ACS NEWSLETTER

a publication of the
AMATEUR COMPUTER SOCIETY

Number 1 August 1966

MEMBERSHIP AND SUBSCRIPTION

Although I'd hoped to be able to send you the ACS Newsletter free, the costs of printing and postage are just too high, despite several contributions, unsolicited but highly welcome.

Therefore, a combined membership and subscription fee of $3.00 has been established. There will be no dues, at least not in the foreseeable future. The number of Newsletter issues you will receive will depend on how many join, and should be at least 8, probably more. The Newsletter will appear about every 6 or 8 weeks.

To become a member of the Amateur Computer Society and receive the ACS Newsletter issues that will follow this one, please send $3.00 to

Stephen B. Gray
Amateur Computer Society
219 West 81 St
New York, N.Y. 10024

Those who sent contributions are ACS members as of now, and will have their subscriptions extended to the full amount of their gifts.

The Beginning

The Amateur Computer Society was launched on the afternoon of May 5, 1966, when letters of announcement were sent to ten technical and hobby magazines. So far, five have printed the letter: Control Engineering (June, p 12); QST (July, p 78); EEE (June, p 142); EDN (July, p 7); and Computer Design (August, p 12).

The original letter of announcement ran this way:

"This is an invitation to your readers who are amateur builders of digital computers to join the new Amateur Computer Society, whose main purpose is to exchange information through a newsletter. To limit the membership to the really serious, the ACS is open only to those who are building or operating a homemade computer that can at least perform automatic multiplication and division.

"The newsletter will contain queries from members with problems, answers provided by myself or other readers, details of computers built by members and by manufacturers, and information on surplus computer hardware, cheap integrated circuits, and relevant publications.

"Will qualified readers please send me information about their computers, such as word length, memory size, clock speed, number of instructions, sources of hardware and schematics, present problems, and details of clever solutions to previous problems.

"If there is enough interest in a lower-level group, it may be possible to form an "Amateur Computer Logic Society," for those who want to construct logic circuits and simple computers."

The first four magazines printed various parts of the first three paragraphs. Only Computer Design printed the entire letter, so the great majority of responses were from a rather high caliber of amateur.

Response

As of today's mail, 54 letters and telephone calls have been received, from 19 states, including Hawaii, plus Canada and Switzerland, and continue to come in at the rate of one a day. A third came from IEEE members; two are Senior Members. Five gave their ham call letters.

Most of the prospective ACS members are in the New York area (19), the Los Angeles area (11), or the Chicago area (9). Many are engineers; several work for computer manufacturers (IBM, Univac, GE, Honeywell) in logic or memory design. Two are in highschool.

As expected, only a very few are past the half-way mark in the building of their computers. One man is about two-thirds of the way toward completion; the rest range from "I've been thinking about building a computer for some time" to "I have the shift registers completed."

The most common problems are with input/output, memory, and finding overall computer schematics. This issue of the Newsletter will deal mainly with the problem of the schematics, as this is the main deterrent to getting started for most of us.

First ACS Mailing

To all those who wrote to the ACS, a two-page resume of the plans and aims of the Society was sent. Because this first issue of the ACS Newsletter will be sent to all future enquirers, the ACS resume, which was dated July 1, 1966, is reprinted here, in part:

"The main reason for the existence of the ACS is to enable amateur computer builders to help each other, saving time and money by trading ideas. And there are many areas where an amateur needs help:

"A. Circuits

1. Surplus. Where can they be bought? Where do you get the schematics? How do you use circuit boards whose terminal contacts have been broken off (as all surplus IBM SMS boards, for example)?

2. Construction. Where can you find schematics, with parts values, for not-too-complicated circuits? What are the most practical and cheapest ways of mounting the components on a board? Are homemade printed-wiring boards cheap enough to use?

3. Integrated Circuits. Who makes the cheapest and most reliable IC's? What are the best and cheapest ways of mounting them?

"B. Mounting of Circuit Boards

1. Fixed. Is there a practical way to do this?

2. Plug-In. What female connectors are cheap enough to use in quantity?

3. Modular Front Panels. Are commercial panels (with jacks) available? What types of homemade modular (individual) panels are most practical and cheapest?

