems, in-motion weighing systems, conveyor scales, truck and tank scales, and force and torque measurements, our engineers realized a better load cell was needed to provide the precision and dependability our standards demand.

So they designed one. We now offer it as an off-the-shelf item for your load cell applications.

Since no other load cell can touch it in tough applications, you’ll want to use it for those easy jobs, too. Write us for specifications.

TOLEDO SCALE SYSTEMS DIVISION

TOLEDO SCALE, TOLEDO, OHIO 43612

Who knows what our ingenious systems engineers will come up with next? One thing is certain, though. You should talk to them if you have a problem in measurement, material handling, control or data processing.
Clark Equipment Company gets data from 127 sales offices, 4 manufacturing plants, and a major warehouse as soon as it's recorded.

Bell System communications is the vital link.

Bell System data communications services link Clark's distant locations to a centralized computer center at Buchanan, Michigan. The result is better management control of all activities—sales, inventory, purchasing, production, payroll and accounting.

With current and accurate information, Clark management can quickly adjust to changing marketing conditions. Important orders get priority scheduling for production and shipment. And yet, purchasing, production and inventories stay at optimum levels.

An integrated information system of this size uses computer switching with store and forward capabilities. The fully automatic Clark system polls satellite stations, receives and transmits messages, assigns priorities, and converts different speed and code formats to one standard code. Other features of the switching unit provide the necessary supervisory control of the network.

Consider the economies a real-time, integrated information system can bring to your business with automatic data processing linked with fast, reliable communications.

Today's dynamic competition requires many companies to consider organizing for data processing in some phase of their operations. It's important to start organizing communications at the same time.

So when you think of data communications, think of the Bell System. Our Communications Consultant is ready and able to help you plan an integrated information system.

See the latest in data communications. Visit the Bell System exhibit at the Spring Joint Computer Conference.
It’s the talk of the industry...

Whatever “language” your present input or output machines speak—punched card or tape, optical or magnetic—the new low-cost NCR “500” computer systems can understand them. (That’s an NCR exclusive.)

Applied to your Vendor Accounting operation, this means a “500” Series computer needs no translating step to communicate with your input or output equipment. Translating steps are costly; a recognized nuisance.

NCR offers you complete, total data processing systems designed and built to work hand in glove with all of their components.

Accounts Payable can be one of the most complex and demanding of accounting applications. But the “500” handles the job with ease.

It provides (1) control over total system, orders, receipts, payments and commitments; (2) audit trail ... certification of proper accounting procedures and processing pertinent data; (3) voucher ... verifies calculations, rejects invalid entries and improper vouchers; (4) Disbursements ... forecasts requirements, earns discounts, writes checks; (5) Distribution ... proves expense, inventory, general ledger, allocations; (6) Reports ... exceptions, cash requirements, vendor analysis.

And it does all this with a minimum of personnel, forms, supplies, equipment complexities, computer runs, and (very important), minimum computer costs.

A complete magnetic ledger NCR “500” computer system for Vendor Accounting rents for as little as $765 a month ... or $1,195 for card system.

Now are we talking your language?

The new “500” speaks your language in Vendor Accounting automation.
the sessions

process of conversion, signaling the start of automation in that sleeping giant, that information utility of the future. The subject of the "checkless" economy has now become popular for thesis writers, including a team from the Harvard Business School that is particularly interested in the emerging integration of the computer, data transmission, and financial interchange sectors of this development.

Neal J. Dean, Booz, Allen & Hamilton
John McCleary, IBM.
Richard Bez, AT&T.

Thursday, 3:30 p.m.
Babbage Room

Hybrid Computing Installations
A Panel Discussion
Chairman:
W. J. Quirk
The Boeing Company
Huntsville, Alabama

Composer of staff members from three different hybrid installations, this panel was chosen to promote an interchange of concepts and techniques employed by operating hybrid computer facilities. A spirited discussion about trends and applications of hybrid computing by some of the leaders in the field should be expected by all attendees. Each installation will introduce its facility to acquaint the audience with its capabilities. This introduction will contain, but not be limited to: equipment layout and pertinent hardware characteristics, software characteristics, application programs, and computer checkout philosophy.

The presentation by each facility will, due to time limits, dwell only on the major points of their installation, but it should give uninformed listeners a good idea of the operating environment of the facility.

The panel discussion should be very informative and helpful to anyone considering the installation of a hybrid computer. In addition, it will point out the trends of the industry in this area and provide manufacturers and suppliers with goals to meet to satisfy the users.

Ralph Belluardo, Gerald Paquette and Ronald Goch, United Aircraft.
Don Augustine, Mark Fineberg and John Clancy, McDonnell Aircraft.

a boston promenade
by James Peacock

avenues & appetites

Boston bureau manager for Business Week, Mr. Peacock covered technology from New York before moving to New England. A mathematician-turned-journalist, he continues to follow the information-processing field.

Boston's not the town it used to be. Scollay Square's no longer there, redevelopment touches most portions of the city, and the air of change is best illustrated by the new complex in which the SJCC is being held.

But the old Boston isn't lost. As you set out to walk the Freedom Trail, walk a "Boston Trail" also. Leave the hotel, find Massachusetts Avenue, and walk down to Commonwealth Avenue. If you would like to sample one of Boston's better attempts to include French cuisine in its international menu—or if you would like a glass of wine and a piece of bread—stop by Les Tuileries, below the Eliot Hotel. Or—if you go a few steps farther and have a friend from Cambridge—you can enjoy the Harvard Club.

But walk down Commonwealth Avenue. Called by some architects the best residential street in a metropolitan area, this mall holds many facets of

WRAP-AROUND MAGNETIC SHIELDS
APPLIED IN SECONDS

Cut to any size or outline with ordinary scissors

Co-Netic and Netic foils are ideal for initial laboratory or experimental evaluation...also for production applications and automated operations. Dramatically enhance component performance by stopping degradation from unpredictable magnetic fields. When grounded, foils also shield electrostatically. They are not significantly affected by dropping, vibration or shock, and do not require periodic annealing. Available in thicknesses from .002" in rolls 4", 15", and 19-3/8" wide. High attention to weight ratio possibilities. Every satellite and virtually all guidance devices increase reliability with Netic and Co-Netic alloys, saving valuable space, weight, time, and money.

MAGNETIC SHIELD DIVISION
Perfection Mica Company
1322 N. ELSTON AVENUE, CHICAGO 22, ILLINOIS
ORIGINATORS OF PERMANENTLY EFFECTIVE NETIC CO-NETIC MAGNETIC SHIELDING

CIRCLE 58 ON READER CARD

April 1966
Raytheon introduces a new, low-cost digital information display system

A completely new, low-cost digital information display system for instantly retrieving and displaying data stored in a central computer is now available from Raytheon. This is the latest of thousands of cathode ray tube displays that have been designed and produced by Raytheon during the past 20 years.

The new system, the DIDS-400, interfaces easily with any type of computer and with various types of remote communication lines. It significantly reduces time required by operators to retrieve and edit data.

Up to 1000 alphanumeric characters can be displayed instantaneously. Operators can add to, correct or erase displayed data before returning it to storage without need of card punching and other intermediary processing. Hard copies of the displayed information can also be obtained.

Each DIDS-400 display console contains its own bright display, character generator, refresh memory and power supply. By combining these items in a single, self-contained unit, console dependence on the control unit or computer is greatly reduced, cabling problems are simplified, reliability is increased and the system given greater overall flexibility.

Highly-legible characters and symbols giving a closed-curve appearance are easily readable in normally lighted rooms, offices, and production areas, thus reducing operator fatigue and providing more efficient, error-free operation.

A brochure describing in detail the Raytheon DIDS-400 Digital Information Display System is available. Write: Manager of Industrial Sales, Dept. D466, Raytheon Company, Wayland, Mass. 01778.
Boston Promenade

The past. Statues celebrate famous U. S. or New England citizens; the buildings also once housed many of Boston’s elite. Now, most of them serve as fashionable apartments or in-town homes for people who can’t resist the charm of this section, called Back Bay.

This area was planned. It was created when early Bostonians shaved off the top of Beacon Hill and filled in a portion of the Charles River basin. (And new construction here is a real problem). Cross streets, those which run north-south, are named alphabetically between Hereford (one block from Mass. Ave.) and Arlington.

Between Fairfield and Exeter, on the left, is the Algonquin Club. It is a very good place, so get a Boston friend to take you for drinks and dinner. You’ll notice the old-British mode of the help, and the gas lights out front.

As you stroll under trees that, luckily, will be budding, continue to Arlington St. You will soon cross into Boston’s beautiful Public Garden, but first you might want to turn right for a half a block to have a drink at the Ritz Carlton Hotel: It’s one of the best in the world, and there is something about “The Bar,” as the downstairs rendezvous is called.

The Public Garden, across the street, must really be seen to be believed. And the swan boats are a must. “Visitors from ‘round the world,” a Boston tourist guide points out, “consider their trips to Boston incomplete until they ride these famous boats.” It is circling the small duck pond, on these boats, where Naval historian Samuel Eliot Morison does much of his writing. It is here, also, that many of Boston’s thousands of students do much of their courting under the guise of study.

East of the Public Garden, just across Charles St., is the Boston Common. This first piece of public property in this country was originally designed as grazing land for cattle belonging to residents of Beacon Hill, and only a few years ago were cows finally banned.

The Hill, which shouldn’t be missed, starts just down Charles to the left (north). Capped by the Bulfinch-designed State House, this federally-preserved area is a favorite living place for students, young working people, and the Boston Brahmins. Be sure to see privately-owned, cobble-stoned Louisburg Square—probably the “best” residential location in the world.

Wander up and around the Hill, or stroll across the hallowed ground of Boston Common, ground that covers a large parking garage. And end up on Tremont St. Along here the Freedom Trail starts; take it.

Before you do, however, you might want to find out why Locke-Ober enjoys its world-wide reputation. It’s just around the corner from the start of the Freedom Trail, nestled away in an alley called Winter Place. The heavily paneled downstairs is for men only, but the ladies are welcome on the second floor. If you have a medium-sized party, call ahead and reserve a private dining room on the third floor. It’s most practical.

Actually, the same food is available...
ASSIGNMENT: BUILD A 16,384-BIT MEMORY STACK FIT FOR OUTER SPACE, TO WITHSTAND:-
50 G SHOCK
10 G VIBRATION
ΔT of -55° to +105°C

Result: This RCA ferrite memory stack, designed to withstand the rigors of space flight, meets the toughest kind of environmental specs:

Vibration—10 g (0 to peak) 5 to 2000 to 5 cps at 1 minute/octave logarithmic sweeps, once along each of 3 mutually perpendicular axes.

Mechanical Shock—50 g, 11 ± 1 msec, half-sine wave, 2 shocks in both directions in each of 3 mutually perpendicular axes, a total of 12 shocks.

ΔT—5 cycles per MIL-STD-202, Method 102A, within limits of -55° C to +105° C. Unit to operate at specs at 0° C, 25° C and 70° C (without use of heaters or other means of internal temperature control).

How did RCA meet these demanding requirements?
- By double-testing each RCA wide-temperature-range ferrite memory core for 100% quality assurance.
- Precision stringing an array of 16 planes, each 32 x 32 cores, with continuous wiring through all 16,384 cores; no splices or internal solder joints are permitted. Then 100% testing the entire array.
- Folding the 16 planes over to form a continuously wired memory stack—and 100% testing it again.
- Encapsulating the stack in silicone rubber and securing it to its support case—and 100% testing it again.
- Shaking, shocking and temperature cycling the stack and 100% testing it at three different temperature levels.

Here's one more example of what RCA can do to build memory-system components to meet your requirements, regardless of how difficult they may be. Whatever you need in ferrite memory components, call your local RCA Field Office or write, wire or phone: RCA Electronic Components & Devices, Memory Products Operation, Section FD4, 64 "A" Street, Needham Heights 94, Mass. Phone: (617) HI 4-7200.
Boston Promenade

in different decor at Joseph's, on Dartmouth St. just south of Commonwealth. At either place (under the same management) luncheons are quite reasonable; dinners are primarily a la carte and push bills to the upper bound of Boston's pricing structure—a little more expensive, but well worth it.

Now, as you walk the Freedom Trail, you will come close to several good eating spots:

When you are in the Faneuil Hall area—and have enjoyed watching the open-air marketing transactions—try Durgin-Park. The food there—roast beef in particular—comes in hearty portions. You'll be seated indiscriminately at long tables covered with checkered tablecloths, and may have to wait in a line out front. To avoid this, go in the downstairs bar, have a drink, and get the special ticket that lets you walk up the inside staircase to the dining area. As you walk past standing sides of beef, don't forget to think of lobster, also. Some of Maine's dwindling supply of big ones are waiting in the kitchen.

Many spots around Boston, however, know how to handle the Aristocrat of the Sea, so don't neglect the nearby Union Oyster House—across from where the striking modern Government Center is rising from the Scollay Square haunts so well-known to servicemen during World War II. And if you like steamed clams, this refuge-in-exile for France's Louis XV is the place to go.

As you complete the Freedom Walk, and see from where Paul Revere saw the light, you will be in the North End, an area called home by many of the Italians who live in Boston. It has several good spots for dinner, if you are in an Italian mood. Many Boston buffs will swear that Felicia's has the best northern Italian food in the country.

If you decide to tour Cambridge—the time-sharing capital of the world—just follow Mass. Ave. north from the hotel. Project MAC is only a few blocks across the Charles River (which separates Boston from several universities). Downstairs, in the Technology Square building that houses the center for study of machine aided cognition is a cocktail lounge/restaurant which features "Clocktail Hour." Arrive between 4 and 6 p.m., punch your time card in an antique time clock, and pay the first two digits for each drink. See you at 4:09.

Farther out Mass. Ave., at Harvard, there are a few things going on, also. The Fogg Museum's glass flower collection is world famous, and, like the Fine Arts and Gardner Museums (not far from SJCC headquarters), contains many outstanding paintings. A beer at the Yard of Ale near Harvard Square goes very well, and there's also a time-sharing console in a nearby Radcliffe dormitory—if you can get in to use it.

Magne/Dex

CONTINUOUS
CONTINUOUS
CONTINUOUS

The first MAGNETIC CONTINUOUS forms for maintaining individual visible card records used in fast computer applications!

Magne-Dex is the only magnetic card record filing system adjudged to be the fastest, most accurate method of record keeping yet devised. Now, with the introduction of Magne-Dex CONTINUOUS—this same magnetic principle becomes practical in high-speed computer applications. Data stored on magnetic tapes, punched tapes, tab or edge punched cards is transferable onto Magne-Dex CONTINUOUS Cards with high-speed computer printers giving you a magnetic random access file that cannot be duplicated!

If you hand pick alpha numeric information in connection with your computer operation—

FIND OUT MORE...

Colorful circular spells out how Magne-Dex Magnetic CONTINUOUS can improve your computer operations. FREE CARD samples will be included with your request.

BUSINESS EFFICIENCY AIDS, INC./8114 N. Lawndale/Skokie, Illinois

Rush me circular on Magne-Dex CONTINUOUS forms—include FREE samples. Dept. D-45

NAME_______________________________________________________

COMPANY____________________________________________________

ADDRESS____________________________________________________

CITY__________________________________STATE________ZIP CODE_____

BEA/BUSINESS EFFICIENCY AIDS, INC./8114 N. Lawndale/Skokie, Illinois

CIRCLE 63 ON READER CARD
More than half of the top computer makers use Lockheed memories

Maybe you ought to know these reasons why:

**Unique Performance.** For example, Lockheed Electronics makes the largest high-speed commercial memory in operation today. It has 32,768 words, 74 bits, and operates at 1 microsecond complete cycle time. We've built the concepts behind it into an integrated circuit memory for military aerospace... and other systems and stacks equally outstanding.

**Economical custom design.** With Lockheed's exclusive "plug in" memory stacks, and other unique modules, we can assemble special memories to fit your need quickly and at low cost.

**Unmatched reliability.** Lockheed has carried "worst case design" further than anyone else in the field. This is a long story. We'd like to tell it to you point by technical point. Just contact us.

Tell us your memory application, so we can give you the most useful information.
Address: 6201 E. Randolph St., Los Angeles, California 90022.

Interested in sub-microsecond and integrated circuit memories? See us at Booth 106-108 at SJCC.

Lockheed Electronics Company
A Division of Lockheed Aircraft Corporation
Have you ordered an IBM/360?

Have you also ordered, or considered, a digital plotter to produce computer data in graphic form?
A picture is still worth ten thousand words — or stacks of printed listings.
Let CalComp show you how volumes of computer output can be reduced to meaningful charts and graphs — automatically, accurately, and completely annotated.
CalComp Plotters are compatible with the IBM/360 and other advanced digital computers ... and with the computer you now use.
Call “Marketing” for details.
If you have data to communicate, why not talk to the world's most experienced data communicator?

Data to communicate?

We have an expression about our data communication modems that will interest you. It's "optimum combination of factors." Best technique (Kineplex). Reasonable cost. Minimum dimensions. Minimum power requirements. Ease of operation. It's experience that makes such a combination possible.

Collins began its continuing research program in data transmission systems shortly after World War II, when the need for more efficient high speed systems of this type became evident.

That program has produced many of the landmarks along the industry's state-of-the-art path.

One of the program's major achievements was the development of Kineplex, a Collins modem technology which is now universally accepted as that which provides minimum error rate with maximum transmission rate per unit of bandwidth.

Our field experience with Kineplex has been extensive. Collins modems are used in Atlantic and Pacific transoceanic long range HF circuits, VHF transhorizon circuits, VLF radio circuits, and all types of wireline and microwave communication networks.

Collins modems are serving in tactical and strategic operations for the military, in defense and business applications for the government, in tracking operations in the nation's space effort, and in large and small industrial communication systems.

They also are used in secure voice and teletype systems to transmit encrypted digitized signals.

Collins modems are available in airborne, rack, and cabinet configurations, and in a wide range of data rates—from very slow to extremely high speeds.

For almost any data transmission problem, Collins is able to offer you an "optimum combination of factors."

For information on specific equipment or applications, call or write to: Data Marketing Department, Collins Radio Company, 19700 Jamboree Road, Newport Beach, California. Phone: (714) 833-0600.
we don't mind making
the second fastest large
scale memory system.

That's because we also make the fastest. How fast?
650 nanoseconds for a full cycle with an access time
of 300. That's our NANOMEMORY™ 650. It handles up to
16,384 words of 84 bits. They don't come any faster.
Right behind it, our NANOMEMORY 900 completes
a cycle in 900 nanoseconds with an access time of
350 for the same capacity.

We've been able to reach these speeds by using a
simple but ingenious magnetic organization. We call
it 2½ D. It combines the speed potential of linear
select with the economy of coincident current
 techniques. We've also reduced stack connections to
80% and widened operating margins to
increase reliability.

Both these compact memory systems fit perfectly
into real time or high speed computers and
checkout systems.

If you've been looking for a memory system that
delivers close to thin film speeds at magnetic core
prices, stop looking. We've got two. For complete
details on our NANOMEMORY 650 or 900,
write or phone.

electronic memories
Memory systems, stacks and cores for commercial,
military and space applications
12621 Chadron Avenue, Hawthorne, California
(213) 772-3201

see us in April at SJCC,
Boston, Booths 410-411
Sometimes we worry about Jim becoming a Narcissist.

It all started with Celanar Polyester Film. We go to extremes to make it the cleanest, clearest, smoothest film available to precision tape manufacturers. Then challenge Jim, and our quality control experts, to find a flaw in it. But stare as he may, it's a rare day when Jim finds a wrinkle, cross-buckle or other visual defect to mar his own reflection on a roll of Celanar. Which is enough to turn anyone into a narcissist.

The cleanliness of Celanar starts in our "White Room" production area at Greer, S.C., where air filtration systems trap dirt specks as tiny as 0.3 micron. This emphasis on cleanliness makes Celanar film a better base for computer and instrumentation tapes. It's one reason why Celanar gives higher production yields in film conversion.