(Continued next page)

"C. Interconnections

1. Fixed. Is fixed wiring practical? What are the most practical ways to use fixed wiring?

2. Plugwires. Is it practical to use plugwires to interconnect circuits? What plugwires, commercial or homemade, are cheapest and best? What cheap plugboards are available?

"D. System Design

1. Overall. Where can computer schematics be obtained? Can an amateur design his own computer?

2. Memory. What type of memory is cheapest? What is the overall cost of a core memory, per bit?

3. Display. Which is cheapest, neon or incandescent lamps? What other displays are economical?

4. Output. What output is cheapest and most practical? Are there cheap tape punches? Is a printer too expensive?

"D. Help

1. What commercial companies are helpful in providing information or surplus parts, or both?

2. What companies refuse to give information, such as schematics for surplus components?

"The plan, at present, for the newsletter is to include the above listing of the basic problems in the first issue, and then go into each of the 14 categories in one of the following issues. Each issue will also contain problems outlined by members and solutions furnished by myself (if I have the answer) or by other members in later issues. There will also be information on commercially made computer trainers, which are usually simple enough to be built by a computer amateur, if he can get his hands on the schematics.

"P.S. As for my own background, I've been an editor and writer on computers for more than 10 years, including five years as the computer editor of "Electronics" magazine."

COMPUTER SCHEMATICS

1. Flodac. The simplest computer for which schematics are available is the Univac Flodac, which is actually a fluid-logic demonstrator. However, if you have a good knowledge of logic, you should be able to convert the fluidics to electronic logic. If any of you do, please let me know; perhaps we can make the electronic schematics available to others.

Flodac has a memory (4 words of four bits each), arithmetic register, function select, clock, four instructions, etc. It's a minimum computer, but contains all the essentials.

Although Univac would not provide the schematics, the patent gives all the details. Send 50¢ to the Commissioner of Patents, Washington, D.C., and ask for a copy of patent 3,190,554, "Pure Fluid Computer," by A.J. Gehring, Jr. et al.

By the way, Univac recently started to market fluidics elements, but the prices are rather steep for an amateur, something

over $10 for a flip-flop.

2. Pedagac. Although never built, this "pedagogic automatic computer" is thoroughly described in three chapters of "Digital Computer and Control Engineering" (R.S. Ledley, McGraw-Hill Book Co., 1960, 835 pages, $15.50).

Pedagac has 19-bit words, 17 instructions, a magnetic-drum memory, serial arithmetic and a single-address scheme. There are six types of circuit cards; the basic package is an AND-OR (three ANDs and one OR), the output of the OR available direct and inverted.

The basic Pedagac transistor is a 2N643, which may be obsolete, and may be equivalent to a 2N395 or 2N397. The basic diode is a DR435 ($80/100), which may be equivalent to a TI55, 1N4009, 1N698, 1N910, 1N911, 1N497 or 1N695. The 1N911 seems the closest match, but this needs checking out.

Pedagac requires about 5,000 wire connections. The book gives a rack layout and a partial wiring table.

An associate of Dr. Ledley has written me that Pedagac has never been constructed. It was not designed to be built; as its purpose was pedagogical, the plans were not checked out as thoroughly as if construction had been the goal. It was noted that Pedagac has no real provision for input or output.

3. Digiac 3050. A $2500 semi-automatic desk-top computer trainer without memory, this has 4-bit words, three registers, input pushbuttons and output lamps, and 7 instructions.

The parallel adder uses different logic in each of the four stages: NOR, NAND, DCTL and AND-OR-INV logic.

Digiac 3050 uses 382 1N60 diodes ($23/100) and 204 transistors, designated "DE01" on the schematics. These are made to order for the company, but are directly replacable by 2N404's ($31/100).

A schematic is included for the power supply, which furnishes the required ±10 volts, and the -17.5 volts.

The Digiac 3050 manuals are $10 for the set of two, one on computer description, the other on programming and applications. Digital Electronics Inc., Ames Court, Plainview, New York 11803.

(The Digiac 3080 manual, originally planned as a $50 set of two, has finally been published as a single programming manual for $8. Digiac 3080 is a $19,500 computer trainer, desk-size, with 25-bit words, over 100 instructions, 4096-word magnetic-drum memory and paper tape I/O, plus IBM Selectric I/O typewriter.)

4. Bi-Tran Six. This $5500 desk-top computer trainer weighs 98 pounds, has a single-address binary parallel scheme, and thirty instructions. The core memory contains 128 6-bit words. Indicator lamps show the operation of all registers.

Volume 1 of the two Technical Operations Manuals covers operation, theory and schematics of individual circuits. Complete parts descriptions are included, except for transformers and core memory. The transistors used are: 2N1304, 2N1305, 2N1309. Diodes: 1N270.

Volume 2 covers maintenance

programs, wiring diagrams and logic diagrams.

Price for both manuals, $29.95; Fabri-Tek Inc., 1019 East Excelsior\Blvd., Hopkins, Minn. 55343.

5. Russian ENC. Vacuum-tube computer trainer, this "Educational Numerical Computer" uses 19-bit words, a single-address system, and has 11 instructions.

It also has a magnetic-drum memory of 1,024 words, using a "drum from a machine of the series Urals-1." Photoelectric tape-reader input, printer output.

Seventeen types of circuits are used in ENC, total of 387, including 163 flip-flops. Main tube types are 6N3P, 6P1P, 6Zh2P, for those of you with access to Soviet tubes.

The 168-page English translation of the original Russian (1963) book gives a complete discussion of ENC; very interesting to read how the "other side" computes. Send $3.00 for "Digital Computer for Training Purposes (ENC), by V.I. Matov, et al, JPRS: 24,498, OTS 64-31219," to Clearing House for Federal Scientific and Technical Information, Springfield, Virginia 22151.

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Negotiations are under way with 4 other manufacturers to see if they can sell us sets of overall schematics, but the outlook isn't good. If you know of other available computer schematics, let me know and I'll mention them in the next issue of the ACS Newsletter.

It was hoped that manuals would be obtainable for the Univac 422 computer trainer, with magnetic-core storage, 15-bit words, nine registers and 64 instructions. However, the 422 has been "destandardized," according to Univac, and the manuals are no longer available.

BOOKS AND BOOKLETS

We Built Our Own Computers, A.B. Bolt, editor. Cambridge University Press (New York office: 32 East 57 St.), 1966. 101 pages, $3.95 hardcover; $1.95 paperback.

This book, reviewed here only because several members had asked about it, describes very simple computers, analog and digital, made by 6th-form boys (12 years old) at a British school.

Of use only to beginners and those working with beginners. The digital "computers" all use relays and are quite small.

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Integrated Circuit Projects From Motorola, available from HEP, Dept. ACS, Box 955, Phoenix, Arizona 85001; $1.10 ($1 plus 10¢ for handling and postage). Has 96 pages, is the first IC project book for the hobbyist and experimenter. Among the contents: a square-wave generator with 10-nsec rise time, frequencies from 6 Hz to 60 kHz; binary computer; organ, etc. (Haven't seen it yet, but seems well worth the dollar.)

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Design of Transistor Switching Circuits for Data-Processing Equipment, 75 cents from RCA, Electronic Components and Devices, Harrison, N.J. Has 44 pages on design considerations, procedures and examples, plus typical switching circuits using RCA transistors. The 16 circuits use a variety of transistors and

voltages; there is not a unified set of circuits. The booklet ends with a computer transistor data chart: 6 memory-driver types, 44 logic types, maximum ratings and electrical characteristics limits for each.

PROBLEMS AND (SOME) ANSWERS

1-1. Where can I buy computer components?

These have been mentioned:

John Meshna, 19 Allerton St, Lynn, Mass. 25¢ for catalog.

ALCO, 3 Wolcott Ave, Lawrence, Mass.

C and H, Pasadena, Calif.

Salvage Depts of Autonetics and Hughes Aircraft, in California, Saturday mornings.

NOTE: Order by mail only as a last resort. Word on one store is that "much of the computer equipment is pretty junky ... the memory drums seemed beyond repair...." Caveat Emptor.

1-2. Does anyone have manuals or schematics for the magnetic-drum system built by LFE in 1955-6 for the RCA 501, with a 15-million-bit capacity, 120 heads, 100-plus mercury-wetted relays and what appears to be two separate amplifier chassis?

1-3. Where can I get "WY" IBM SMS circuit cards?

1-4. How can I solve the problem of high-speed, high-power drum-head-switching at low cost?

1-5. What is a suitable connector for a 10" x 12" PC board? I'd like to use wire-wrap interconnections.