Of course, clean just begins to describe Celanar. It's more uniform than the other polyester film. We assure its gauge uniformity by radioactively inspecting every foot of every roll before it's shipped. Celanar is also stronger—in both tensile break and tensile yield strengths. And we go a long way to supply it in the roll lengths, widths and gauges most convenient to manufacturers. Even guard it during shipment with temperature recording flags. Or impact recorders, when necessary.

Send for complete details about Celanar Polyester Film—and how we can help you make the best use of it. Celanese Plastics Company, Dept. 113-D, 744 Broad Street, Newark, N. J.

Celanese Plastics Company is a division of Celanese Corporation of America. Celanese® Celanar®
profit by air

compare:
by surface $1,358
by Air France $1,086
saving $272

Time plus money saved
means profit for you!

Read how one company saved $272 and 23 days by shipping heavy machinery on Air France: The items involved were paint conditioning machines, transported from Minneapolis to Paris, and the net weight was 3309 pounds. While the machines weigh the same no matter how they're shipped, the rate for air shipment is only 270 lbs.—a saving of over half a ton on the container alone. The reason is simple: ship this product by Air France and all you need is the original carton.

When you compute the surface costs, don't forget hidden charges such as warehousing, drayage, high insurance rates, at both point of origin and destination. They add up...but not with Air France. We'll fly your cargo direct wherever and whenever you're ready.

Another saving not to be overlooked, of course, is time. Surface shipment from Minneapolis to Paris took 29 days; by Air France, a maximum of 6 days. (And less time in transit means capital tied up for a much shorter period!) Cut your overseas inventory...let your salesmen guarantee fast delivery of your product...and your customers will like the way you do business.

Air France, Cargo Manager
683 Fifth Avenue, New York, N.Y. 10022

☐ Please send information showing how I can make a cost comparison between surface shipment and Air France jet cargo flights.

☐ Please have your representative call on me with information on this cost analysis.

Name______________________Title______________________

Firm______________________

Address______________________

City______________________State______________________Zip______________________

AIR FRANCE
THE WORLD'S LARGEST AIRLINE

April 1966
Advanced Scientific Instruments uses DATA·PANEL for complete display and control console of their new ASI ADVANCE Series 6040 Computer.

NEW CONCEPT OF INFORMATION DISPLAY AS DRAMATIC AS TODAY'S COMPUTER DESIGN!

DATA·PANEL indications are visible only when illuminated in EAI 8400 Scientific Computing System by Electronic Associates, Inc.

Leading designers of modern computers specify TEC-LITE DATA·PANEL for its dramatic new appearance in operator consoles and maintenance panels. DATA·PANEL offers a new concept of display versatility and visual impact, in addition to greatly increasing operator accuracy.

Extremely flexible visual and mechanical parameters of DATA·PANEL give designers display freedom never before available. There are no restrictions, within practical limits, to the shape, color, size or arrangements of the information displayed. Indications and digital readouts stand out emphatically in color behind smooth planes of glare-free black glass. When "off", legends and indications can be totally invisible until illuminated. For control, complete range of switch actions can be an integral part of DATA·PANEL design.

Write for full-color brochure, specifications and ordering information.

Transistor Electronics Corporation
Box 6191 · Minneapolis, Minnesota 55424 · Phone (612) 941-1100

CIRCLE 70 ON READER CARD
SHARE MEETING HEARS
WATSON REPORT ON 360

IBM's top salesman, board chairman T. J. Watson, Jr., faced some 1200 members of SHARE (IBM large scale system users) last month to discuss, among other things, the delays in delivery of 360 software and hardware. Citing the 360 program as one of the largest corporate tasks in history, Watson said the 360 problems "are our own, attributable only to IBM." He noted that logic chip and SLT (IBM's name for their hybrid circuit) problems were being solved: production is up nine times, three plants are now operating at capacity, and chip yields are 70%. Shipments so far total 1360 systems, he said, and the rate will climb to 400/month by May. The 360 will go monolithic integrated circuit, he said.

Commenting on the recent report of the President's Commission on Technology, Automation, and Economic Progress (of which he was a member), Watson noted that the press had inaccurately reported the findings of the Commission, highlighting a plan to pay people for not working. This concept of the negative income tax, he said, was not revolutionary (it was part of Goldwater's platform), and the recommendation of the Commission was that Congress look at the substantial poverty payments now being made to see if the money is going where it can do the most good.

The report, he feels, made one of the strongest statements in favor of automation and technological change, pointing out that automation is not a massive threat to employment, does not require inhibitive government controls.

Elsewhere at SHARE, members gathered to hear representatives of IBM, CDC, RCA and GE discuss their plans for PL/I. All are interested in it; the three "other guys" will implement it "as soon as appropriate." But the language was variously described as "unwieldy," overly expensive (the user will really foot the bill), and not independent of at least one machine (the keypunch). From the floor, one user said damn the other manufacturers; we need PL/I right now. Let IBM push ahead with it: "If that means a two-, three-year delay for the other manufacturers, that's tough."

AMA CONFERENCE LOOKS AT COMMUNICATIONS PROBLEMS

By 1972, communications and input/output will account for 60% of data processing costs to the user, Robert Francisco of Western Union told attendees at a recent American Management Assn. conference.

Almost 300 high-level administrative and dp managers crowded into the data communications session to

USC GETS FIRST OF NEW HONEYWELL BRAILLE PRINTERS

The Computer Sciences Laboratory at the Univ. of Southern California has been given a computer-driven Braille printer by Honeywell that can produce 300 Braille "cells" (up to six dots) a second, about 100 times as fast as the most commonly used methods.

USC's unit is the first produced by the company and it is being used in connection with projects for training the blind, together with a special Teletype machine for preparing input, developed by Ray Morrison of the Illinois Bell Co.

In addition to simplifying the training of blind programmers and providing them with a system that can be used efficiently, the Braille unit will be applied to on-order production of educational materials for other blind students. A library is being built up and stored on magnetic tape.
Least square fits the model with the least square error.

For a better fit, we incorporate other.

Least square the parameters, in particular, it.

It lacks strength and weight too much.

A common observations is encouraging CM.

It provides a clear indication suggesting that the

In some academic material, such as the work
developed in this program, and the data.

The data we observe on resonant and
damping, originates with the tendency of

How to decrease. In a design, where a resonant
material is stretched or increased.

What happens, unfortunately, is that it does not fail!
news briefs

hear what AT&T, WU, and a user had to say about the problems they were facing in adding communications capabilities to their systems.

All panelists noted the great need for systems planning and the innumerable hardware, software, communications facilities, and human considerations. The dilemma is not only the “how,” but which piece of equipment and what speed do you need? Fracisco noted that there are more than three dozen CRT devices alone on the market now, and if the user is to make the right selection in I/O equipment, he had better start developing a comprehensive file on what is available. W. B. Quirk of AT&T added to a long list of modems available by announcing that Bell Labs is developing a new unit which will provide speeds of 3600-9600 bps over voice channels.

Further improvement in nationwide communications services provided by the common carrier will be up to the user, noted Quirk. For example, he said, there is some demand for a common user wide band service (only private service is now available) but the market is not great enough yet to justify the expense. Francisco noted that WU’s microwave system, which will supply all speeds up to 48K bps by the end of the year, now only goes between some of the major U.S. cities. Again, the market is not great enough to extend the service into smaller communities.

Technologically and economically, the equipment exists or will, said D. J. Dantine of Clark Equipment Co., but there are serious problems blocking data communications progress. One is the “inability of Western Union to compete with AT&T on a cost and capability basis.” The government, he said, should not attempt to strengthen WU by weakening AT&T, but perhaps should financially aid WU to become more effective. TELPAK should be left alone by the FCC, he thought, disagreeing with the idea that all services should be compensatory (it has been claimed that TELPAK is being supported by Bell voice operations). In the area of private microwave, Dantine felt such systems are “difficult to justify for most corporations, especially because of interconnection restrictions.” For example, the private system can’t interconnect with the Bell System.

And if all these considerations weren’t enough, a major point of other AMA sessions was the increasing, serious shortage of systems analysts and, to a lesser degree of programming talent to develop data communications/processing systems.

ILLIAC IV PLANNED BY UNIVERSITY OF ILLINOIS

Execution of a contract for over $8 million to build and operate Illiac IV has been authorized by the board of trustees and the University of Illinois. Some $6 million is budgeted for construction of the computer, which may be “up to 50 times faster than any other now contemplated.” The contract is from the Department of Defense through the Air Force Rome Air Development Center.

Prof. Daniel L. Slotnick will be in charge of the project, which will be based on his machine organization concept using one control unit and several hundred arithmetic and storage units. Development and construction is expected to take two and a half years.

HUNTER AND HUNTED LINKED BY ON-LINE SYSTEM

For job recruiting, the nation’s firms will soon have the chance for on-line access to a computer data bank on college graduates. The College Placement Council of Bethlehem, Pa., a non-profit organization representing about 1,000 colleges and universities and 2,000 U.S. and Canadian employers, has begun to gather resumes from graduates with job experience for its GRAD service (Graduate Resumes Accumulation and Distribution). A thesaurus of job skills has been developed to standardize data input and queries.

GRAD will be in operation by this summer, but it won’t include graduating seniors until the class of 1967 or ’68. Size potential of the system is indicated by CPC figures on graduates: four million in the last decade and seven million in the next.

GE, which developed the computer file system, is making available for GRAD four GE 235 computers, two Datanet 30’s and three 6-megacharacter disc files, located at its Missile and Space Technology Center in Valley Forge. Charges for on-line service are a $10 teletype-connection fee, 50 cents a minute for computer time (each inquiry averages three minutes) and $2 for a copy of each resume, which will be stored on microfilm. Mail inquiries are the same except for connection fee. Graduates pay $10 to have their resumes on file.

The project faces some legal problems as the placement and consulting firm of Information Science, Inc., which also bid on the contract, has filed suit against GE for “unfair competition” in bidding on system develop-
news briefs

ITT DIVISION OPENS WALL STREET SERVICE CENTER

ITT Data Services has opened a Wall Street dp center, the second of a network of satellite computer centers planned for the New York-New Jersey area. An IBM 1460 is processing data and transmitting larger problems, via a 7711 transmission unit, to a 7094 in main ITT center in Paramus, N. J. A variety of computer services is offered, including investment appraisal, short-range economic forecasting, and structural design.

This spring the Paramus center will begin converting to third-generation equipment with the installation of Models 40 and 50 systems. In 1967, a 360/67 time-sharing system will be installed to process not only data from satellite centers but also from on-line terminals located at customers’ offices. Other small ITT centers are slated this summer for Princeton, N. J., and mid-town Manhattan.

WU LAUNCHES INFORMATION UTILITY

Western Union has formally opened its first computer service center in New York and announced that four others by early 1967 in San Francisco, Chicago, Dallas, and Atlanta. These centers comprise Phase I of a WU information utility program, Info-MAC, which will provide a series of new communications, data processing, and reference file services to WU customers all over the continent. Under Phase II, third-generation systems will go into centers in key cities, including New York, Chicago, and San Francisco, and into smaller, satellite centers in at least 25 additional locales.

Phase I centers, equipped with Univac 418 computers, initially are to provide automatic routing of single and multiple-address messages between Telex customers anywhere in North America, and from Telex to TWX stations in the U.S. AT&T, owner of TWX, has approved the latter arrangement. About 3,000 subscribers are now using the New York center, and by the end of 1966, about 14,000 Telex users in 200 cities are expected to be on-line to the network. Another service being developed is on-line access to information files on various fields, such as the legal reference service soon to go into operation (see Datamation, Feb., p. 79). WU is using and adding Fastrand drums to provide storage for these data banks.

A major feature that will mark the program when it has been fully developed, possibly by 1968 or ’69, will be the switching service permitting a customer, using one terminal, to send messages to Telex, TWX, and broadband stations here and to similar stations abroad.

● System Development Corp. has completed a study for the Federal Council for Science and Technology, resulting in recommendation of a national document-handling system for scientific and technical information. The SDC group was headed by Dr. Launor F. Carter and worked with a team from the Committee on Scientific and Technical Information under the direction of William T. Knox. The report recommended organization of a new agency to give policy guidance to various federal departments and

AN IMPORTANT ANNOUNCEMENT ABOUT DISPLAYS FOR GE 425 USERS

Economical CRT Computer Controlled Displays, compatible with the GE 425, are now available from INFORMATION DISPLAYS, INC.

All solid-state (except for 21” rectangular CRT), these displays write up to 75,000 points or characters per second. Light pens, vector generators, size and intensity controls, buffer memories, and other equally useful options can be included.

One typical GE 425 compatible system is the IDI Type CM 10057. This unit operates with the GE 425 communication system and includes the CURVILINE® Character Generator, vector generator, mode control and light pen. The price of the CM 10057 Computer Controlled Display System is $31,020.

Other combinations to meet each user’s requirements can be assembled from the assortment of standard options.

Please write or call for complete information.

NOTE TO USERS OF OTHER COMPUTERS — IDI probably has delivered displays compatible with your computer . . . too!

INFORMATION DISPLAYS, INC.
102 E. SANDFORD BLVD. • MOUNT VERNON, N.Y. 10550 • 914 OWens 9:5515

CIRCLE 73 ON READER CARD
Is the engineer fated to be frozen out of the computer loop?

Not if EAI can help it.

That is why we designed the EAI 8400 Digital Computer.

Often overlooked in digital computation is the battery of people and procedures which stand between the design engineer and the execution of his program. He’s working one step away from the machine—and his problem.

This is tough on anybody who is used to the “hands-on” approach to computer usage.

The EAI 8400 fills this gap in man/machine communication.

It’s a sophisticated digital computer that brings the engineer and his thinking back into the design loop. Designed to satisfy the stringent requirements of computer simulation, the 8400 lets the creative engineer use the familiar model-building, trial-and-error design process... in real time and faster than real time... in an online environment.

We’ve given the 8400 the power to perform extremely high speed, floating point arithmetic. How important is this? Well, 40% to 60% of all instructions in simulation and real time programs deal with floating point operations.

The EAI 8400 offers a new high level of capability in software. Throughout all phases—program preparation, debug and execution. It has a FORTRAN IV compiler and four other powerful languages. You can talk these languages while being interrupted for real time processing—without even knowing it.

You’ll also be hearing a lot about EAI’s Dynamic Storage Reallocation—a fundamental innovation that allows programs to be reassigned within memory, at will.

We didn’t design the 8400 as the computer to do everything. It was designed specifically to expand the creativity of the engineer and the scientist, and it answers the exacting needs of the simulation laboratory. Why not investigate the EAI 8400 for the solution of your engineering problems? Write for detailed information.
Can an engineer flunk Fortran and still find happiness?

Happiness is finding a digital computer with a simple keyboard, whose language is algebra.

Happiness is having 48 to 88 individually addressable storage registers plus 5 separate registers for arithmetic manipulations, 480 steps of program memory, and/or 18 optional prewired programs of 48 steps each, right in your own department.

Happiness is not spending a million dollars for a digital computer, or $50,000, or $20,000, or even $10,000.

Happiness is getting 8 to 9 significant digit accuracy with a 2 digit power of ten exponent, automatic decimal placement, paper tape readout, 100 column number capacity.

Happiness is getting intelligent accessories, like a paper tape punch and reader, or a page printer.

Happiness is a Mathatron 8-48 plus the new Auxiliary Program Storage.

MATHATRONICS, INC.
257 Crescent Street
Waltham, Mass. 02154
(617) 894-0835

news briefs

Pan American Airways is using CRT displays to check-in passengers and monitor and plan cargo loading. Agents and load controllers at New York's Kennedy Airport and city terminals are using a total of 28 Bunker-Ramo 212 keyboard/displays which are on-line to an IBM 1440 system. Data on 30 active flights are stored at one time. In the future, Pan Am intends to develop such systems at other major points in the U. S. and abroad.

The first Honeywell 2200 has been delivered, going to Courtalds Ltd. of Coventry, England. It has a 65K, 1 usec core memory, six tape units, and other peripherals; data transmission equipment is being added, linking the computer to Courtalds factories throughout England. In addition to general business data processing, applications included operations research, simulation, critical path, and a management reporting system specially developed in cooperation with Honeywell.

Cornell University has ordered an IBM 360/67 time-sharing system, which will be in operation in fall of 1967. It is expected that up to 50 typewriter and display terminals will be linked to the system, which will be applied to teaching, research and administrative tasks. The 360/67 configuration includes two processors with 256K characters of core each, a 4-megacharacter 2301 drum, a 208-megacharacter 2314 disc file, a 400-megacharacter 2321 data cell, six tape units, three printers, and two card read/punch units.

Minnesota has inaugurated a cooperative program under which many of the state's 180 hospitals will use an on-line central computer complex. Eight hospitals are now using two Honeywell 200 systems at the Minnesota Blue Cross Cooperative Data Center for payroll accounting. Other functions, such as inventory control, payroll and property accounting, preventive maintenance scheduling, patient care management, and laboratory test reporting will be added as the system develops. Cost of the service for a 300-bed hospital is $2,200 a month.
DATA
INPUT-OUTPUT

ULTRONIC SYSTEMS CAN HELP YOU BUILD YOUR EQUIPMENT TO DO EITHER—
FASTER, MORE EFFICIENTLY, MORE ECONOMICALLY—WITH PROVEN RELIABILITY.

DATA PUMP™
Enables you to transmit or receive data, up to 1200 BPS over conventional leased voice-grade circuits. Sales price is less than one year's rental of similar type equipment.
High MTBF. Presently used in world-wide data network.

ENCODING KEYBOARD
Allows you to put any combination of information into your digital system, such as BCD code. Thousands of these units are now in operation in Ultronic's global data communications network.
Available in numeric and alphanumeric modules, with flexibility of keyboard layout.

TAPE TERMINAL
For magnetic tape transmission and reception of up to 9-level digital information over conventional switched or private lines. Ultronic's tape terminal is completely self-contained, and provides error detection and correction.
Units are now in operation on transcontinental data communication networks.

CHARACTER MULTIPLEX
Reduces the number of dedicated data circuits by multiplexing various code configurations and bit data rates onto a conventional voice-grade circuit. The equipment is completely solid-state, fully duplexed, and exhibits exceptionally high reliability.

Ultronic Systems Corp. is in the business of data communications. 100% of our resources are devoted to the manufacture of hardware for this field. When we contribute these resources to OEM, we contribute the most advanced know-how available.

ULTRONIC SYSTEMS CORP.®
Sub-System's Division, 7300 North Crescent Blvd., Pennsauken, N.J.

April 1966
How's this for getting no place slow?

The Processionary Caterpillar (*Roundanda Rounda' Gogo*) was never much in the initiative department. Seems all these fuzzies want to do is play 'follow the leader'. Set 'em around the rim of a flowerpot and they keep marching around in a circle until they drop off from sheer exhaustion. (This symptom in *homo sapiens* is called the "mistaking-activity-for-accomplishment" syndrome.)

There are more "m.a.f.a." sufferers around than you might imagine. Take our own line of work, for instance: Did you know there are still data processing people using Tab Labels in horizontal 16th-of-an-inch sizes?! That's right! . . . and they could use Brady Tab Labels in tenth-of-an-inch sizes. Then they'd match the number of print-out-characters-per-inch of their Tab equipment. And why are they using these old style labels? Just because some other Tab Label manufacturers made labels that way from the start, and never thought much more about it.

If you're a "m.a.f.a." sufferer, shake the fuzz now. Get information, samples and prices on Brady Tab Labels by calling your Brady Tab distributor, or writing us today.

*Actually, the scientific name is *caethocampa processionaria.*
Check the office forms you'd like prepared automatically...

Now read about this one machine that automates them all

The Dura® MACH 10®. It automates sales orders, invoices, inventory reports—virtually any business application. Data is read, punched, and typed automatically at up to 175 words per minute. Edge-punch cards or punched paper tape are used to capture repetitive data—accurate data to produce documents. By-product tapes provide information for management decisions before the data is old history. Check into the Dura MACH 10 today. Call your local Dura representative. Or write your name and address on this advertisement and mail to: Dept. D21-46, Dura Business Machines, 32200 Stephenson Highway, Madison Heights, Michigan 48071.
No one has a larger line of disc memories.

See the largest line of disc memories available at the Spring Joint Computer Conference, Booth 913-916

Whether your information storage requirements are small or require data stored in millions of bits, Librascope Group of General Precision, Inc., has a disc memory system for every application. These systems have a proven history of reliable performance in computing systems designed for military, business, engineering, and educational applications.

**LIBRAFILE mass memories:** Large-capacity, high-speed, random-access information storage systems. Two disc sizes available. 48" discs capable of storing up to 400 million bits. 38" discs with a capacity of 200 million bits. LIBRAFILE mass memory information retrieval is either fixed-address search or search-by-record content. Access time less than 20 ms. Data transfer rates in the megacycles.

**Militarized disc-memory systems:** High-speed, random-access, information-storage systems. Consists of disc memory for data storage and an electronic subsystem that provides complete interface, control, and read/write electronics. These systems can be used as a data base for shelter, van, or shipboard applications. Storage capacity of 25 million bits on 24" discs. Customized capacity up to 80 million bits.

**L-400 magnetic-disc memory systems:** Provide data storage and transfer in computer systems, peripheral equipment, and other systems where rapid-access memory is a requirement. 24" disc storage capacity up to 36 million bits. 10/1 disc with a capacity of 275,000 bits.

**L-300 disc memory:** For use in computer systems and peripheral equipment as main storage, buffer storage, or as a supplemental memory. 10" disc with a capacity of 275,000 bits.

For complete details, write for our technical bulletins.

**Engineers:** For career openings, call or send resume in confidence to B. Larson, General Precision, Inc., Librascope Group, 808 Western Avenue, Glendale, California 91201. An equal opportunity employer.

A Plans-for-Progress Company.

CIRCLE 79 ON READER CARD
new products

document retriever
The CARD (compact automatic retrieval-display) system is a self-contained desktop microfilm file reader with up to 67,800 pages accessible in an average of 2 seconds. Document images are stored in filmcards, 90 pages to a card; 25 filmcards comprise a magazine; and 30 magazines fit in a reader.

Pushbutton selection from a control panel locates the desired record, positions it in a projector, and displays it on a screen. There is a 24x magnification. Selection of a new record automatically returns the displayed record to the file. HOUSTON FEARLESS CORP., Los Angeles, Calif. For information:
CIRCLE 130 ON READER CARD

gp digital computer
The LSI 8800 is an I.C. computer intended for such applications as data conversion and formatting, message switching, and process control. It has a core memory capacity of 2-65K (8-bit) bytes, cycle time of 1.5 usec, a 600-nsec access time, and data transfer rate of 200K bytes/second. Several CPUs may share the same memory. The I/O facility is a six-channel multiplexer system, expandable to 254 channels, which is externally scanned for interrupt. Interfaces are available for a variety of peripherals and for IBM 360 computers. Software package includes an assembly language called LNSGO, a subroutine library, and utility routines. DATA AND CONTROLS DIV., LEAR SIEGLER, INC., Long Island City, N.Y. For information:
CIRCLE 131 ON READER CARD

badge reader
The model 0107 is part of the Transaction line of data collection systems. It accepts 15- or 22-column plastic cards singly, as well as variable data up to 10 digits. With a self-contained scanning control, interface can be directly to a main data collection trunk line. Transmission rate is 120 cps. The model 2013 adapter generates control signals for badge readers via its scanner circuits, and adds fixed digital data, up to 30 characters, to messages. CONTROL DATA CORP., Minneapolis, Minn. For information:
CIRCLE 132 ON READER CARD

incremental cartridge recorder
The 2200 series has writing speeds from zero to 300 steps/second, incremental read to 150 steps/second, and synchronous reading from 250 to 500 steps. Cartridge capacity is 780K 8-bit characters; other models store the same number of 7-bit characters. A random-access memory unit holding up to 100 million bits and with a maximum access times of 50 milliseconds is the model MCM-1. The unit uses flexible magnetic cards mounted in interchangeable cartridges. Each cartridge, which can be loaded or unloaded in less than five seconds, holds 64 cards. Each card has 128 tracks divided into 32 channels, and 325,000 bits per track. Card size is 16 x 4.5 inch.

The machine uses a content address system, and the cards in the cartridge are randomly ordered. When a card is addressed, either by the computer or by the control panel buttons, the address is stored internally. When the extract command is issued, the appropriate card is selected, extracted, and passed over the read/write head. There are two capstans for card recirculation, and a capstan for re-entry, card selection, and extraction mechanisms. Delivery is in six months. COMPUTER ACCESSORIES CORP., Santa Barbara, Calif. For information:
CIRCLE 133 ON READER CARD

management software
A package called AIMS (automated industrial management system) consists of 10 applications programs for the 315 family of computers. Included are inventory control, forecasting, accounts receivable, etc. Although useable separately, they're intended as a total system, establishing a single master file that accepts inputs and effects exception reporting. NATIONAL CASH REGISTER CO., Dayton, Ohio. For information:
CIRCLE 134 ON READER CARD

multi-function chips
Containing as many as 40 conventional IC functions on a one-layer silicon chip is the Monolithic Digital Functional Arrays. Included are a "fast adder," 4-bit binary register, and a decade frequency divider. The regis-

April 1966

135
How does Midwestern guarantee data reliability?

The M4000 pneumatic tape transport system is guaranteed to read tapes recorded to IBM compatibility specifications with less than one transient error per $10^9$ data bits; at densities to 800 bpi, and at transfer rates to 120 KC. Every production tape transport is factory tested for a minimum of 100 full reel passes; reading and error checking random record length, variable pattern data tapes under full program control. Actual statistical results of these tests, over a number of transports and many thousand full passes, have shown an average data reliability rate of one transient error in $27.1 \times 10^8$ characters read. This safety margin, developed from actual test data, makes Midwestern's guarantee of one error in $10^9$ a realistic promise, not just another empty claim.

For more information on the M4000, write or call Ralph P. Bohn, Digital Tape Products Division, P. O. Box 1526, Tulsa, Oklahoma 74101. Our phone number is 918-627-1116.
new products

ter reportedly can store and transfer up to 250 million bits/second. SYLVANIA ELECTRIC PRODUCTS INC., New York, N.Y. For information:
CIRCLE 136 ON READER CARD

keypunch/verifier
The model 65 can be used as a punch and a verifier. In the punch mode, the holes are shorter than normal, and in the verifier mode they are elongated to standard length. Holes escaping elongation (errors) are subsequently detected by a mod 131 automatic verifier, which runs at 200 cpm. INTERNATIONAL COMPUTERS & TABULATORS LTD., Putney, England. For information:
CIRCLE 137 ON READER CARD

flowchart software
On mag tape is the FLO-TRAN program, which automatically produces flowcharts of FORTRAN IV source decks. Output is on the SC-4020 microfilm plotter in the form of 35mm film or hard copies. In addition to generating flowcharts from input commands, it supplies program listings, and operates in the typewriter fashion for general documentation purposes. The program interprets and classifies source statements, and processes these statements and associated data according to their classification. Binary output tape has SC-4020 commands with information from source cards. Software is by David J. Clark of GE. MARSHALL SPACE FLIGHT CENTER, Huntsville, Ala. For information:
CIRCLE 138 ON READER CARD

card counter
The CC-350 has an input card hopper, card counter, and output stacker, and counts at the rate of five cards/second. There's also a manually-resetable 4-digit counter. Duplicate card sensing and counting circuitry are used for ac-

---

GO AHEAD

Spend a dime.
Add 80,000 sq. ft. to your office.
Fill it with twenty-five million dollars worth of computer equipment and staff it with 950 experienced consultants, systems designers, programmers and data processing specialists.
It won't cost a cent until you use it.
How?
Call us. (314) 731-2121
And after we've talked, you can call our capabilities and facilities yours. It is the practical and economical way to effective management.

Consulting • Systems Design • Programming • Data Processing and Computing

MCDONNELL AUTOMATION CENTER
DIVISION OF MCDONNELL AIRCRAFT
Box 516, St. Louis, Missouri, 63166 Telephone: (314) 731-2121
Colorado Office: DELCAS Denver - Tel. (303) 524-8291
Texas Office: MACTEX Houston - Tel. (713) 224-5821
CIRCLE 81 ON READER CARD
new products

curacy. SYSTEMATICS OF MISSOURI INC., Kansas City, Mo. For information:
CIRCLE 139 ON READER CARD

portable digital recorder
DR 1200 digital tape recorder reads and writes IBM computer compatible tape at 200, 556, and 800 bpi at speeds to 120 ips, seven or nine tracks. Weight of the portable unit is 45 pounds and operation takes only 100 watts. RALPH M. PARSONS ELECTRONICS CO., Pasadena, Calif. For information:
CIRCLE 140 ON READER CARD

tape canister
Measuring only 1¾-inch wide, styrene container for mag tapes is said to be half-inch thinner than other models. Eliminated are divider inserts to hold tapes in place. A molded hook, an integral part of the canister, permits reels to be suspended on a bar in the cabinet; this and a molded hook form legs for the container when it's in a standing position. DIEBOLD INC., Canton, Ohio. For information:
CIRCLE 141 ON READER CARD

card reader for teletype
CRU automatic card input unit is used in data communications, processing, and collection. When used with standard model Teletype machines, it operates in the same way as the TTY tape reader, without sacrificing any teletypewriter functions. Options allow use with computer equipment, billing and accounting machines, or numerical process control systems.
DIGITAL ELECTRONIC MACHINES, Kansas City, Mo. For information:
CIRCLE 142 ON READER CARD

automatic writing machines
The 2300 series of Flexowriters includes five new models, all with speeds up to 145 words/minute, with varying capabilities depending on application needs. Featuring quiet operation, the series read and punch 8-channel tape. FRIDEN, INC., San Leandro, Calif. For information:
CIRCLE 143 ON READER CARD

paper tape reader
A photoelectric paper tape reader, the PTR-60 competes in cost with mechanical units and is suitable for data processing and machine tool control applications. Opaque tape is read at 150 characters/minute; and optional feature permits reading of translucent tape. The PTR-60 operates on a step-pulse supplied by the user. OMNI-DATA DIV., BORG-WARNER CORP., Philadelphia, Pa. For information:
CIRCLE 144 ON READER CARD

paper-tape correction system
Editmaster Series 110 is an automatic tape-merging system for editing and correcting tapes to be used in photographic and metallic typesetting. The original and correction tapes, are loaded on upper and lower stations, respectively, and the unit produces a third, corrected, six- or eight-level tape at 110 cps. The 110 searches for the point of error on the original at 500 cps. PHOTON, INC. Wilmington, Mass. For information:
CIRCLE 145 ON READER CARD

drum memory
The model 52 system, with clocking, read-write, and address decoding elec-
The Library of Computer and Information Sciences invites you to accept any 3 of these outstanding books (values to $49.50) for only $4.95

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Author(s)</th>
<th>List Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>THE ENCYCLOPEDIA OF ELECTRONICS, edited by Charles Buxkind.</td>
<td>The most authoritative survey of electronic science now available.</td>
<td>$22.50</td>
</tr>
<tr>
<td>2</td>
<td>MANAGEMENT STANDARDS FOR DATA PROCESSING, by Dick H. Brandon.</td>
<td>A unique volume covering methods standards for data processing. Includes functions of systems analysis, programming, and computer operations.</td>
<td>$12.00</td>
</tr>
<tr>
<td>3</td>
<td>PROGRAMMING AND CODING DIGITAL COMPUTERS, by Philip M. Sherman.</td>
<td>Complete, lucid survey of the concepts, techniques, and special problems of computer programming. Discusses the characteristics, structure, and language of the digital computer.</td>
<td>$9.25</td>
</tr>
<tr>
<td>4</td>
<td>MATHEMATICAL METHODS FOR DIGITAL COMPUTERS, edited by Anthony Ralston &amp; Herbert S. Will.</td>
<td>Detailed, step-by-step report on actual processing of mathematical and physical problems for digital computers.</td>
<td>$17.00</td>
</tr>
<tr>
<td>5</td>
<td>REAL-TIME BUSINESS SYSTEMS, by Robert V. Head.</td>
<td>A complete, lucid guide to the principles, techniques, and special problems of computer programming, providing clarifying examples on a hypothetical computer.</td>
<td>$9.00</td>
</tr>
<tr>
<td>6</td>
<td>COMPUTER SOFTWARE: PROGRAMMING SYSTEMS FOR DIGITAL COMPUTERS, by Ivan Flores.</td>
<td>Practical handbook on the techniques and applications of computer software. Shows how sequences for software are built, and how to construct a complete system.</td>
<td>$11.95</td>
</tr>
<tr>
<td>7</td>
<td>BUSINESS DATA PROCESSING AND PROGRAMMING, by Philip M. Sherman.</td>
<td>Complete, lucid survey of the concepts, techniques, and special problems of computer programming. Discusses the characteristics, structure, and language of the digital computer.</td>
<td>$9.25</td>
</tr>
<tr>
<td>8</td>
<td>SCIENTIFIC DECISION MAKING IN BUSINESS, edited by Abe Shuchman.</td>
<td>Wide-ranging collection of the best writing available on the aims, methods, and tools of management science or &quot;operations research.&quot;</td>
<td>$7.95</td>
</tr>
<tr>
<td>9</td>
<td>ADAPTIVE CONTROL PROCESSES, by Richard Bellman.</td>
<td>Comprehensive overview of automatic control theory. With original techniques for making problems involving decision processes amenable to solution.</td>
<td>$6.50</td>
</tr>
<tr>
<td>10</td>
<td>RECENT DEVELOPMENTS IN INFORMATION AND DECISION PROCESSES, edited by Mochel &amp; Gray.</td>
<td>Wiener, Bellman, Diamond, and 13 others report on the most significant optimal decision-making techniques.</td>
<td>$8.00</td>
</tr>
<tr>
<td>11</td>
<td>INTRODUCTION TO ALGOL, by Ned Chapman.</td>
<td>Up-to-date explanation of the most widely-used computer language. Discusses basic symbols and expressions, and the construction of ALGOL programs.</td>
<td>$9.00</td>
</tr>
<tr>
<td>12</td>
<td>COMPUTERS AND THOUGHT, edited by Feigenbaum &amp; Feldman.</td>
<td>Twenty significant reports by leaders in the computer sciences on machines that think and their unlimited potential for science and industry.</td>
<td>$7.95</td>
</tr>
<tr>
<td>13</td>
<td>AUTOMATIC DATA-PROCESSING SYSTEMS, by Gregory &amp; Van Horn.</td>
<td>How to use these systems to make more effective, profitable business decisions. Covers all aspects of business data flow and control.</td>
<td>$14.35</td>
</tr>
<tr>
<td>14</td>
<td>APPLICATIONS OF DIGITAL COMPUTERS, edited by Freiberger &amp; Prager.</td>
<td>Timely report on new areas of computer application in the fields of mathematics, the sciences, business, and the professions.</td>
<td>$10.00</td>
</tr>
<tr>
<td>15</td>
<td>INFORMATION STORAGE AND RETRIEVAL, by Joseph Becker and K. M. Hayes.</td>
<td>Well-documented, detailed introduction to the field's theory and design, man-machine relationships, language data processing, many other topics.</td>
<td>$11.95</td>
</tr>
<tr>
<td>16</td>
<td>INFORMATION, COMPUTERS, AND SYSTEM DESIGN, by Ira O. &amp; Marthana E. Wilson.</td>
<td>A comprehensive book examining systems concepts in the light of information theory - and the roles people and information play in system design and operation.</td>
<td>$12.50</td>
</tr>
<tr>
<td>17</td>
<td>HUMAN BEHAVIOR, by Berson &amp; Sven.</td>
<td>The highly acclaimed, extraordinary &quot;introduction to people's behavior,&quot; scientifically substantiated facts about the way man behaves in vital experiences.</td>
<td>$11.00</td>
</tr>
<tr>
<td>18</td>
<td>SCHEDULE, COST, AND PROFIT CONTROL WITH PERT, by Robert W. Miller.</td>
<td>The first fully-rounded analysis of Program Evaluation and Review Technique (PERT), the most effective and widely applicable new planning and control system.</td>
<td>$8.50</td>
</tr>
</tbody>
</table>

Why not share in these advantages of membership in The Library of Computer and Information Sciences?

- Your choice of the most authoritative, most important books covering new frontiers in the computer and information sciences. Members receive free monthly reports describing books on data processing, systems design, operations research, information retrieval, and many other areas.
- A savings of up to 40% on all books (the most economical way to build a basic computer library).
- No fees or dues. Members need accept as few as three more Selections during the next twelve months - and they receive a free Bonus Book after every fourth book purchased.

(Membership offer counts as the first Selection.)

The Library of Computer and Information Sciences
59 Fourth Avenue / New York 10003

Membership Application

The Library of Computer
& Information Sciences
59 Fourth Avenue
New York 10003

Please enroll me as a member and send me at once the 3 Selections circled below, for which you will bill me only $4.95, plus postage. As a member, I need take as few as 3 more Selections during the next 12 months, always at reduced Member's prices. I will receive a free Bonus Book of my choice after every fourth Selection.

1 2 3 4 5 6 7 8 9
10 11 12 13 14 15 16 17 18

Name:
Address:
City State Zip Code:
L-C01 Please be sure to insert correct zip code.

April 1966

CIRCLE 84 ON READER CARD
Your incremental recorder should have these features:

- Stepper motor reliability
- Complete remote operation
- All silicon semi-conductors
- 300 step per second operation
- Binary zero to BCD 10 conversion
- Easy loading—completely visible co-planar reels
- Non-removable quick acting reel hubs
- 2½ million character capacity
- Extender card included

**Model 1400**

$3500 F.O.B. PASADENA

**Kennedy Co.**

275 N. Halstead Ave., Pasadena, Calif. 91109
(213) 681-9314

---

new products

tronics, has an 80-track storage capacity of 10-200K bits and a data rate of 200K bps. A 60-cycle power source provides speeds of 1800 or 3600 rpm and a maximum access time of 34 or 17 msec. A 400-cycle power source for higher speeds is also available. VERMONT RESEARCH CORP., Springfield, Vt. For information: CIRCLE 148 ON READER CARD

**Laboratory computers**

Micro-LINK II and III are integrated circuit systems designed primarily for use as laboratory or satellite computers. Both models offer 2K-32K word memories, in increments of 2K, but II has an 8-usec cycle time, and III has a 2-usec time. A full complement of peripherals, including oscilloscope, is included in each basic system. SPEAR INC., Waltham, Mass. For information: CIRCLE 147 ON READER CARD

**Computer room file**

Jumbo Spacefinder file is multipurpose unit suitable for a variety of office, data processing, and computer room materials. Storage compartments include tape reel rack and large-document bins. TAB PRODUCTS CO., San Francisco, Calif. For information: CIRCLE 148 ON READER CARD

**I.C. data on microfilm**

The Integrated Circuit Information Retrieval System has microfilmed specs on IC's offered by a specific industry, as well as all available application notes and price lists. It is updated every 60 days. Hardware is a tabletop selector. By pushbutton, user finds a descriptor card that shows location of every spec in the file fulfilling the description. He can search in any order of descriptors and determine which

---

**Who reads DATAMATION?**

A world-wide assortment of high-level decision-making technical professionals of the data processing field. If you sell a product or a service that is centered around this group — tell it where it will be read.

Tell it in DATAMATION

**The Magazine of Automatic Information Processing for Business & Science**

DATAMATION

An F. D. Thompson Publication

THE ONE PUBLICATION THAT SERVES THE WHOLE DATA PROCESSING FIELD

NEW YORK, 10017
141 East 44th St.

CHICAGO, 60606
205 W. Wacker Dr.

CLEVELAND, 44113
75 Public Square

LOS ANGELES, 90006
1830 W. Olympic Blvd.

MANCHESTER, N. H.
112 West Haven Rd.

LONDON
27 Baker St., London W.I.
There are all kinds of space-savers. The one on the left is called the TAPE-SEAL System. It takes the bugs out of tape storage and handling.