1-6. Where can I buy low-cost integrated circuits?

The cheapest IC's I've seen are the Fairchild RTL epoxy TO-5 devices, newly reduced to:

	1-99	100-999	1,000 up
Buffer	$.80	$ .54	$ .36
Dual 2-input gate	.80	.54	.36
JK FF	1.50	1.00	.67

Fairchild Semiconductor, 313 Fairchild Drive, Mountain View, Calif.

The Motorola MC700P series includes a dual JK flip-flop for $2, 1-999; the Philco E-line Series DTL has a JK FF for $2.80, 100-999.

1-7. How can I design a 10-μsec delay line using RC elements?

1-8. What are the pros and cons on serial versus parallel address and associated circuit requirements?

1-9. Where can I locate a cheap electroluminescent output display?

YOUR ANSWERS TO THESE PROBLEMS WILL BE PRINTED IN THE NEXT ISSUE.

THE LAST WORD

That's it for the first issue. As of today's mail, we have 60 potential members. And the latest word on the possibility of being able to buy overall schematics for a couple of standard computers is more encouraging now. See the next issue.

NEXT ISSUE will be about input-output equipment. If you have had any experience with this, or thoughts to share, send details. What is cheap and reliable? Can we make it? Where can we get it? How much of an interface does it require?

[A][C][S] NEWSLETTER

INPUT/OUTPUT ISSUE

a publication of the
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Number 2 October 1966

MEMBERSHIP

Inquiries about ACS membership have been received from 77 men thus far, in 23 states, Canada, Switzerland and Italy. Of these, 36 have sent in the $3 to become members (4 have sent in more), including the Canadian, so the ACS is now an international group.

INPUT/OUTPUT

Although there are a great many types of input/output equipment, nearly all are beyond the financial reach of the average amateur, or they take up too much space. Card readers and punches, magnetic tape, electric typewriters, electroluminescent panels, printers, crt display -- these are usually too expensive and most of them are too big. In the middle ground are such devices as rear-projection display, Nixie tubes, paper tape readers and punches, magnetic drums -- expensive if new, often reasonable when used or surplus. That leaves, at the cheap end of the scale, lamps and pushbuttons.

With only lamps and pushbuttons as input/output, automatic program loading is not possible, nor is the read-in of external data. Output consists of reading the register lamps.

This is well and good for the first stages of computer building, but sooner or later the amateur wants to get into automatic operation. His first step is often in the direction of Teletype gear.

The ACS is fortunate to have a member with much Teletype experience, Jim Haynes, who has analyzed the various models of Teletype equipment for us:

Teletype Equipment

Although Teletype gear is slow and awkward to use, it is readily available and relatively cheap. The only stuff that is widely available uses the 5-level Murray (often called Baudot) code.

The old Model 12 has the advantage, for computer use, of having a parallel-input printer and a parallel-output keyboard. This is so old it is obsolete even for amateur use, but probably some of the machines can be obtained from hams in the New York area, which was its mainstay.

The more recent and more popular Model 15 is quite widely available (for example, see the All-tronics-Howard ads in QST magazine). This, like the rest of the later Teletype line, has the disadvantage for computer use of requiring serial signals. Thus one must build an electronic serial/parallel/serial converter, or find an electromechanical one (not too hard to find, particularly in New York).

The current Model 28 line is usually available, and although serial in operation, is more attractive for computer use because of its higher speed capability (100 wpm, 10 char/sec) and because it is more readily recoded to a more computer-compatible code. In fact, one who is ambitous could even convert it to a

Model 35, which uses the ASCII code. But probably it would be easier to keep the 5-level code and just rearrange the numeric characters for a BCD code. However, once one has a program in and running, he can convert code to Murray in the computer, so that odd-coding would be needed only to get the initial program in and running. For a serial computer, this might well be done as in the Raytheon 250, loading one bit for each character of input.

For information on the availability of 28-line equipment, contact Bert A. Prall, 558 Ridge Ave., Winnetka, Illinois. If one plans to do his own rebuilding and repairing, this should be specified, as the gear is much cheaper that way.

One can also get new Teletype gear from the factory; the Model 33 8-level ASCII machine is quite popular with small computer makers, and can be had for about $600. Contact Mr. R.R. Bogdan, Teletype Corp., 5555 Touhy Ave., Skokie, Illinois.