You get a lot more mileage out of a tape library with the Tape-Seal System*. This new system for storing and handling computer tape features a unique belt that is 45% narrower and 90% lighter than a canister. Because the belt hangs in storage, it doesn't need wire supports like a canister does. In the floor space you're now using to store 96 tapes in canisters, you can store 200 in Tape-Seal Belts. Handling? A breeze. Tape protection? Better than ever. Labelling? A real pleasure, for the first time. So write for complete details soon, won't you? Before tape storage problems drive you buggy.

(When you order new tapes, insist that they be shipped without canisters. Buy Tape-Seal Belts and save.)

*Patents Pending
are you paying more than $600 a month for computer tape handling?

Investigate the lower-cost, super-dependable IBM interchangeable.

Datamec D 3029 Tape Unit
(Interchangeable with IBM 729-II and 729-V)
$600 a month
Datamec D 2030 Tape Unit
(Interchangeable with IBM 7330)
$400 a month

Purchase Prices:
D 3029—$14,500
D 2030—$12,500

Make your own profit-saving move. Write Tom Tracy at Datamec, 345 Middlefield Road, Mountain View, California 94041. Better yet, phone Tom at (415) 968-7291.

new products

descriptors are excluding circuits he'd like to consider. ASCAM INC., Palo Alto, Calif. For information:
CIRCLE 149 ON READER CARD

control software
The Free-Time System package makes possible both off-line and on-line computations with the GE/PAC 4000 computer line. Placing a low priority on such functions as scientific calculations, inventory control, etc., it enables these to run on a time-shared basis while the machine controls a process. G.E. PROCESS COMPUTER BUSINESS SECTION, Phoenix, Ariz. For information:
CIRCLE 150 ON READER CARD

data cell holders
Line of dp accessories to hold data-cell cartridges, which must be kept upright even when removed from the drive, includes a carrying case for up to three cells plus a tape or notebook; rolling cart that holds five cells, tapes, disc packs; other carts with capacities up to 40 cells; and library fixtures holding multiples of 10. LUNDE LUGGERS, Granada Hills, Calif. For information:
CIRCLE 151 ON READER CARD

tape drive
The model SC-1080 operates bidirectionally at 150 ips, 800-bpi NRZ or 1600-bpi phase-modulated recording. It is 7- or 9-channel (IBM 729 and 360/2400 or ASCII) compatible. A single-capstan transport, it loads automatically once tape is threaded directly from the supply to the take-up reel. No pinch rollers, valves, guide rollers or air guides are used. POTTER INSTRUMENT CO. INC., Plainview, N.Y. For information:
CIRCLE 152 ON READER CARD

automatic tester
Using paper tape for the program data, the 9400 can be used for a variety of tasks by changing the tape. Results of a test, such as out-of-tolerance conditions, can be programmed to automatically stop or modify the test. Front panel keyboard allows manual insertion of data. The basic system consists of a digital voltmeter or multimeter, input scanner, tape reader, and data control unit. AUTO-DATA INC., San Diego, Calif. For information:
CIRCLE 153 ON READER CARD

Looking for a better high speed commercial tape reader . . . ?

here's a 1000 char/sec tape reader at better than competitive prices.

and a spooler that revinds at 2000 char/sec.

The 4002 Tape Reader has a free run speed of 1000 char/sec and will stop before the next character at this speed. It is available in a rack mounted or desk top version. The 4003 Tape Spooler stores 1000 feet of Paper Tape and is suitable for 19" rack mounting to RETMA standards.

The units can be purchased separately or as a combination. For information on logic, speed and other options wire, write, or phone.

FERRANTI-PACKARD ELECTRIC LIMITED
ELECTRONICS DIVISION
Industry Street
Toronto 15, Ontario, Canada
Area Code 416 762-3681

DATAMATION
THE FREE ENTERPRISE PATRIOT

By JOHN RICKEY

In humorous satire that bites without bitterness, author John Rickey recounts the cannon building adventures of a colonial blacksmith faced with the red tape frustrations of today's defense contractors. First serialized in Research/Development magazine and now in its second printing, the "Patriot" rings with the author's knowledge of industry-government relationships.

☆ SOLD ONLY BY MAIL ☆
Send $1.50 per copy (cash with order) to Dept. FEP, F. D. Thompson Publications, 205 W. Wacker Drive, Chicago, Illinois 60606.

TAKE 1500 MICE TO LUNCH.

It takes $10.00 to feed and care for 1,500 mice each day, in research laboratories throughout the country. Mice are used in experiments which are looking for answers to cancer's riddles. Is cancer virus-caused? Can drugs be developed to cure it? To prevent it?

These and other questions will be answered...if you care enough. Support the research attack on cancer by a check to your Unit of the American Cancer Society. Fight cancer, too, with a health checkup once a year. It's your best insurance against cancer.

American Cancer Society

April 1966

COMPUTER PROGRAMMERS
We're going to the top and we're looking for top people to help us get there.

Now that the ITT Data Processing Center has been established as ITT Data Services -- a separate Division of International Telephone and Telegraph Corporation -- we're out for bear. While our growth over the past few years has been impressive, we're not planning on resting on our laurels. We're not going to spare any effort in moving into the top spot in commercial data processing services in addition to handling programming and systems analysis for government customers.

One of our most challenging programs is under way at Virginia Beach, Virginia (incidentally, a top vacation area) where we are engaged on large-scale computer systems and programs for the Navy Tactical Data System.

These positions provide an opportunity for candidates interested in gaining experience in the field of command/control systems, real time programming. Applicants should have meaningful programming experience on large scale digital computers, preferably in Engineering/Scientific discipline. Programmers who have had significant large scale Commercial or Business oriented programming experience are also invited to apply. Real time experience and knowledge of high level languages desirable.

For immediate consideration, please rush your resume now to Mr. David Schindler, ITT Data Services, FAAWT, Fleet Computer Programming Center, Virginia Beach, Virginia.

ITT DATA SERVICES
A Division of INTERNATIONAL TELEPHONE and TELEGRAPH CORPORATION
An Equal Opportunity Employer (M&F)
Most computer-room floors have to be swept, scrubbed, waxed, polished, buffed, stripped, and reconditioned.

Perma-Kleen® has to be mopped. Period.

Considering a solid vinyl or rubber floor for your computer room? Then you better read that little book.
You know, the book that tells how to prepare these surfaces for cleaning—how to mix all those fancy cleaning solutions—how to buff and polish.
And don’t skip the section on approved cleaners—the ones that won’t harm vinyl or rubber.
Then, after you’ve finished reading, figure out how much all this maintenance is going to cost for a year.
If it’s a lot (and it will be), better send for our little book.
You know, the one that tells why Perma-Kleen laminated plastic floor tile doesn’t have to be swept, scrubbed, waxed, polished, buffed, stripped, or reconditioned.
For our little book, write to General Electric Company, Department 12, Coshocton, Ohio 43812.

DECORATIVE SURFACING
GENERAL ELECTRIC
new literature

TAPE RECORDING HEADS: 10-page catalogue lists three types of heads offered by manufacturer, including erase heads, record/playback heads, and combination heads that record, playback and erase. 24 basic heads are illustrated. MICHIGAN MAGNETICS, Vermontville, Mich. For copy: CIRCLE 154 ON READER CARD

DATA CONDITIONING SYSTEM: Eight-page brochure features description of system that uses analog input and digital output and consists of compatible off-the-shelf modules. Systems may also incorporate high-level and low-level commutation or may combine the two. Brochure shows diagrams of low, high and high-low switching and lists system specifications. BECKMAN INSTRUMENTS INC., Fullerton, Calif. For copy: CIRCLE 155 ON READER CARD

ANALOG COMPUTERS: 12-page booklet describes basic principles of analog computation and explains problem-solving technique that can be used to increase engineering efficiency. Several types of computer modules are described, and sample problems are stated and solved. ELECTRONIC ASSOCIATES INC., West Long Branch, N.J. For copy: CIRCLE 156 ON READER CARD


PUNCHED TAPE READERS: 12-page brochure covers specifications and applications of SBR-642 and 5100 series; gives definitions, punched tape dimensions and coding standards; and shows handlers/spoolers and tape-length chart. CHALCO ENGINEERING CORP., Gardena, Calif. For copy: CIRCLE 157 ON READER CARD

CIRCUIT TECHNOLOGY: 20-page brochure describes Solid Logic Technology (SLT), used in IBM computers. Included are sections on circuits, explanations of the concept, chip and module and circuit packaging techniques. IBM CORP., Hopewell Junction, N.Y. For copy: CIRCLE 158 ON READER CARD

DATA COMMUNICATIONS SYSTEM: How terminal equipment is being used in a variety of different data communications systems is described in 10-page brochure. Included are systems in use for billing, ordering and distributing, centralized accounting operations and inventory control. Examples include businesses from food processing and drug manufacturing to steel production, investment banking, trucking and electricity. TELETYPER CORP., Skokie, Ill. For copy: CIRCLE 159 ON READER CARD

FUNCTION MODULES: 12-page bulletin describes function modules and their use in control systems. Also included are general specifications for over 30 encapsulated analog function modules and descriptions of controllers, recorders, transmitters, preamplifiers, and computers which utilize modules. CONSOLIDATED ELECTRO/NAMICS CORP., Pasadena, Calif. For copy: CIRCLE 160 ON READER CARD

MANUFACTURING CONTROL: Four-page booklet covers descriptions of inventory control methods, linear pro-

ON-LINE
Machine Language
Data Acquisition
Process Control
Optimization

OFF-LINE
Management Information
Supervisory Control
Process Models
Fortran

This jargon describes some of the disciplines that are employed with our expanding COMPUTER AUTOMATION activities. Our technical effort is directed toward broader developments that offer challenge and growth opportunities.

We have positions for SENIOR PROGRAMMERS and PROGRAMMER-ENGINEERS, who are creative, imaginative, have leadership qualities, broad experience and systems orientation.

Positions in New York and other locations throughout the country.

Submit confidential resumes to Department 3208.

SOCONY MOBIL OIL COMPANY, INC.
150 East 42nd Street New York, New York 10017
An equal opportunity employer / A Plans for Progress Company
CIRCLE 90 ON READER CARD

April 1966
let yourself grow

at NCR's expanding electronics division in los angeles

Your digital-systems career can blossom now at NCR. By early next year the fast-growing Electronics Division, already the largest commercial computer facility in Southern California, will more than double its present size. The reasons: rapid, worldwide acceptance of NCR systems and a record backlog. Incoming computer orders during 1965 climbed 85 per cent over the 1964 level and for the first time passed the $100,000,000.00 mark. Sales of NCR 315 systems in 1965 were more than twice those of the previous year. NCR means business—not someday, but now. How about putting your future in the present tense?
new literature

programming, discrete production resource allocation, stochastic simulation, data collection, user benefits and services associated with the total system approach. MCDONNELL AUTOMATION CENTER, St. Louis, Mo. For copy: CIRCLE 165 ON READER CARD

PRESET COUNTER: Two-page bulletin describes model PR-40, which is lightweight, small size, built with integrated circuits. Single or dual channel models may be used in industrial counting, batching and measuring applications with photoelectric, magnetic, or other transducers. Counting speeds from dc to 1-megacycle. UNITED COMPUTER CO., Tempe, Ariz. For copy: CIRCLE 162 ON READER CARD

INDUSTRIAL COMPUTER SYSTEM: 12-page booklet illustrates how PCP 88 computers are used in master-slave relationship. Explained are parallel cascade processing, how the control system operates and is programmed, and how the supervisory computer functions. Center spread shows four compatible system configurations. THE FOXBORO CO., Foxboro, Mass. For copy: CIRCLE 163 ON READER CARD


CONTROLLED COMPUTER ROOM SYSTEMS: Four-page booklet illustrates and describes environment and operating cooling systems designed for computer rooms in banks, laboratories, hospitals and other commercial and industrial buildings. General specifications and data are listed. BLAZER CORP., East Rutherford, N.J. For copy: CIRCLE 164 ON READER CARD

VIDEOFILE DOCUMENT STORAGE & RETRIEVAL SYSTEM: 12-page booklet explains the concept of recording document images on mag tape, and covers frame size, recording a document, organizing the file, ordered and random filing, updating and file expansion, videofile system modules, and features a flow chart of document filing and retrieving. Remote stations and uses of videofile system are also included. AMPEX CORP., Redwood City, Calif. For copy: CIRCLE 165 ON READER CARD

CORE TEST JIG: Bulletin describes model 4031, which makes possible analysis of switching ferrite memory cores of 20, 30 and 50 mil size. Jig provides identical test circuit conditions, assuring repeatability of test results and accurate analysis of core performance. Included also are schematic diagram of the circuit and electrical specifications. COMPUTER TEST CORP., Cherry Hill, N.J. For copy: CIRCLE 166 ON READER CARD

DIGITAL PLOTTING SYSTEM: 16-page booklet summarizes digital incremental plotting system and presents pertinent points of consideration in evolution of plotting systems. Comparative specifications and the available equipment are included. CALIFORNIA COMPUTER PRODUCTS, INC., Anaheim, Calif. For copy: CIRCLE 167 ON READER CARD

ODP COUPONS: Six-page pamphlet provides description of original document processing coupon system. Flow charts show how payments are processed and chart compares this system with punch card and micro books. CUMMINS-CHICAGO CORP., Chicago, Ill. For copy: CIRCLE 168 ON READER CARD

MAG TAPE UNIT: Tape transports feature a servo-controlled single-cupstan drive mechanism that eliminates tape wear and dynamic skew associated with pinch roller mechanisms. Six-page brochure describes two available standard versions: Model 95461 and 95462, and lists features and general specifications and describes control panels. SCIENTIFIC DATA SYSTEMS, Santa Monica, Calif. For copy: CIRCLE 169 ON READER CARD

ANALOG INDUSTRIAL CONTROL SYSTEMS: Introductory section of 16-page catalog presents principles of operations with schematics of materials and fluids processing systems. Separate sections present descriptions and photography of eight physical presence sensors and matched components available to transmit, amplify, receive, record, track and control process signals from the sensor and to initiate corrective action. INDUSTRIAL CONTROLS DIV., GENERAL PRECISION, INC., Morton Grove, Ill. For copy: CIRCLE 170 ON READER CARD

digital systems

opportunities at NCR electronics division

The National Cash Register Company

NCR

ELECTRONICS DIVISION
2837 W. El Segundo Blvd. Hawthorne, Calif.
Telephone: Area Code (213) 757-5111
An equal opportunity employer

CIRCLE 91 ON READER CARD

April 1966
NEW PROGRAMMER CARD PUNCH SAVES TIME

WRIGHT PUNCH MODEL 2600

• Precision desk-top model simple to use.
• Lets you make computer corrections on the spot.
• Handles 80-column-and-shorter cards.
• Does not duplicate or print.
• Only $159 for accurate recording.

SEND NOW FOR COMPLETE DETAILS

Wright LINE
DATA PROCESSING ACCESSORIES
170 GOLD STAR BOULEVARD, WORCESTER, MASS. 01606
A division of Barry Wright Corporation

FREE! CAREER OPPORTUNITIES BULLETIN

A complete and comprehensive listing of outstanding positions at salaries from $6,000 to $30,000 with National Companies for:

ENGINEERS / DATA PROCESSING

Our professional staff combines Customized Service with technical know how to insure for you maximum career development in the following areas:

• LOGIC DESIGN
• CIRCUIT DESIGN
• SYSTEMS DESIGN
• SYSTEMS ENGINEERS
• OPERATIONS RESEARCH
• PROGRAMMING
• PROCESS CONTROL
• APPLICATIONS PROGRAMMERS
• SYSTEMS PROGRAMMERS
• INFORMATION RETRIEVAL
• MATH ANALYSIS
• MANUFACTURING

No charge to you for our custom service. Employers pay our fee. Expedite your development by sending resume in confidence with present salary & geographic preference to:

La Salle Associates
Professional Search Dept.
2136 Locust Street, Philadelphia, Pa. 19103

For your free bulletin without any obligation, circle subscriber service card. Please use home address only.

PROGRAMMER

... one who wants professional growth and advancement with one of the country's leading research institutions

THE LAWRENCE RADIATION LABORATORY of the University of California offers an exceptional opportunity to a programmer with these qualifications:

Education:  ■ B.S. or M.S. in Mathematics or Physical Science.
Experience: ■ Minimum of two years' experience with scientific computations on large tape computers.
Responsibilities: ■ Programming for bubble and spark chamber data processing systems employing specially designed input hardware together with IBM 7090/7094 computers in a sophisticated, real-time scientific data processing environment. You will be expected to demonstrate initiative and responsibility as a member of the team that formulates these systems and puts them to work.
Location:  ■ Berkeley, California, in the San Francisco Bay Area.

SEND YOUR RESUME TODAY... AIR MAIL TO
Mr. R. E. Mortiboy

LAWRENCE RADIATION LABORATORY
University of California
Berkeley, California 94720
An Equal Opportunity Employer
Fast-fading from the grasp of mainframe, communications and defense systems manufacturers is the $300 million NATO air defense and ground environment system, NADGE. On two counts this scheme looks to be coming apart at the seams. First hitch is contract price, and the second came with de Gaulle's threat to take France out of NATO. Bids were due in the fall of '65, but late specs by the NADGE Management Office caused a delay until January.

Three consortia bid, as forecast earlier here, with ITT, Westinghouse, and Hughes as primes. All are understood to have included letters stating that the full project (a computer-based defense line covering nine countries from Norway to Turkey) would demand an additional $100 million. Already stretched financially, the management office considered either cutting one country from the network or reducing the system capability. Proposals to drop Turkey were unacceptable; the result: a reduction in the long distance radar scan capability to bring costs down to original estimates.

No sooner had this been settled than the "de Gaulle bombshell" dropped amidst already harassed bidders. Problem is whether to continue NADGE for the eight other countries, and also whether to re-form members of the consortia. These had been diplomatically agreed, with French, German, and British membership included so that the European countries contributing substantially to NATO funds received business roughly proportional to their defense payments.

Further ramifications of this mess are likely effects on firms specifically chasing the strategic markets. Paris has become a natural base for this activity with its SHAPE and NATO offices. France, for example, is the only extra-United States territory where IBM maintains a Federal Systems Div. to serve Europe. Others are in the same boat and may perform a move if France goes ahead and contracts out of NATO.

Defense is also a major issue in Britain right now. The government's budget for 1966-67 of $6.5 billion is a part of a drastic reshaping of the country's policies. But implementation depends on a return to power of the Socialistic administration after March 31 elections. On this eve of the election, political pollsters are computer processing their samples and forecasting a runaway victory for the incumbents.

Changes in defense, under Prime Minister Wilson, bring in a new fleet of cruisers with computer-based weapons systems. To be equipped with the Royal Navy's ADA (Action Data Automation), this will bring several multiple-processor contracts for real-time machines. Ferranti is tipped as a likely contract winner with its Hermes computer. This is the CPU end of a complex similar to one Ferranti installed in Britain's aircraft carrier Eagle. A second-generation Poseidon was used in the Eagle. Its successor, Hermes, is a more compact machine.

(Continued on page 151)
Ever tried programming your future?

Sorry. Not even an IBM computer can do that yet—there are too many variables, too many unknowns. The point is, your future is up to you.

That's why you owe it to yourself to look at these points:

- IBM is the leader in the major growth industry—information processing and control.
- Programmers work closely with hardware designers.
- They are continually exposed to all the aspects of advanced programming.
- They have the chance to grow within the company, to take on new responsibilities.
- They realize all the accompanying rewards, both professionally and personally.

If you're a concerned, go-places programmer, this data could be an important factor in your "master program" for the future. Consider these points of fact. Then consider the many diversified career opportunities available at IBM's Federal Systems Division in Bethesda, Maryland, in the areas listed: Real-Time Scientific Systems, Information-Retrieval Systems, Management Information Systems, Research.

These positions require a B.S. or B.A. degree or equivalent, and at least one year's experience in information handling or programming.

To obtain more information about your future chances with IBM, write, outlining your experience, to: Mr. J. B. Farrington, Dept. 701R, IBM Federal Systems Center, Federal Systems Division, 7220 Wisconsin Avenue, Bethesda, Maryland.

It's your future.

An Equal Opportunity Employer (M/F)
According to a Navy systems designer, ADA has some advantages over the comparable U.S. NTDS. However, Poseidon handled logistics for administration as well as fire and command procedures. Implementing an operating system caused considerable delay to the software teams. Approximately $100 million has been budgeted for ADA equipment and extensions to the national air traffic control complex. Major computer contracts for the latter have gone to Plessey, with smaller ones to Ferranti and Marconi. Also mentioned in the defense estimates is "a special study of future defense requirements for on-line data processing equipment, with the intention of drawing up a spec for a family of computers to meet the bulk of these needs."

What is believed to be the first full-time and local authority-sponsored school for data processing is planned for Boeblingen near Stuttgart, Germany. Of the $450,000 capital building cost, 80% is to be shouldered by the local department of education. Due for opening in 1967-68, the school will take 100 high school graduates in the 18-19 age group. 50% of the education in a 32-hour week will be in computers, the rest will be in general subjects such as languages and math. Intended to beat a possible shortage of up to 100,000 personnel by the mid-'70s, the school may be a fore-runner of others in major German cities.

German salesmen unable to replace 1004's and 1005's say users are awaiting an early or late-summer Univac announcement. Supposedly, the machine will rent for upwards of $1K/month, is 360-compatible up to the mod 40, and features a 2-usec plated wire memory. Processors are said to be upgraded by a turn of a console knob, which "unmasks" surplus store, and have up to a million low-cost, plated-wire bits.

Bull-GE has topped the 1,000 mark with orders for the Gamma 10, a $65K-plus card computer. Introduced prior to GE's takeover of the French firm, more than 500 have been delivered. ... The European Computer Manufacturers Assn. has formed a PL/I committee, TC 10. Most major European firms are represented in the 13-man group. ... London pundits figure either RCA, Univac or GE will be first with a PL/I compiler; IBM is a long shot. ... Britain's General Electric Co. (no relation) will make and market the Sigma 7 under an SDS license. ... Japan's Electronic Industries Assn. is reported to have forced Osaka Univ. to refuse an IBM 7090 donation and take a Nippon Electric 2200-500. Reason: Buy Japanese. In Europe, IBM has successfully given 90's to five key universities, accompanied by research endowments for post-graduates. ... After only two years with its IBM 1410 seat reservation system, Scandinavian Airlines approaches capacity. Consideration is being given to a new system in 1968. ... Delays in 360 deliveries reportedly has the U.K.'s Martins Bank, with five on order, looking elsewhere. In France, Shell Oil is awaiting its mod 65; the European trend-setter, though, is also shopping around.
today's information for tomorrow's products
an operations research approach

By George K. Chacko, The MITRE Corporation

Here is a brand new, Space Age treatment of one of the oldest problems faced by management—that of decision-making. Dr. Chacko, a staff member of the renowned MITRE Corporation—holds that insight into interrelationships is the essence of decision-making; that information for the decision-maker can be systematized to a great extent so that the decision-maker can be more readily aware of the missing links in his information structure.

TODAY'S INFORMATION FOR TOMORROW'S PRODUCTS deals with operations research rather than with an assortment of mathematical techniques about information handling. It is concerned with strategies of policy instead of with techniques of suboptimization. Drawing its illustrations and case histories from real life, the book develops an integrated way of looking at widely varying entities that enter into decision-making with respect to tomorrow's products—consumer products, durable goods, weapons systems, space technology and hardware, and services of all types. Employing only a bare minimum of mathematics, TODAY'S INFORMATION FOR TOMORROW'S PRODUCTS will be of interest to all persons working in management research and operations, as well as to graduate and undergraduate students in these and related fields. Theory and practice are expertly blended in this highly lucid and engaging work by an international expert.

INTRODUCTION: At Stake—Survival

Part I: Perspective of Organism
1. Orientation to Operations Research
2. Ordering of Objectives

Part II: Principle of Potential
3. Technological Feasibility Basis of Research Planning
4. From Idea to Output: Process, Decisions

Part III: Processing of Information
5. Processing Current Information to Produce Potential Products: Periodic Table of Product Diversification
6. Central Intelligence Retrieval System

Part IV: Philosophy of Allocation
7. Concomitant Conditions in Business Bargaining: With and Against the Same Players
8. Committing Today's Reserves to Tomorrow's Hopes

TEXT LOGICALLY DIVIDED INTO THESE FOUR PARTS

PART I—surveys the perspective of operations research in practical situations, leading to development of a consistent set of objectives for corporations, government, military establishments, institutions of all types. Operational levels of decisions are identified and related to overall objectives.

PART II—develops feasibility considerations from technological point of view which enter into pursuit of objectives covered in Part I. Again, management decisions required to develop ideas into actual outputs are identified, clarified, and related to specific problems.

PART III—considers the ordering of information from within and from without, and the drawing of implications from such information for the scrutiny of the decision-maker. Two new concepts have been developed here for the first time—PTPD, or Periodic Table of Product Diversification, and CIRS, Central Intelligence Retrieval System. Both these new concepts provide new insights into potential and present outputs.

PART IV—discusses the philosophy of information usage, presenting still another new concept—Concomitant Coalitions—and explores the implications of this concept for committing today's resources to tomorrow's plans and hopes. Throughout the book the importance of policy strategies is constantly stressed, utilizing the technique of analogy.

Examine this book FREE for 30 days . . .

THOMPSON BOOK COMPANY
National Press Building • Washington, D.C. 20004
WOULD YOU BELIEVE

we have the career opportunity you have been searching for? Applications which reach from Wall Street to Madison Avenue, from the Classroom to the Launching Pad, from the Bank to the Hardware Manufacturer.

CTI is an aggressive, fast-growing, dynamic young company with openings for like-minded SYSTEMS ANALYSTS and PROGRAMMERS.

These are permanent, career-building positions working on some of the most interesting and rewarding projects in the industry.

If you do believe, send your resume for thorough consideration by S. R. BUTTON.

COMPUTING TECHNOLOGY INCORPORATED
P. O. BOX 803 • TUXEDO, N. Y. • (914) 351-4719

We'll be interviewing at the SJCC Systems Software LINKS MAN AND MACHINE

an equal opportunity employer

April 1966
CIRCLE 95 ON READER CARD
New scientific research laboratory for high energy particle physics, located on Stanford University Campus, has openings for high level professional programmers in the following areas.

**ENGINEERING AND PHYSICS APPLICATIONS**

Responsibilities will include generation of computer methods, development of programs for analysis of experimental data, engineering calculations in the design of experimental devices, theoretical model calculations, and other similar assignments.

Qualified applicants will have a Master's Degree in Computer Science, Mathematics, Statistics, or Physics; or a Bachelor's of Science Degree with appropriate experience.

**PROGRAMMING SYSTEMS**

Responsibilities will include the development of real-time analysis and control programs, advanced assembly routines, special purpose compilers, and system simulators.

Qualified applicants will have a Master's Degree in Computer Science, or equivalent, with appropriate experience.

In addition to the opportunity to be associated with a new laboratory that will be an international center for high energy particle physics research, the above positions offer the many benefits available to career professional employees of Stanford University.

If you have education and experience in one or more of the areas mentioned above, you are invited to address your résumé to G. F. Renner, Professional Employment Manager, Stanford Linear Accelerator Center, P.O. Box 4349, Stanford, California.

**STANFORD LINEAR ACCELERATOR CENTER**

An Equal Opportunity Employer
GOVERNMENT STUDY DEALS WITH COMPUTER LEASERS

Fortress IBM, under siege once again; the General Accounting Office, in a recent ruling, gave a qualified OK to a procurement procedure whereby independent leasing companies could take title to government-leased dp equipment, exercise the purchase option, and lease it back. Result would be substantially lower long-haul rentals for the user agencies, and a stifling of long-lucrative IBM lease revenues. The General Service Administration is currently conducting a census of equipment that might profitably be given such procurement treatment (or purchased outright by the government through the revolving fund authorized in the recently-enacted Brooks Bill).

Big money is involved. Currently the government is forking over almost $300 million annually for tab and computer rentals, most of this going to IBM. Having observed private concerns achieve good-sized savings through the purchase-leaseback procedure — 20% in some cases — GSA feels the same thing can be done in the government. IBM has not yet made known any official reaction to the new GSA tack; but it's a good bet some deep thinking is now going on in the appropriate executive suites. IBM's acquiescence is needed to implement the purchase-leaseback technique via lease companies, at least so thinks GAO. Since IBM contracts with the government contain a "non-assignable" clause on leased equipment, leasing companies can be designated as "agents" of the government only if IBM agrees, GAO believes. "If ... responsible officials of IBM (i.e., those who have authority to waive contract provisions such as involved here) have been or are contacted and agree to the proposed procedure ... we will interpose no legal objection to such procedure," wrote acting Comptroller General Frank Weitzel to GSA chief, Lawson Knott. Weitzel noted pointedly that no such indication has yet been forthcoming. Other government execs believe, however, IBM will not stand in the way of procurement procedures which have become standard practice in private industry for fear of antagonizing its number one customer.

FULL-TIME DP NEGOTIATORS ARE IN GSA FUTURE

In another move to streamline government dp procurement procedures, GSA has requested, and the Budget Bureau has blessed, funds in fiscal 1967 for a roving team of dp contract negotiators to "assist" civilian agencies strike better dicker with manufacturers for their goodies. Currently, these negotiations are conducted solely by agency personnel within the framework of the Federal Supply Schedules and BOB guidelines. GSA, feeling much more muscular since passage of the Brooks Bill, believes the civilian agencies would strike better deals if they draw upon the services of a full-time expert staff, rather than rely just upon the FSS and the knowledge

(Continued on page 157)
the surprising role of programming at Xerox

or

(how to quietly put your skills to work on the mainstream of some very unusual corporate and scientific problem-solving...decidedly upstream.)

The first surprise generally comes with the comment that throughout the corporation's many operating divisions, as well as within the more centralized business and scientific computing groups, Xerox already employs a healthy number of programmers (upwards of 100). Not neophytes. And we have ample room for more. Also not neophytes.

The second surprise surrounds the kind of work we'll invite you to do, and the way we encourage you to do it.

To begin with, we've toppled the concept that a lot of people have—that computers are merely data processing machines, no matter how wondrous. We've had the good fortune to participate in (maybe precipitate) a thorough organizational awakening to the fact that a computer in a scientific environment should be used to enhance the insights of scientists and engineers—not just be used to process a problem they may have. And the same goes for non-technical, decision-making management.

If these be platitudes, they're platitudes in action.

And so you'll find many of our "programmers" acting as consultants to managers of fundamental and applied research, advertising, marketing, manufacturing, finance, etc.

This is not routine programming. And a routine programmer wouldn't be up to it.

In addition, there's some interesting work in progress on time-sharing systems. The software aspect is a challenge all its own.

You'll find enough modern EDP equipment here so that your creativity isn't likely to be inhibited by a lack of hardware. To give you a few examples, we've recently installed a 7044 at our Scientific Computing Center. Then there are two 7010s sharing almost a billion characters of random access storage, supported by 1460s and 1401s, all in one of our installations.

One last possible surprise. If you thought Xerox was in the office copier business, you were not entirely correct. This will be more apparent when you visit us and we discuss your approach to problem-recognition in fields like optical technology, laser studies, behavioral science, remote imaging, and a few additional subjects that are peculiarly relevant to the real business of Xerox—graphic communications.

Most, but not all, of these positions are in Rochester, New York. Send your resume, in confidence to Mr. David E. Chambers, Dept. YVD-119, Xerox Corporation, P.O. Box 1540, Rochester, New York 14603.

An Equal Opportunity Employer (M&F)

NOTE: Xerox will conduct Boston Interviews (April 26-28, 1966) during Spring Joint Computer Conference. Please check the local papers for details at that time.
acquired in their once-in-a-while procurements. The
new team of negotiators, to be located in the GSA HQ
procurement group, will concern itself principally
with the larger dp procurements, attempt to put
together multi-system deals involving several agencies.
This approach hopefully will enable the Government to
take better advantage of its burgeoning potential,
cut some of the fat out of computer procurements.
Undoubtedly, these helpful negotiators will again pose
for the line agencies the spectre of "big brother"
control over their dp operations.

The high cost of transmitting data in a long-distance
time-sharing hookup was one of the subjects under
scrutiny in hearings held recently by the House Small
Business subcommittee. Gist of the complaint was that
present AT&T rates, the same as are assessed for long­
distance phone calls, are not reflective of actual
costs and are repressive of a promising new industry.
AT&T's side of the story will be heard at a future
session. Back at the FCC, where a general
investigation of Ma Bell's pricing structure is under
way, no sense of urgency on time-sharing rates can be
discerned. The results of the present study are not
likely to be ready for two years, if then. The only
hope for a sooner relief, according to an FCC official,
would be AT&T's voluntary lowering of these rates if its
execs felt themselves being cornered. 'That's one of the
best ways to take the heat off something like this,' he said, "... it's occasionally happened in the past."

Strong pressures are being placed on the Commerce
Dept. and the executive branch in general to ease the
rules proscribing shipment of computers to Eastern
Europe and the Soviet Union. In the next several
years, it's reasoned, installation of third-generation
equipment will throw scads of second-generation
computers out of work, but this still-sophisticated
gear can readily find homes overseas because of a
still-lengthy useful life.

Better trade relations with the communist bloc
is a plank in the Johnson platform, and some
manufacturers point to the growing commerce in
computers between the Reds and Western European
nations, a market that might forever be denied the
U.S. unless open trading is permitted. On the other
hand, the administration is mindful of its role as
leader of the Western military alliance.

A possible denouement might be the relaxation of
embargoes on computers of "demonstrably civilian use," according to a top Commerce official, as a step to
be taken in conjunction with the 15 other nations
subscribing to the COCOM listings. The effort would
still be made to hold back sale of any computers which
might be construed as being of military use. It's
admitted, however, the distinction between civilian and
military use would be hard to maintain on computers
once they have slipped behind the Iron Curtain.
ENGINEERS AND PROGRAMMERS
GROW WITH LOCKHEED IN HOUSTON

Immediate opportunities for personal and career growth are now available with our expanding organization in Houston, Texas. New long-term programs at the NASA/Manned Spacecraft Center require individuals with experience in the following specialties:

- Scientific Programming
- Business Programming
- Programming Analysts
- Hybrid Specialists
- Solid State Circuitry
- Instrumentation
- Telemetry
- R. F. Systems
- Guidance and Control
- Simulation
- Analog Programming
- Optics
- Radar Systems
- Antenna Design
- Flight Test
- Data Analysis

You are invited to submit your resume in strict confidence to the Employment Manager.

LOCKHEED ELECTRONICS COMPANY
A Division of Lockheed Aircraft Corporation
16811 El Camino Real, Houston, Texas
An Equal Opportunity Employer

BOSTON - EDP
$7000 - $18,000

Perspective, Boston’s leader in professional placement of computer personnel has many outstanding growth opportunities with all of the major EDP companies on a local and national basis. Immediate positions are available in mathematics, programming, systems design. Experience should be a minimum of one year in either commercial and/or scientific computers.

Programmers  Mathematicians  Manufacturing
Sales/Marketing  Circuit Design

Our staff of professional employment counselors, specialists in the scientific, engineering, and commercial computer fields, will arrange suitable interviews and be available at all times for follow-up consultation until you have located a new position. CALL, VISIT or send your resume in complete confidence.

Client companies assume all costs
FREE RESUME SERVICE

PERSPECTIVE
A Professional Placement Organization
TEN KEARNEY RD., NEEDHAM HTS., MASS.
Highland Ave., Exit 50W off Rte. 128 (Merr Bldg.)
Phone 444-7113

CIRCLE 97 ON READER CARD

CIRCLE 98 ON READER CARD

CIRCLE 99 ON READER CARD
Investigate these opportunities for your personal growth and success

Control Data is growing rapidly. The number of people now employed is 5 times what it was in 1963. We have grown by giving our employees exceptional freedom to develop and reach their full potential. They enjoy a strong measure of personal success based on the unprecedented growth of the corporation.

If you would like to be a member of one of the fastest growing teams in the business world, then talk to us at Control Data. Our continuing success is creating opportunities which may be the beginning of your personal good fortune.

Check these career opportunities and air mail us your resume. Interviews arranged at Employment Centers around the nation.

SYSTEMS PROGRAMMER ANALYSTS: New application areas for high-speed digital computers and programming systems. Positions require varied backgrounds in command and control, real-time, monitor systems and knowledge of scientific programming languages. A degree in math, physics or engineering and 3 years' experience required.

PROGRAMMER ANALYSTS: Analyze Data Center Customer problems for customer's computer applications. Also entails work in sales support and the preparation of programming proposals. Experience on large-scale machines in either commercial or scientific programming is necessary.

PRODUCTION ENGINEERS: These positions involve production and pre-production functions in a Computer Manufacturing environment. Openings exist at all levels and require a degree in Mechanical, Industrial or Electrical Engineering.

CHECK-OUT ENGINEERS: Positions involve working in computer check-out. An excellent opportunity to learn the intricacies of large scale computer systems. Positions require a BS degree in Electrical Engineering and 0 to 3 years experience.

QUALITY ASSURANCE ENGINEERS: Openings exist in the areas of test equipment design and component engineering. Positions require a B.S. degree in Electrical or Mechanical Engineering and 1 to 5 years' experience.

MECHANICAL ENGINEERS: Openings require a B.S. degree in Mechanical Engineering with refrigeration or air conditioning orientation, to work at a customer site. Responsibility for assisting in air conditioning design, power requirements, installation of large computer systems, project administration and plant layout.

PRODUCTION ENGINEERS—I/O EQUIPMENT: Responsible for the fabrication and producibility of electro-mechanical I/O equipment. At least 2 years' experience required plus a BSEE, BSIE, or BSME degree.

I/O DESIGN ENGINEERS: Logic and circuit design of I/O devices for computer systems. BSEE degree plus at least 2 years' experience. Experience in power supply, servomechanisms, or control circuits design desirable.

MECHANICAL ENGINEERS: Design of small precision mechanisms for electro-mechanical peripheral equipment. BSME and at least 2 years experience preferred.

If you are planning to attend the SJCC in Boston April 26-28, contact Control Data representatives during the conference for information on other opportunities.
### SENIOR PROGRAMMERS

**LEEDS & NORTHRUP COMPANY**

... is supplying large computer control systems for automation of industrial processes such as electric power, steam power, basic oxygen furnaces and cement plants.

**YOU OWE IT TO YOURSELF TO FIND OUT MORE**

- **YOU OWE IT TO YOURSELF TO FIND OUT MORE**
  - if ... you want to work in a field that today offers the greatest challenges to top flight programmers — You want a varied fare in your day to day activities — You want to push back the frontiers of programming science in the most rapidly expanding field of computer application.
  - **AND**
    - if ... you want to work with a recognized leader in process automation — a dynamic and growing company — a company that prides itself on providing reward commensurate with results — an organization that is noted for technical excellence.
  - **AND**
    - if ... you have 3 to 6 years programming experience — extensive experience with assemblers - a working knowledge of procedural languages, interpreters, and list processors — the desire and ability to create.

---

**LEEDS & NORTHRUP**

Pioneers in Precision Instruments — Automatic Controls — Computer Systems

4911 Stanton Avenue, Philadelphia, Pa. 19144

An Equal Opportunity Employer/Males & Females

---

### PROGRAMMERS & SYSTEMS ANALYSTS

**IMMEDIATE OPENINGS**

#### GERMANY

412L System — various locations throughout West Germany providing maintenance programming on command and control systems.

#### PHILADELPHIA

Suburban location, Willow Grove, Pa. Development of overseas AUTODIN programs. Later assignment available throughout Europe, etc.

#### BOSTON

Several positions, Lexington, Mass. in scientific programming and systems analysis for command and control air defense, missile re-entry, etc.

#### OKLAHOMA CITY

Development and maintenance of programs involving communications switching for air weather information.

In general, we are seeking persons with 2-3 years' applicable experience. Degree is desirable and in several instances, mandatory. Some qualifying experience areas are:


**Excellent Benefits Program. — Send Resume to Dept. 801-TH**

---

**PHILCO TECHREP DIVISION**

A SUBSIDIARY OF FORD MOTOR COMPANY.

P.O. BOX 10 — FT. WASHINGTON, PA. 19034

An Equal Opportunity Employer

---

### How can you profit from the information revolution?

Consider the challenging new ground-floor opportunities open at Western Union for personal career development in our Information Systems and Services Division.

**Manager—Network Analysis**

Six to ten years experience in communications field, three to five years managerial, with experience in transmission systems, switching systems, terminal devices, and operations. Thoroughly familiar with literature in fields of netting and traffic analysis and general communications theory. Extensive background in numerical analysis, modeling techniques, having used digital and analog computers to solve engineering problems. Prefer MS or better in Electrical Engineering.

**Senior Level Programmers**

**Real Time/Systems/Scientific**

Minimum of six years concentrated programming experience. MS degree and/or communications experience desirable. Must demonstrate knowledge of several machine and higher level languages and prior experience in the development and programming and understanding of complex engineering problems. Will work on state-of-the-art digital/communications on line real time; multiprocessing; message switching; simulations of computer/communications systems; executives; compiler/assembler developments.

**Data System and Computer Engineers**

BSEE all levels. Must know digital logic circuits, modules, and memory system applications. Capable of evaluating commercially manufactured computer peripheral equipment and carrying projects from initial design to completion.

**Programmer Analysts**

Minimum of three years experience with at least one year in one of the following areas: Message switching, time sharing, on line real time systems, management information systems, file organization, and information retrieval.

An Equal Opportunity Employer

Metropolitan New York and nearby New Jersey locations. Send résumé, including salary requirements, in full confidence to Mr. D. V. Lusk, Box D4, Employee Relations Dept., Room 2111, The Western Union Telegraph Company, 60 Hudson St., N.Y., N.Y. 10013.

---

**Western Union**

CIRCLE 101 ON READER CARD

**DATAMATION**
The foreword sets a lofty aim, to describe the principles and methods of Operations Research in a simplified nonmathematical form for the practical manager and the interested student. "It should equip him to make many applications of OR himself, and caution him when he will need to call for assistance from experts."

The first of four parts deals with the general nature of Operations Research as a management science. The audience to which the book is directed could easily feel that management science (OR) should take over the responsibilities of, and make up for the deficiencies in, accounting, controllership, market research, and economics. The second chapter deals with a presumed conflict between traditional accounting and management science. The third chapter deals with a case history of a firm that decided to diversify instead of putting money into product research and development. The factors that management should have examined are typical of most sound management decisions, and it stretches a point to say that OR would have been the cure.

The fourth chapter has some excellent warnings about the problems of effectiveness in getting Operations Research results successfully applied in the firm. "Four seem to be particularly detrimental: (1) overemphasis on technique; (2) poor communication between the OR team and management; (3) failure to make use of the experience and judgment of operating managers; and (4) inadequate participation of management in the project." These points are amplified, and should be carefully considered by practitioners and by employers of Operations Research. "The decision to use linear programming not only cost the company money unnecessarily, but also left management's real problem unsolved." "It is difficult for people with different technical backgrounds or functional responsibil-

April 1966
PEER MEASURING

Occasionally, the best of us need to look through a window at our peers—in order to judge ourselves. For the typical person, this is an extremely difficult task. An individual may not have all the facts nor is he able to remain objective in self evaluation. EDP is unique in this regard. We are able to “peer gaze” for you. Through our extensive field exposure to the scientific and commercial computer field, we will assist you in evaluating your progress and professional standing against that of your peers. Peer gazing may lead you into another world of greater challenge and compensations. * Write today for our free computer opportunities bulletin. For immediate consideration, forward a detailed experience resume. All inquiries are held in strict confidence.

David N. Grimes
edp personnel, inc.
EXCLUSIVELY DATA PROCESSING
100 S. Wacker Drive, Chicago, Ill. 60606, Ph. (312) 782-0857

CIRCLE 105 ON READER CARD

Commercial Applications Programming

Westinghouse
Astronuclear Laboratory

The Astronuclear Laboratory was founded in 1958 to expand the Westinghouse nuclear power pioneering capability into the most exotic project of our time...SPACE NUCLEAR POWER. Astronuclear has developed and successfully tested the only nuclear reactor applicable for space propulsion. This achievement has brought the space nuclear rocket program of age. Westinghouse using the development of propulsion systems, high performance nuclear power units, space materials development, nuclear reactor subsystems, and over-all systems for inner and outer space. Experience in the nuclear field is not required. Talented scientists and engineers seeking challenging and technical excitement should...STEP INTO THE FUTURE WITH WESTINGHOUSE.

COMPUTER PROGRAMMERS

Data processing methods and systems for possible computer applications on IBM 7094 Model II and IBM 360 Model II with associated data transmission equipment. Cobol and/or IBM experience desired. Will also be responsible for business systems analysis, conclusion, presentation, implementation and follow through. Must be capable of independent thought, developing and selling new and improved business procedures. Complete responsibility.

Please send your confidential resume to: Mr. C. T. HAMILTON, Dept. 385.

Westinghouse
Astronuclear Laboratory
P.O. Box 10864, Pittsburgh, Pennsylvania 15236
An Equal Opportunity Employer, M&F

CIRCLE 106 ON READER CARD

Why do Programmers and Data Processing Professionals select FOX-MORRIS PERSONNEL CONSULTANTS?

1. FINANCIAL IMPROVEMENT – Our select group of blue chip clients offer unexcelled starting salaries in the $10-30,000 range. (All fees & employment costs paid by client companies).


3. PERSONALIZED CONFIDENTIAL SERVICE – Our National Data Processing Division is professionally recognized as the most complete, effective, & confidential service in the placement industry. (Affiliate offices coast to coast).

For full details, reply in strictest confidence by letter or resume, or call collect, W. B. McNichols, Manager-Data Processing Division, 215 - LO 3-7922.

FOX-MORRIS ASSOCIATES
Personnel Consultants
1500 Chestnut Street Philadelphia, Penna. 19102

CIRCLE 107 ON READER CARD

commericially
oriented
systems
personnel

Our planned growth pattern in both the United States and overseas, and substantial progress has created unique and challenging positions for the forward looking engineer and scientist...To continue this expansion we currently need the following:


Programmer Analysts. Present systems to be replaced by systems 360's in the United States and Latin America. Projects underway include Real Time Ocean Freight & Sales Inventory Systems. Requires college training with emphasis on mathematics preferred.

Above positions are located at Corporate International Headquarters in Boston, Mass. Top salaries, excellent benefits and opportunity for advancement.

Please submit resume & salary requirements in confidence to:
MR. C. B. WATKINS

United Fruit Company
Prudential Center, Boston, Mass., 02199
All applicants will be considered on merit basis.

CIRCLE 108 ON READER CARD
After this well-taken sermon on looking for the real problem instead of technique, Part Two of the book spends the next six chapters on linear programming, illustrating five different techniques of solution and a couple of case histories. There is a short chapter on MAPI analysis, two on PERT, and one on Line-of-Balance analysis.

Part Three manages to cover Inventory Management in 50 pages. Part Four deals with sampling and statistical analysis. There are several cases and problems for the student in an appendix.

The interested student will find that the tools of management science are covered so quickly as to give him little understanding of the use of these tools and techniques, and little (except Chapter Four) on how to find the right problem, how to monitor the progress of the project, how to evaluate and implement the results.

Most of the chapters seem to be based on papers that other authors have published, and fail to demonstrate any real practical experience on the part of Professor Enright.

Three matters of style make the book difficult to read.

The author uses “OR” instead of spelling out “management science” or “operations research.” He treats the initials of Machinery and Allied Products Institute and Program Evaluation and Review Techniques as proper names: Mapi and Pert.

Except in Chapter 10, the tables referred to in text are located at the end of the chapter, usually five to seven pages away from the reference. Some of these tables contain the entire message of the chapter in capsule form.

Finally, the author shows little familiarity or sympathy with the power of expression possible with careful English. Fowler should have seen several sentences, of which the following may serve as an example. “Management’s efforts are concerned with the utilization of the productive, financial, sales, personnel, and related resources of the company towards optimization regarding final profit.”

—R. C. BROWN

They’re fluent in various aspects of total system development—operational sensors, display devices, communications, programming and operations research for example. Without the talent, they’d hem and haw when it comes to getting across their total systems development concepts and functional specifications for computing systems, peripheral equipment and software of the future.

Like everyone else, there’s always one “language” that’s their specialty. Some think most comfortably in systems, integrated software systems, applications, or range systems. Others in compiler and machine language, radar systems, command and control, or library systems.

Where does all their knowledge go? Into a complete range of data processing equipment, scientific and commercial. It keeps track of Gemini and Apollo. It flew by Mars. It’s in the software and hardware systems for aircraft and missile tracking, target discrimination, intercept programming, missile guidance, and computer simulation for design evaluation and into systems for business and industry. Among many other things.

The working atmosphere is just as savvy. Systems programmers work on their own machines (development engineers have their own). Software men can correct hardware design limitations. And since you’re working with the number one real-time leader in the field, the computer technology is more than big time.

If you see the advantage of programming at UNIVAC, send a resume at once to Mr. R. K. Patterson, Employment Manager, Dept. D-12, UNIVAC Division of Sperry Rand Corp., Univac Park, St. Paul, Minnesota 55116. An Equal Opportunity Employer.
Exciting New Biomedical Projects in COMPUTER RESEARCH & TECHNOLOGY AT NIH

The new Division of Computer Research and Technology of the National Institutes of Health is pursuing vitally-important projects involving many types and aspects of biomedical investigation as well as patient treatment and information handling/management.

These projects offer computer-oriented engineers, mathematicians, mathematical statisticians, systems analysts, operations research analysts and topflight programmers (specifically systems programmers, scientific data processing programmers and information retrieval programmers) an opportunity of exceptional scope and promise.

Just for example, we are seeking to develop these:

**Special-Purpose Computers (Digital and Analog)**
**Networks of Remote Data Stations**
**Specialized 360 Software**
**New Statistical Methodology in Time Series**
**Multivariate Computer Techniques**
**Large-Scale Information Systems**
**Scientific Data Handling Tools**
**Mathematical Model of Heart and Nerve Action**

. . . in order to support and perfect diverse biomedical as well as administrative activities throughout NIH.

Participating in a uniquely significant and timely program with humanitarian objectives, you will also enjoy the liberal and comprehensive benefits of Federal employment and the chance to work with today's most modern computing and ancillary equipment.

For further information, please submit your resume or Standard Form 57 (application for Federal employment) to: Chief, Division 7 Computer Research and Technology—Building 12-A, Room 2017-1.

NATIONAL INSTITUTES OF HEALTH
Bethesda, Md. 20014. An equal opportunity employer M&F
PROGRAMMERS—ANALYSTS—ENGINEERS

Let's compute your EDP future

INPUT: Your Career Data
       Processed • Analyzed • Programmed

OUTPUT: Problem Solved

We match your EDP talent to important technical positions available with client companies: ... Industrial leaders located in New England, New York, New Jersey, Philadelphia, Florida, in the Midwest, Southwest or on the West Coast.

Experienced members of our industry-oriented staff will evaluate your capabilities and recommend your name to the Director of Professional Placement who can offer you advancement, as well as a stable future.

Check the discipline of your interest and experience:

- Scientific Programming
- Real Time Systems
- Software Development
- Operations Research
- Applied Systems
- Systems Design
- Consulting

- Digital or Logic Design
- Circuit Design
- Commercial Programming
- Mathematics
- Development Engineering
- Communications
- Sales

Starting salaries range to $25,000, according to your level of experience. All fees, including interviewing and relocation paid by our client companies. Submit your resume in confidence, including salary requirements and geographic preferences, directly to Mr. R. L. Keilholtz or Mr. Donald Wayne.

EVERETT KELLEY ASSOCIATES
Consultants to the Computer Industry
1211 So. Broad Street (Suite 300) Philadelphia, Pa. 19107
SJCC INTERVIEWS

... at Honeywell EDP’s nearby facilities, or at the Convention hotel in Boston, may be arranged by calling Mr. Edwin Barr at 266-7128 during SJCC or 891-8400 prior to your arrival.

Take full advantage of this dual opportunity, meet and talk with our senior technical staff about the present and future career positions at Honeywell EDP, and accept their invitation to visit Honeywell’s suburban Boston facilities.

Positions exist in all major areas of advanced computer technology, with emphasis in the areas of:

LOGIC DESIGN
SYSTEMS DESIGN
CIRCUIT DESIGN
MEMORY SYSTEMS DEVELOPMENT
SYSTEMS ANALYSIS
TERMINAL EQUIPMENT DESIGN
MASS STORAGE DEVELOPMENT
DESIGN AUTOMATION PROGRAMMING
DIAGNOSTIC PROGRAMMING

If an interview during the SJCC is not convenient, forward your resume to Mr. Edwin Barr, Employment Supervisor for prompt consideration.

Honeywell
ELECTRONIC DATA PROCESSING
200 Smith Street, Dept. D-4
Waltham, Massachusetts

Opportunities exist in other Honeywell Divisions. Send resumes to F. E. Laing, Honeywell, Minneapolis, Minnesota 55408. An equal opportunity employer M&F.
SYSTEMS PROGRAMMERS

LOS ALAMOS SCIENTIFIC LABORATORY has several openings for Systems Programmers with real-time computer control experience. Applicants should have B.S. degree in computer science or equivalent.

The Laboratory is involved in a research and development program related to the construction of 800 MeV high intensity proton linear accelerator to be used in meson physics research. The accelerator will be controlled by one or more on-line digital computers. A computer to control prototype systems is already on order. Future plans call for installation prior to the beam-on date, of a multi-computer complex for real-time data acquisition and reduction.

Initial responsibilities will include development of programs for real-time analysis and control. Future responsibilities will include development of special purpose compilers and system simulators.

Los Alamos Scientific Laboratory, operated by the University of California, is located in the mountains of Northern New Mexico. Cool summers and mild winters. Excellent working conditions and fringe benefits, including 24 days annual vacation, ample sick leave and progressive retirement plan.

Qualified applicants are invited to send complete resume to:

LOS ALAMOS SCIENTIFIC LABORATORY Recruiting Department University of California P.O. Box 1663 Los Alamos, New Mexico


TIME SHARING OPPORTUNITIES

A newly formed organization in the Northeast, engaged in commercial time shared computer services in the health and medical fields, has openings for staff members at several levels in the following areas:


Communications Design. Design of communications system, data concentration, remote terminal service routines, and development of the programming for the communications computers.

Applications Programming. Design and Development of user programs in areas ranging from arithmetic processes, to file manipulation and retrieval, to advanced medical research projects.

Opportunities for development into technical management exist in the above areas. Nation-wide expansion is anticipated, giving opportunities to relocate, as desired.

Interviews will be conducted in Boston during the SICC, April 26-28. Interested parties are invited to contact the address below for more information or interview appointments, before, during or after the conference.

Please Contact:

THOMAS V. HEFFELFINGER ASSOCIATES
Computer Personnel Consultants Dedham Office Park
886 Washington Street
Routes 128 & 1 Dedham, Massachusetts 02026
(617) 329-1040

CIRCLE 115 ON READER CARD

SCIENTIFIC PROGRAMMERS

Opportunities in Florida

These openings are for real-time, data reduction applications associated with range operations in support of the Gemini and Apollo space programs at the John F. Kennedy Space Center in Florida—where Federal Electric Corporation is engaged in implementing KSC's central scientific computers to the task of data recording, reduction, transmission and real-time display of thousands of measurements telemetered from the vehicle, spacecraft and ground support equipment.

Requirements include a degree in mathematics and/or related fields with a minimum of 2 years of programming experience on large-scale computer systems. Experience in symbolic and FORTRAN languages required.

Please forward your resume, in confidence to Mr. H. B. Arnold, Federal Electric Corporation, 8660 Astronaut Blvd., Cape Canaveral, Florida.

FEDERAL ELECTRIC CORPORATION
An Equal Opportunity Employer (M/F)

CIRCLE 117 ON READER CARD
April 1966
RCA, one of the world’s largest companies devoted entirely to electronics, is dedicated to sweeping growth in the electronic data processing field in commercial, scientific, aerospace and military applications. The next ten years will see a great expansion in this vital area, and a growing need for EDP professionals in software development, in applications programming, in field systems support, engineering and sales. So—when we speak of “growth,” we are talking about real ground floor opportunities, for qualified individuals to play a vital role in this rapidly expanding activity.

Why not see the RCA representatives at the Midtown Motor Inn, in Boston during the SJCC Convention, April 26th through 28th.

PROGRAMMERS—ENGINEERS
CURRENT OPENINGS IN THESE AREAS:

- Logic Engineering
- Computer Design Engineering
- Systems Engineering
- EDP Sales
- Field Systems Support
- Software Development
- Micro Programming
- Commercial Applications Programming
- Scientific Programming
- Design Automation
- Diagnostic Programming

OPENINGS EXIST AT:
RCA Electronic Data Processing,
Cherry Hill, N.J.
RCA Government Services,
Cherry Hill, N.J.
RCA Graphic Systems Division,
Princeton, N.J.
RCA Aerospace Systems Division,
Burlington, Mass.

And other locations throughout the United States.

To arrange a confidential interview with RCA at the Midtown Motor Inn, near the Convention Headquarters, call:

Mr. J. B. Burke
At (617) CO 2-1008

Or write to: Mr. J. B. Burke, RCA Staff Employment, Dept. SJ-2, Bldg. 2-2, Camden, New Jersey 08102.

An Equal Opportunity Employer M & F

The Most Trusted Name in Electronics
LEASING 138 NEPPERHAN AVENUE, YONKERS, NEW YORK 10701, Phone 914-9 0-6807.

Isn't it worth a phone call to make sure you get the best price for your IBM, EAM, or EDP equipment? Call EDP Leasing Corp., 745 Fifth Avenue, New York, N.Y. 10022 Phone: (212) 421-9155.

HIGH PRICES PAID FOR USED I.B.M., DATA PROCESSING MACHINES: Sorters, verifiers, collators, computers, tape drives, key punches, reproducers, interpreters, accounting machines. WE PURCHASE AND LEASE BACK, Advise exact model and serial numbers and we will quote prices by return mail. Phone: 912-Dragon 9-6535, L.A. PEARL CO., 901 SECOND AVENUE, NEW YORK, N. Y. 10017

FOR SALE USED EQUIPMENT
EQUIPMENT—LIKE NEW
COMPUTER: Bunker-Ramo TRW 340
ADDRESSOGRAPH: Model 9313
ADDRESSOGRAPH: Model 9143
with Lister & Associated Equipment
ADDRESSOGRAPH: Key Punch Mode 7100
Contact: L. G. Wells—P.O. Box 2029,
Tulsa, Oklahoma 74300 Ext. 437

DATA-MATION
Classified Advertising

The classified section is open for the following advertising categories: Used equipment; positions wanted; help wanted; educational institutions, maintenance services; professional cards; hobby products; business opportunities and educational courses. Rates are based on total number of insertions used within each contract year.

For further information please contact: DATA-MATION Magazine, Classified Advertising Dept., 141 East 44th Street, New York, N. Y. 10017—212-MU 7-5180.

COMPUTER CARRIERS

Should you base your career on just one interview? Make your choice from among several career positions!

EUROPEAN and
NATIONWIDE CHOICE

N.Y., N.J., NEW ENGLAND, WASHINGTON, D.C., PHILA., MINNESOTA, TEXAS, HUNTSVILLE, FLORIDA, ARIZONA, CALIFORNIA AND OTHERS

Contact us if you have some experience or interest in any of the following:

□ Scientific Computation — Data Reduction or Numerical Analysis — Unusual Outerspace/Lunar and Advanced Programs
□ Software Development — Languages, Compilers, Assemblers, Monitors or Sub-Routines
□ Real Time Systems — Message, On Line, Process Control
□ Technical Representatives— Programming and Systems Support to Sales
□ Digital or Logical Design
□ Management Sciences
□ Sales and Marketing

Unique opportunities exist in the $9000-25,000 class for Managers & Seniors and Men who can accept management responsibility and professional growth

Unusual Opportunities

TECHNICAL
WRITERS/EDITORS
Automated Documentation Programming/Systems
$9,000 to $18,000

All expenses are assumed by our client companies.

Write in confidence, including presents, salary, acceptable locations or call (Collect) Mr. Nellissen (Area Code 212) Plaza 9-1720

a & n
ALBERT NELLISSEN, INC.
Leading Consultants to Management in the Data Processing Field

510 MADISON AVENUE, N.Y., N.Y. 10022
CIRCLE 130 ON READER CARD

April 1966

CIRCLE 210 ON READER CARD
At Lockheed, opportunities in the field of scientific computer programming abound. And the range of assignments is as interesting as it is broad: in the physical sciences, engineering dynamics, command and control, simulation advanced software, and research programs. That is why, to this task, Lockheed brings one of the world's largest industrial computer installations. Clearly, Lockheed is deeply committed to scientific computerized systems. And clear, too, are the unduplicated opportunities that await experienced scientific programmers at Lockheed. Please write to Mr. K. R. Kiddoo, Professional Placement Manager, Sunnyvale, California. Lockheed is an equal opportunity employer.
WOULD YOU BELIEVE?

THAT WE'RE ABLE TO SATISFY OUR CLIENTS'
REQUIREMENTS IN THESE AREAS:

• Applied Systems
• Compilers
• Assemblers
• Automatic Languages
• Utility
• Commercial Programming
• Scientific Computation
• Real Time — Operational
• Operations Research
• Systems Design
• Information Retrieval
• Diagnostics
• Digital and Logical Design

WOULD YOU BELIEVE WE'RE NOT?

GET SMART!

Expedite your development by sending resume in confidence with present salary & geographic preference to:

La Salle Associates
Professional Search Dept.
2136 Locust Street, Philadelphia, Pa. 19103

or circle subscriber card. Please use home address only.

No charge to you for our custom service. Employers pay our fee.

CIRCLE 122 ON READER CARD

PROGRAMMER

— SCIENTIFIC —

New York City Headquarters of Internationally known Petro-Chemical firm has a requirement for a FORTRAN PROGRAMMER. IBM #360 System will be installed this Summer.

REQUIREMENTS FOR THIS POSITION ARE:

Math or Engineering degree or equivalent. Assignments will involve analysis & programming of a wide variety of challenging problems such as — process simulation, control theory, equipment design, cost estimation and automated drafting.

This is your opportunity to apply your talent to creative work in a professional atmosphere.

Extensive Employee Benefit Program including profit-sharing plan.

IF YOU ARE ATTENDING the Joint Spring Computer Conference in Boston — Arrangements will be made for a convenient New York City interview.

CALL (COLLECT) (212) MU 9-3000.

OR SEND YOUR RESUME IN CONFIDENCE TO:

M. ROBBINS

SCIENTIFIC DESIGN COMPANY, INC.

2 Park Avenue
New York, N.Y. 10016

CIRCLE 123 ON READER CARD

PROGRAMMERS

Scientific

New Research & Engineering center located in Westchester, N. Y. Area has immediate openings for scientific programmers with a BS in science or engineering, 2 years experience in programming and coding, large scientific problems on machines of the CDC 1604A or IBM 7094 class. Must be familiar with FORTRAN & COBOL languages.

We offer high salaries, merit increases, profit sharing, non-contributory pension plan plus liberal benefits. Please send resume in complete confidence to:

Box 4-66 Datamation
141 E. 44th Street, New York, N. Y. 10017

CIRCLE 123 ON READER CARD
Are you ready to hit the ceiling?

Have you gone as far as you can wherever you're working now? Are you getting restless? Eager to move on and up to a higher professional level — with more opportunity to prove your ideas will work?

Then consider joining MITRE, where the work is on the frontier of large-scale systems design. We design and engineer information, sensor, command, control and communications systems, and develop new techniques which contribute to the advancement of the general technology.

The challenge is to mate present and predictable technology to the nation's future electronic systems. Work covers a broad spectrum of problems and the technology needed to solve them.

We are located in a pleasant suburban community just 25 minutes west of Boston, in the center of one of the Nation's most important electronic complexes. And many of the finest cultural, recreational and educational facilities in the country are minutes away.

Interested? Check the openings available, and, if you qualify, join us at MITRE.

COMMUNICATIONS — We need people who can help conceive new communications systems, recommend development programs to achieve these, and analyze special communications requirements generated by new systems concepts. Work areas include systems planning, analysis, simulation and design for command and control systems, missile and space systems and test range and weapons support systems, engineering of communication networks, range instrumentation, tactical air control, and survivable communications.

SENSOR SYSTEMS — Scientists and engineers are now needed to conduct theoretical and experimental programs on advanced radar and optical detection and tracking systems. Work includes advanced radar systems planning, design and analysis with emphasis on radar signal design, signal processing, parameter estimation, target radar characteristics, and radar coverage. Basic studies are to be conducted of sensor systems and sub-systems with focus on receiver techniques, spectrum analysis, delay-line techniques, signal processing, pulse compressors, MT and HF propagation.

TACTICAL SYSTEMS — One of our current systems engineering projects is 407L TACS (Tactical Air Control System) — a system encompassing all mobile communications systems, electronics systems and operating facilities required for command and control of deployed USAF tactical forces. Openings are available for Systems Engineers who have experience, or training in a combination of several of the following: digital data processing and displays; system test planning, instrumentation and evaluation; ground based radar systems; communications (voice and data transmission); operations analysis.

TELEMETRY — Engineers are needed to work with telemetry and instrumentation. Particular work areas include telemetry standards, systems, and techniques for both airborne and ground applications. Experience should include design or analysis of telemetry systems as well as modulation theory, RF techniques and receiving and transmitting antenna systems.

COMPUTER PROGRAMMING — People needed with experience in the development and support of monitors, compilers, real-time simulations, time-sharing systems, etc.

If you have at least three years' experience and a degree, preferably advanced, in electronics, mathematics or physics, contact us. Write in confidence to Vice President — Technical Operations, The MITRE Corporation, Box 208AU, Bedford, Massachusetts.

MITRE also maintains facilities in Washington, D. C., Patrick Air Force Base and Tampa, Florida, as well as Colorado Springs. MITRE’s overseas facilities are in Paris and Tokyo.

Pioneer in the design and development of command and control systems, MITRE was formed in 1958 to provide technical support to agencies of the United States Government. MITRE's major responsibilities include serving as technical advisor and systems engineer for the Electronic Systems Division of the Air Force Systems Command and providing technical assistance to the Federal Aviation Agency and the Dept. of Defense.
EDP SPECIALISTS... Commercial & Scientific WE WERE “BORN WITH THE INDUSTRY”

How many personnel consultants can say the same? We’ve been in the field since its inception. Our contacts with the industry are unmatched. Our computer oriented staff can evaluate your peak professional potential and open important doors for you in the dynamically expanding fields of automation.

Professional Opportunities for:
- Computer Programmers
- Applied Mathematicians
- Systems & Methods Analysts
- Operations Research
- Digital Circuit Designers
- Logic Circuit Designers
- Electronic Engineers
- Sales Engineers

Our clients assume all fees and expenses. Discuss your career goals with us, or direct your confidential resume, including salary and geographic preference, to Don Sabia or Jack McEwee, EDP Search, Department D.

E. J. BETTINGER COMPANY

Technical Personnel Consultants to the Electronics Industry
20 South 15th Street Philadelphia, Pennsylvania (215) Locust 4-0700

CIRCLE 126 ON READER CARD

ARE YOU AWARE OF OPPORTUNITIES . . . IN INDUSTRIAL COMPUTER TECHNOLOGY

The field of industrial computers has mushroomed on a national and international scale. In fact, it is one of the fastest growing of the whole computer industry and presents a highly sophisticated real-time hardware and software challenge. The Foxboro Company, over 25 years a leader in industrial controls, is at the forefront of industrial computer technology.

DEVELOPMENT ENGINEER — CIRCUIT DESIGN
BS or MS in electrical engineering. 3-5 years’ experience in circuit design. Emphasis on integrated circuits is desirable. Some knowledge of logic design, programming, and computer organization is required. Will participate in the design and application of solid state digital and analog circuits as applied to computer control systems and related products. Also, the design of advanced I/O equipment which interface digital computers.

DIGITAL PROJECT ENGINEERS
BS in Electrical Engineering with at least one year of experience. Must have training in systems engineering and a knowledge of digital computer equipment. Would be responsible for the design of digital systems, including 3/4/8 bit microprocessors and dedicated logic circuits.

SYSTEMS ENGINEERS
BS or MS in engineering. Minimum 3 years’ experience in systems engineering, including project planning, programming, instrumentation, application of digital computer equipment, system start-up, and customer negotiation. Ability to define system specification, design, checkout, etc. Technical decisions on application requirements, manpower capabilities, time and cost. Principal technical responsibility for customer projects.

PROGRAMMERS & SENIOR PROGRAMMERS
Engineering or Scientific degree desired with systems programming ability. At least 2 years’ experience in digital computer equipment, system start-up, and customer negotiation. Mathematical analysis and process control experience plus knowledge of assemblers and compilers desirable. Responsible for application development.

ARE YOU AWARE OF OPPORTUNITIES . . . IN INDUSTRIAL COMPUTER TECHNOLOGY

The field of industrial computers has mushroomed on a national and international scale. In fact, it is one of the fastest growing of the whole computer industry and presents a highly sophisticated real-time hardware and software challenge. The Foxboro Company, over 25 years a leader in industrial controls, is at the forefront of industrial computer technology.

DEVELOPMENT ENGINEER — CIRCUIT DESIGN
BS or MS in electrical engineering. 3-5 years’ experience in circuit design. Emphasis on integrated circuits is desirable. Some knowledge of logic design, programming, and computer organization is required. Will participate in the design and application of solid state digital and analog circuits as applied to computer control systems and related products. Also, the design of advanced I/O equipment which interface digital computers.

DIGITAL PROJECT ENGINEERS
BS in Electrical Engineering with at least one year of experience. Must have training in systems engineering and a knowledge of digital computer equipment. Would be responsible for the design of digital systems, including 3/4/8 bit microprocessors and dedicated logic circuits.

SYSTEMS ENGINEERS
BS or MS in engineering. Minimum 3 years’ experience in systems engineering, including project planning, programming, instrumentation, application of digital computer equipment, system start-up, and customer negotiation. Ability to define system specification, design, checkout, etc. Technical decisions on application requirements, manpower capabilities, time and cost. Principal technical responsibility for customer projects.

PROGRAMMERS & SENIOR PROGRAMMERS
Engineering or Scientific degree desired with systems programming ability. At least 2 years’ experience in digital computer equipment, system start-up, and customer negotiation. Mathematical analysis and process control experience plus knowledge of assemblers and compilers desirable. Responsible for application development.

CHEMICAL ABSTRACTS SERVICE
COLUMBUS, OHIO, 43210

Key to the World’s Chemical Literature
An Equal Opportunity Employer

ARE YOU AWARE OF OPPORTUNITIES . . . IN INDUSTRIAL COMPUTER TECHNOLOGY

The field of industrial computers has mushroomed on a national and international scale. In fact, it is one of the fastest growing of the whole computer industry and presents a highly sophisticated real-time hardware and software challenge. The Foxboro Company, over 25 years a leader in industrial controls, is at the forefront of industrial computer technology.

DEVELOPMENT ENGINEER — CIRCUIT DESIGN
BS or MS in electrical engineering. 3-5 years’ experience in circuit design. Emphasis on integrated circuits is desirable. Some knowledge of logic design, programming, and computer organization is required. Will participate in the design and application of solid state digital and analog circuits as applied to computer control systems and related products. Also, the design of advanced I/O equipment which interface digital computers.

DIGITAL PROJECT ENGINEERS
BS in Electrical Engineering with at least one year of experience. Must have training in systems engineering and a knowledge of digital computer equipment. Would be responsible for the design of digital systems, including 3/4/8 bit microprocessors and dedicated logic circuits.

SYSTEMS ENGINEERS
BS or MS in engineering. Minimum 3 years’ experience in systems engineering, including project planning, programming, instrumentation, application of digital computer equipment, system start-up, and customer negotiation. Ability to define system specification, design, checkout, etc. Technical decisions on application requirements, manpower capabilities, time and cost. Principal technical responsibility for customer projects.

PROGRAMMERS & SENIOR PROGRAMMERS
Engineering or Scientific degree desired with systems programming ability. At least 2 years’ experience in digital computer equipment, system start-up, and customer negotiation. Mathematical analysis and process control experience plus knowledge of assemblers and compilers desirable. Responsible for application development.

CIRCLE 127 ON READER CARD

ARE YOU AWARE OF OPPORTUNITIES . . . IN INDUSTRIAL COMPUTER TECHNOLOGY

The field of industrial computers has mushroomed on a national and international scale. In fact, it is one of the fastest growing of the whole computer industry and presents a highly sophisticated real-time hardware and software challenge. The Foxboro Company, over 25 years a leader in industrial controls, is at the forefront of industrial computer technology.

DEVELOPMENT ENGINEER — CIRCUIT DESIGN
BS or MS in electrical engineering. 3-5 years’ experience in circuit design. Emphasis on integrated circuits is desirable. Some knowledge of logic design, programming, and computer organization is required. Will participate in the design and application of solid state digital and analog circuits as applied to computer control systems and related products. Also, the design of advanced I/O equipment which interface digital computers.

DIGITAL PROJECT ENGINEERS
BS in Electrical Engineering with at least one year of experience. Must have training in systems engineering and a knowledge of digital computer equipment. Would be responsible for the design of digital systems, including 3/4/8 bit microprocessors and dedicated logic circuits.

SYSTEMS ENGINEERS
BS or MS in engineering. Minimum 3 years’ experience in systems engineering, including project planning, programming, instrumentation, application of digital computer equipment, system start-up, and customer negotiation. Ability to define system specification, design, checkout, etc. Technical decisions on application requirements, manpower capabilities, time and cost. Principal technical responsibility for customer projects.

PROGRAMMERS & SENIOR PROGRAMMERS
Engineering or Scientific degree desired with systems programming ability. At least 2 years’ experience in digital computer equipment, system start-up, and customer negotiation. Mathematical analysis and process control experience plus knowledge of assemblers and compilers desirable. Responsible for application development.

Senior Systems Analyst
Advanced degree in Computer Science or Engineering with 1-3 years’ experience in systems engineering. Knowledge of computer science, application programming, and computer organization and architecture required. Strong written and oral communication skills desired. Responsible for application development.

Senior Developers
Advanced degree in Computer Science or Engineering with 1-3 years’ experience in systems engineering. Knowledge of computer science, application programming, and computer organization and architecture required. Strong written and oral communication skills desired. Responsible for application development.

Senior Developers
Advanced degree in Computer Science or Engineering with 1-3 years’ experience in systems engineering. Knowledge of computer science, application programming, and computer organization and architecture required. Strong written and oral communication skills desired. Responsible for application development.

Senior Developers
Advanced degree in Computer Science or Engineering with 1-3 years’ experience in systems engineering. Knowledge of computer science, application programming, and computer organization and architecture required. Strong written and oral communication skills desired. Responsible for application development.
PROGRAMMERS

SCIENTIFIC PROGRAMMERS

Engineering applications on C-130, C-141, and C-5A cargo aircraft, VTOL/STOL development, and the JetStar airplane. Problems to be solved are in the areas of: Structural Analysis, Aerodynamics, Loads, Dynamics & Flutter, Flight Simulation, Statistical Design of Experiments, and Numerical Control.

SYSTEMS PROGRAMMERS

Work is in progress on system design and development of:

1. Airborne Command and Control System
2. Computer Graphics Project
3. Real-time Data Acquisition and Monitoring Systems
4. Remote Access Computing Facility

THE TOOLS YOU USE SHAPE YOUR FUTURE

The Lockheed-Georgia Company was one of the first companies to install IBM's System 360. In August, 1965, operation was begun in a real time environment with 12 remote terminals. The Remote Access Computing Facility (RACF) is now operating with 22 remote terminals and includes capability to do concurrent scientific batch processing. Scope of this system is being further enlarged and developed.

Scientific Computing equipment in use includes:
- IBM 360/50 — remote access and concurrent batch processing
- Two IBM/ 7094’s — scientific batch processing
- UNIVAC 418 — computer graphics research
- CDC 3300 — production application of computer graphics
- IBM 360/30 — peripheral operations

OPENINGS AT ALL LEVELS

BS degree in mathematics or engineering and minimum one year's experience with one or more large-scale digital computers for entry-level openings. We are also seeking personnel with several years programming experience and/or advanced degree to fill higher-level technical and supervisory positions.

Send complete resume, including current salary, to: Charles E. Storm, Professional Employment Manager, Lockheed-Georgia Company, 834 West Peachtree Street, Atlanta, Georgia 30308, Dept. 4-D.

LOCKHEED-GEORGIA COMPANY

A Division of Lockheed Aircraft Corporation

An equal opportunity employer
John G. Morey, recently elected to the board of directors of the ARIES Corp., has also been chosen manager of the corporation's new offices in New York City.

Lawrence M. Isaacs has been appointed staff vice president, management information systems, Radio Corporation of America, New York City.

Robert M. Gordon has joined Scientific Data Systems, Santa Monica, Calif., as manager, applications programming. He was formerly with Raytheon Computer.

Milton F. Tucker has been named manager, computer communications for the McDonnell Automation Center, McDonnell Aircraft Corp., St. Louis, Mo.

George E. Monroe has been chosen deputy manager of the computer systems and engineering division, Planning Research Corp., Los Angeles, Calif.

Raymond F. Parmentier has been named manager of the Associated Spring Corp.'s new computer service center, Bristol, Conn.

Ralph W. Pearson will head the business development program at Computer Sciences Corp.'s new systems programming division, El Segundo, Calif. He was a former sales executive with the Burroughs Corp.

Yougene J. Lamar, associated with the Burroughs Corp. for 27 years, has been appointed vice president, planning, of the Uptime Corporation, Golden, Colo.

Systems analysts Verne Van Vlear and James L. Ryan have been added to the staff of Tymshare Inc., Los Altos, Calif., time-sharing service which opened its doors April 1.

LITTLE BY LITTLE, SPACE IS YIELDING its mysteries to man's inspection ... the previously unknown is becoming knowledge to help attack further unknowns. One important attack is the National Aeronautics and Space Administration's manned space flight program leading to exploration of the moon. Bellcomm is doing technical studies—systems planning, analysis and engineering for NASA in this exciting effort. We offer career opportunities to experienced men in physics, mathematics, engineering, flight mechanics, propulsion, man-machine relationships, computer programming, aerodynamics and aeronautical engineering in general. The work is creative, the staff is highly professional, and the location is stimulating. Bellcomm, an equal opportunity employer, works in Washington, D.C. Interested? Bellcomm will give your résumé prompt and thoughtful study. It should be sent to Mr. N. W. Smusyn, Personnel Director, Bellcomm, Inc., Room 1404-E, 1100 17th Street, N.W., Washington, D.C. 20036.
SORRY

— no time for mediocrity. We are in a position to help those individuals who are able to ask for and obtain the best career opportunities. If your abilities or potential are such as to place you in the top 20% of your field, our unique service will enable you to

CHOOSE THE AREA you prefer to live and work in FROM COAST TO COAST

Investigate not just a job, but a challenging career opportunity in any aspect of computer based systems or management science.

A SMALL SAMPLE OF CATEGORIES RANGING FROM $10 — $30,000:

- Software development
- Programming research
- Scientific computation/Analysis
- Technical representative
- Marketing/Sales
- Operations Research
- Systems design
- Management consulting
- Real time/Communications systems
- Digital systems engineering
- Process control
(Managers, Seniors, Intermediates)

Burroughs has a 78 year record of accomplishment in the field of computation. A significant barometer of Burroughs growth today is reflected in our Corporate profits—up 20% in 1964 and a phenomenal 71% in 1965. Specializing in the design, development and manufacture of commercial electronic data processing systems and auxiliary equipments, our Pasadena Plant is playing an important role in the overall growth of the Corporation. Few California businesses have charted a steadier, more progressive growth pattern. This Division has developed such industry-acknowledged firsts as the B 5500 Information Processing System, the B 100, 200 and 300 series of computers and the On-Line Disk File System. A whole genealogy of sophisticated systems such as these have contributed importantly to Burroughs reputation.

This growth pattern is conducive to the advancement of career-minded programmers. Creative efforts are rewarded with stimulating and challenging assignments in broad areas of the total systems concept.

Professional individuals whose background and interests are in systems, engineering or applications programming are invited to submit a resume to Mr. F. P. Wilson, Employment Manager, 460 Sierra Madre Villa, Pasadena, Calif.

Burroughs Corporation
PASADENA, CALIFORNIA
An Equal Opportunity Employer
CIRCLE 201 ON READER CARD

INFORMATION SYSTEMS
SCIENTISTS AND ENGINEERS

Bendix Research Laboratories has excellent career opportunities for B.S., M.S., and Ph.D. graduates with 2 to 15 years experience in one or more of the following key areas:

- ARTIFICIAL INTELLIGENCE, pattern recognition, trainable systems, adaptive logic.
- COHERENT OPTICAL PROCESSING, spatial filtering, optical correlation, electro-optical systems and components.
- DIGITAL COMPUTER DESIGN, systems analysis, logic and circuit design, real-time computer control.
- ANALOG COMPUTERS AND SYSTEMS, information theory, control theory, circuit and servo analysis, correlation techniques.
- REAL-TIME COMPUTER PROGRAMMING, mathematical analysis, scientific computing.

Assignments involve research and development in automatic extraction of information from photographic records, image processing and analysis, adaptive and trainable control systems, digital and hybrid computing techniques, and advanced real-time computer control applications.

Interested individuals are invited to call collect or to send a resume to our Personnel Director.

Research Laboratories Division
Southfield, Michigan • (313) 353-3500
An equal opportunity employer
Stability

The stability of a body in motion can best be evaluated when interfering forces are severe enough to test its structure or divert it from a pre-established direction. A corporation is a body of people in motion and its stability is measured by planned achievement.

As a corporation NCR has been tested for more than 79 years. Throughout this period, direction has been maintained and objectives achieved. The objective of NCR? Better systems for business. This singleness of purpose with balanced diversification has led to growth and the TOTAL SYSTEMS concept. The products and services of NCR, made possible by practical research and development, are respected throughout the world in 120 countries.

Research and development at NCR is broad and reflects a seriously considered investment of past years. Plans for future expansion of facilities reflect a faith in the stability of the Company and in the devoted talents of NCR men of science who will add impetus to overall plans. The stability of NCR is conducive to the advancement of career-minded scientific and engineering personnel. Creative efforts are rewarded with responsible, challenging work. Professional individuals at NCR find the personal stability, understanding and encouragement required for growth.

Personnel with professional backgrounds and systems interest in materials handling, hotel management, retail merchandising, or commercial, financial and industrial sales related to EDP Systems are invited to contact us.


An equal opportunity employer, M&F

N C R

THE NATIONAL CASH REGISTER COMPANY®

April 1966

CIRCLE 203 ON READER CARD
THE DOW CHEMICAL COMPANY
ROCKY FLATS DIVISION
NEEDS THREE PROGRAMMERS

Should have college or will accept 2-3 years experience in Computer Programming with minimum one year on IBM 1400 series computers.

Will develop programs for various business application.

Send Resume, including salary requirements to:

Technical Employment
THE DOW CHEMICAL COMPANY
ROCKY FLATS DIVISION
P. O. Box 888
Golden, Colorado

Operating Contractor for the Atomic Energy Commission
An Equal Opportunity Employer
(Can Consider Only U. S. Citizens)
Participate in important breakthroughs in computer technology... in the Sun Country, Phoenix, Arizona

As a professional, you should be familiar with the impressive strides General Electric's Computer Equipment Department has been making in the past years. Now, to meet rapidly expanding commitments, a substantial number of appointments in many diverse areas are being made to our headquarters staff in Phoenix, Arizona.

Just a few are listed below. For more information, send us an informal resume today.

<table>
<thead>
<tr>
<th>Programming Documentation Specialists</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS degree required. Needed to develop automated techniques in the use of documentation. Experience in scientific and/or systems programming with technical writing background.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Consultant—Advanced Programming</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS degree in Math, Science or Engineering. 4 years in advanced programming systems; work at the design level. This would require extensive experience in the programming field. Desirable to have project leader experience on at least one compiler or operating system of a significant stature.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Utility EDP-Systems Analyst</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience with systems and methods, especially in the area of computer applications or utility accounting. Systems design experience is most desirable.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Marketing Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>College degree. Successful field sales experience. Formal or informal training experience. Technical training. 4 years EDP experience.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Senior Application Engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td>College graduate, Math or Science. 4 to 6 years experience in computer programming, numerical analysis and computer systems work. Customer relations work in sales or application engineering. Knowledge of Fortran or Algol and data communications. Real-time, multi-programming environment.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Engineer—Business Systems Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS in Math, Engineering or Business or equivalent. 3 years of computer programming on major projects. Must have worked on a variety of applications. 1 year GAP programming or experience in comparable language. Tab experience and good understanding of computer capabilities is essential. Experience with software programming. Application engineer experience in Marketing Section.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Communications Analyst</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proven programmer with at least 2 years experience in the areas of telecommunication. Knowledge of telecommunication or computer applications—with heavy programming experience.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specialist—Business Systems Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS degree in Business or Math or equivalent. Several years of systems design experience for business systems utilizing computers, or equivalent. Programming and tab experience. Functional experience in Manufacturing, Marketing, Finance or Product Service.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Programmer</th>
</tr>
</thead>
<tbody>
<tr>
<td>High school education and formal or on the job training in programming techniques. 2 years programming experience or experience working in Product Service training with programming experience or equivalent experience in logic design, test and diagnostics design or related programming experience.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Programming Analyst</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS degree in Math, Engineering Sciences or Business. 4 years programming experience on large or medium scale digital computer system. Application and/or techniques programming experience. Machine and/or assembly language programming experience. Mass Random Access storage device programming.</td>
</tr>
</tbody>
</table>

Please send detailed resume, including salary requirements to:

**Computer Equipment Department**

**General Electric**

An equal opportunity employer (M&F)
advertisers' index

Fabri-Tek, Inc. ....................................... 94, 95
Federal Electric Corporation .......................... 169
Ferranti Electronics A Division of Ferranti-Packard
Electric Limited .................................. 142
Ferroxcube Corporation of America .................. 127, Cover 4
Fox-Morris Associates ............................... 162
The Foxboro Company ................................ 175
General Electric ...................................... 144
General Electric Computer Department .............. 181
General Motors Research Laboratories ............... 126
General Precision Inc. Librascpe Group .............. 134
General Precision Inc., Link Group ................. 71
Thomas V. Hoffelfinger Associates ................... 169
Hoffman-La Roche Inc. ................................ 158
Honeywell Electronic Data Processing ................. 35, 36, 37, 38, 168
Honeywell ............................................. 106
IBM .................................................. 64, 65, 150
Information Development Co. ......................... 88
Information Displays, Inc. ........................... 128
ITT Data Services .................................. 143
Everett Kelley Associates ............................. 165
Kennedy Company .................................... 140
La Salle Associates ................................... 148, 173
Lawrence Radiation Laboratory ......................... 148
Leeds & Northrup .................................... 160
Library of Computer and Information Sciences ... 139

Lockheed Missiles & Space Company ................. 172
Lockheed-Georgia Company, A Division of
Lockheed Aircraft Corporation ....................... 176
Lockheed Electronics Company, A Division of
Lockheed Aircraft Corporation ....................... 118, 158
Los Alamos Scientific Laboratory .................... 169
McDonnell Automation Center, Division of
McDonnell Aircraft ................................... 137
McGraw-Hill Book Co. ................................ 49
Midwestern Instruments ................................ 136
The Mitre Corporation ................................ 174
Monroe Data/Log Division of Litton Industries ...... 51
Moore Business Forms, Inc. .......................... 74
MAC Panel Company .................................. Cover 3
Magnetic Shield Division Perfection Mica Company 113
Mathatronics, Inc. .................................... 130
The National Cash Register Company .................. 112, 179
The National Cash Register Company, Electronics Division 146, 147
National Institutes of Health .......................... 164
Perspective ............................................ 158
Philco Techrep Division, A Subsidiary of Ford
Motor Company ........................................ 160
Planning Research Corporation ....................... 105, 107, 109
Potter Instrument Company, Inc. ..................... 44, 45
Precision Instrument Company ......................... 60
Programmatics Incorporated .......................... 105
Raytheon ............................................... 5, 114, 127
RCA ................................................. 170
RCA Electronic Components and Devices ............. 116
RCA Electronic Data Processing ....................... 98
Robins Data Devices, Inc. ............................ 107
Sanders Associates, Inc. ............................. 100, 104
Scientific Control Corp. ................................ 96
Scientific Data Systems ................................ 2, 3
Scientific Design Co. .................................. 173
Socony Mobile Oil Company, Inc. .................... 145
Sola Electric Co. ...................................... 48
Stanford Linear Accelerator Center ..................... 154
SYSTEMAT ............................................ 182
Tasker Instrument Corp. .............................. 13
Texas Instruments Incorporated ........................ 18
Teletype Corporation .................................. 52, 53
F. D. Thompson Publications, Inc. .................... 143
Thompson Book Company ................................ 152
3M Company .......................................... 72
Toledo Scale, Systems Division ........................ 110
Transistor Electronics Corporation ..................... 124
Ultronic Systems Corporation ......................... 131
United Fruit Company .................................. 162
Univac Division of Sperry Rand Corporation ........... 163
University Computing Company ....................... 4
URS Corporation ...................................... 171
U. S. Magnetic Tape Company .......................... 14, 15
Vermont Research Corporation ......................... 11
Wang Laboratories .................................... 109
Western Union ........................................ 160
Westinghouse Astronautical Laboratory ............... 162
Wilson Jones Co. ...................................... 55, 56
Wright Line .......................................... 141, 148
Xerox Corporation .................................... 77, 156

ElectronicsDataProcessing ............... 35, 36, 37, 38, 168

E J CC INTERVIEWS

Programmers and Systems Analysts
Call or visit our Suite
at Sheraton Plaza Hotel, Boston
9 A.M.—9 P.M., April 26—28

We will be interviewing at the conference, representing
Boston and Washington, D. C. employers who have a
need for programmers and systems analysts. Visit our suite
to obtain more information about positions immediately
available.

All fees, interviewing and relocation expenses are paid
by the employer. There is no cost to you — no contract
to sign.

If you cannot visit us during the conference, write or send
a resume to either the Boston or the Washington office.

Salaries to $20,000

Serving the E. D. P. Industry since 1961
Affiliated Offices in 54 Cities
CIRCLE 204 ON READER CARD
Computer Engineers:

Check these Boeing assignments

Openings for computer engineers at Boeing Aerospace Group installations across the country span the entire discipline. Boeing computer facilities are among the nation's finest. The largest known single hybrid computer system in the world, for example, is at Boeing's Simulation Center at Huntsville. The others are equally distinguished. The following are some of the positions now open:

**Senior Computer Engineers**

Requirements include an M.S.E.E. or B.S.E.E., plus 3 to 5 years' directly related experience in computer design, computer logic design, analysis of computer controlled checkout equipment, or complex weapon systems simulation. Positions are available for:

**Computer Systems Engineers** - Responsibilities include conducting system studies and analyzing and translating overall system requirements into associated sub-system specifications covering both hardware and software. Duties involve providing technical support in the development and integration of digital computers for research and project programs of deep space, missile, and airborne systems, and their associated checkout equipments.

**Computer Research Engineers** - Assignments involve supporting planetary and missile system efforts by application of logic design optimization procedures, adaptive techniques, Boolean analysis, and hybrid functions. Duties involve performing research, conducting studies, and directing development of unique special purpose and advanced general purpose computers. Duties also include the development of special logic circuit designs and the utilization of integrated microcircuits required for advanced and unique computer implementation.

**Data Processing and Display Engineers** - Responsibilities include analyzing overall systems objectives and defining requirements for communications, display and advanced data processing sub-systems and resolving difficult system integration problems employing microelectronic techniques. Additional duties include the simulation of complex systems by hybrid equipment, and the development of new processing and display techniques relating to sensors, instrumentation, communications, guidance and control. Positions are also available in advanced memory and display research.

**Information Systems Simulation Engineers** - Positions require applying simulation techniques to information systems in order to validate accuracy and adequacy of functional system design prior to physical implementation. Applicants must have a broad background in computer-oriented problem areas, and be capable of assuming major responsibilities involving both computer software and computer hardware.

**Computer Systems Engineers**

Requirements for the following positions are a B.S., M.S., or Ph.D. in engineering, physics or mathematics, preferably with experience in computer applications, computer systems analysis or related fields:

**Computer Applications** — Develop digital computer systems for calculating trajectories and trajectory optimization, guidance and control, loads and stresses, and temperature distributions.

Design and implement real time and near real time spacecraft performance computer programs. Assignment will involve coordination with other contractors and participation in space flight control.

Analyze and design computer programs and information processing systems to be used in support of operational command and control systems. Experience in the fields of information retrieval or query languages is desirable.

**Computer Systems Analysis** — Evaluate, develop and implement programming languages and compiler systems for scientific computing systems. Experience in large scale systems, design and development of compilers or major applications programs is desirable.

Develop and implement software systems for small and medium size computers used for on-line data acquisition and processing, military and space systems simulation and crew training simulators.

Analyze and define the requirements for digital hardware systems, specify the computer configuration required and evaluate present and proposed systems in a continuing program to advance Boeing's computing facilities.

Send your resume today to: Mr. Robert Laurie, Aerospace Group, The Boeing Company, P.O. Box 3822-DAF, Seattle, Washington 98124. Salaries are competitively commensurate with experience and educational background. Moving and travel allowances are paid to newly hired personnel. Boeing is an equal opportunity-employer.
THE INFORMATION IMPLOSION

It is a truly horrifying conclusion, but one becoming ever more tenable, that the computer has done more to aggravate man's paper work burden than to ameliorate it. What goes into a data processing system need not necessarily come out, but all too frequently the input is transduced and magnified into reports and statements of monstrous girth, which seem to serve but purposes beyond the puzzlement and arraignment of the alleged beneficiaries of the information system. The tolerance threshold of these report recipients is remarkable, but it would probably drop considerably if management ever found out that one of their computer technicians' current preoccupations is with improvement in high-speed printer speed, there having been no significant "breakthrough" here in the past few years.

The role of the computer as a kind of paper work Sorcerer's Apprentice is viewed with alarm by Congressman Arnold Olsen (D. Mont.) who notes that forays into the "Federal Paper Work Jungle" by his subcommittee on Census and Government Statistics indicate "that any overall savings brought about by EDP are more imagined than real. In fact, there is substantial evidence available that EDP is increasing our national paper work load."

Mr. Robert Widener, president of the New York firm Information Management Facilities, attributes this data generation and assimilation problem to the professional computer man's almost chronic inability to slim down his charge's output and make it sexy enough to attract the managerial interest it deserves. IMF specializes in the design of board rooms and briefing centers crammed with batteries of communication aids designed to transform the computer's squalid digital disgorgement into multi-hued charts and pictures, projected in wide-screen splendor for an executive audience lolling comfortably in capacious swivel chairs. (Thus, as the quarterly sales curve—color it red—is overlaid on that for the same quarter last year to show a startling dip, the president swivels abruptly to confront his sales vice-president who cringes nervously in the luminous half-light.) The most celebrated IMF installation is the windowless chamber used by the Bell System in Chicago for executive seminars on data communications.

The American Management Association has for some time sponsored a Continuing Seminar on Management Information Systems, with participants drawn from the ranks of top systems men in major U.S. companies. This seminar (which has, in fact, been continuing since 1955 with no signs of abatement) recently felt impelled to create a subcommittee on Management Control Center Systems to examine the benefits which would accrue to management by the establishment of an information management facility. The subcommittee, which presumably partakes of its parent's immortality, will study the technology associated with the organization and presentation of the products of the information system. Not surprisingly, one of the first things this new group did was to compare notes with IMF.

There has also emerged, as a rallying point for those interested in coping more effectively with the swelling torrent of indigestible data, the Society for Information Display. Although AFIPS has not yet clutched this society to its bosom, it has been granted diplomatic recognition by the IMF and MCCS people.

One of the things that the Society for Information Display does is hold conventions. And one of the inevitable by-products of such confabs is—you guessed it—a volume of proceedings. Thus, paradoxically, SID finds itself producing information about information and, in so doing, contributing at one level removed to the amount of data created by computer technology. And this—the generation of information that would not be needed if there were no computers generating information—brings us to Part Two of the problem.

For if there has been an explosion of information cranked out by the computer for managerial scrutiny, there has also occurred what might be termed an information implosion: an astounding increase in the amount of data about computers directed toward those who engineer and program the machines. Some people in the field have responded to this new challenge by saying the hell with it, resigning themselves to an ever-narrowing specialist's role with an attendant reduction in the range of technical literature with which they must be conversant.

Those of us who sense the anomaly of a general purpose computer driving its devotees into increasingly specialized professional niches must strive mightily to stay aloft on the rising sea of data. Were it not for the ACM's Computing Reviews, which surveys some 200 U.S. and foreign professional journals, and the Data Processing Digest, which covers about 150, it is likely that the technicians would go under long before the managers.

If Representative Olsen is receptive to suggestions, I would like to propose that he introduce legislation requiring that:

1. Governors be placed on all high-speed printers to limit their speed to 250 lines per minute.
2. All applications of computers to typesetting be proscribed forever, in order to nip in the bud yet another assault by the computer on information production.
3. A 50% excise tax be levied on all books and journals which contain the terms "Information explosion" or "management information system."

And if any of this violates the First Amendment, then the next convention I would like to see held is a constitutional convention.

—ROBERT V. HEAD

sometimes,
you can have
too much
of a good thing.

MAC Panel has taken 600 feet of top
guality, heavy-duty computer tape
and put it on a seven-inch, solid
flange reel, complete with a Wright
Line Tape Seal.
The result? Greater convenience,
greater savings in storage space,
greater economy for your computer
tape operations.
You get guaranteed computer tape,
full-width tested at 800 BPI. Also in-
cludes the standard file protect ring
and photo sensing markers. And to
brighten your day even more, you
can have MAC 600 reels in blue,
gray or red.
MAC 600 is another MAC Panel first,
and is the result of knowing what
you need and then producing it.
Whether your needs call for the
short run features of 200-foot MAC
TransiTape, the small-reel MAC 600,
or the standard 1200 or 2400-foot
lengths, MAC is your source. Your
MAC representative can give you
the full details, or write MAC Panel.
A while back, we got an order for 2,000 identical memory systems. We started making them, and before we knew it we had an assembly line. That assembly line is still going full blast.

The system is the FX-12. As far as we know, it's the first time a memory system has been mass-produced. The FX-12 costs you $1,390. That's about 40% less than you'd pay for a customized memory.

You may wonder about the FX-12's adaptability to your operations. We've standardized a memory system with a wide range of applications: small business machines, I/O equipment, data acquisition, transmission and display systems. Now that we've got an assembly line, our core memory is priced low enough to compete with core-rope, delay line, flip-flop, relay or other small capacity memory systems. And the FX-12 is a lot more versatile and reliable than those other types. Listen to these specs:

*Available in three standard sizes (512 x 8, 256 x 8, and 128 x 8).

Complete with stack and sense preamps, inhibit and x/y drives, data register, timing and control, 10 μsec full cycle operation.

Wide operating margins (±10% from 0° to 65° C).

LTC cores.

Power requirements are ±12V; less than 25W.

I/C compatible interface.

Compact size: 9" x 5" x 15".

That's our FX-12. It's ready for immediate delivery. We'll be glad to tell you all about it. Just drop us a line on your company letterhead, or call Charles Breen at (914) 246-2811. And if you've got a different memory system in mind, tell us about that also. We make memory systems. Lots of them.