Teletype also has punched-tape apparatus capable of higher speed (105 char/sec). There is very little of this on the surplus market, but Bert Prall is the one to try.

Some saving can be had on the Teletype equipment new from the factory, by buying the bare-bones units (typing unit, keyboard) separately and doing your own cabinet or cover. The regular keyboard has to have the typing unit to make it work.

One nice feature of the 33 line is that the keyboard is parallel and there is an electrical parallel/serial converter. Thus one can use the parallel interface rather than the serial interface that is normally used for communication purposes. Also, the paper tape reader in this line is magnet-driven, which makes it nice if one wants to use the tape reader by itself. The punch is made to be used with the typing unit and cannot practically be used alone.

Then there is the more rugged Model 35 line, but an amateur would not likely want any of this, as it is quite a bit more expensive. (This is used in some SDS and Univac computers, and others.)

If one wants to be a bit archaic, he could find out all he wants to know about the Teletype and magnetic-wire I/O gear used with SEAC by contacting the National Bureau of Standards. This is, of course, completely obsolete by today's standards. However, one might be able to do something in the way of working over a cheap tape recorder to get high-speed operation on the computer and slow-speed recording and playback from Teletype gear.

(National Bureau of Standards Circular 551, issued Jan. 25, 1955, "Computer Development (SEAC and DYSEAC) at the National Bureau of Standards," was at one time available for $2 from the Supt. of Documents, Govt. Printing Office.)

This is about all except to mention that in San Francisco one should try Buckley's. He usually has Teletype gear, and he once had some old IBM Electrowriter stuff, although the latter was in pretty bad condition. But the Electrowriter is not at all wanted by hams, which should hold its price down.

P.S. The 5-level Murray code is a bit awkward to handle, but then one could rearrange the Teletype keyboard and the type pallets to get his own 5-level code based on

BCD or excess-3 or whatever is desired. But then, in a machine of any size, one can do the code conversion by programming, or by making an off-line converter, so that the standard machine may be used, thus preserving the normal keyboard arrangement. Therefore, the major I/O problem is what to do when Teletype equipment isn't fast enough.

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Another member, Fred Strother, has furnished the names and addresses of companies that sell used Teletype equipment:

Where to Buy Used Teletype Gear

Atlantic Surplus Sales Corp.
250 Columbia Street
Brooklyn, New York
(catalog)

J. Thamsen W9YVP
11001 South Pulaski Road
Chicago, Illinois 60655

Alltronics-Howard Co.
Box 19
Boston, Massachusetts 02101

Elliott Buchanan W6VPC
1067 Mandana Boulevard
Oakland, California

Columbia Electronics (catalog)
4365 W. Pico Boulevard
Los Angeles, California 90019

R.E. Goodheart Co., Inc.
Box 1220-A
Beverly Hills, California 90213

Fred suggests the Teletype Model 14 reperforators and tape distributors, available at a very nominal price. These units print and perforate 9/16" tape from a five-level coded signal. The keyboard and the tape distributor both generate the same 5-level code.

Neon Drivers

Jim Haynes writes that a most economical and satisfactory display is a neon indicator driver by a high-mu triode such as a 12AX7 or 5965. The grid of the tube can be driven direct from the usual sort of logic voltages in a transistor system. A 100K series resistor at the signal source prevents the indicator-circuit wiring capacitance from loading the circuit at all.

One can get very nice-looking neon indicators encased in plastic for panel mounting for around 20 cents each. Jim puts ten of the 12-volt tubes across the power line so that no filament transformer is needed. An isolation transformer capable of supplying about 1 ma per lamp is satisfactory for the plate supply. A full-wave bridge rectifier without a filter is satisfactory.

This arrangement doesn't load the circuit as a transistor-driven indicator would, and it is much cheaper than either a transistor-driven indicator or a 6977 indicator triode. It gives a nice bright light, and allows the use of isolating resistors to prevent capacitive loading from bothering anything.

With integrated circuits and low-voltage transistor logic there are problems with this arrangement, however, because the gain of the triodes isn't high enough. And there is the problem of all that heat from the tubes.

Neon Lamps

According to Pete Showman, neon lamps are cheaper and more efficient than incandescents, an NE-2 costing 10¢ and a #1819 with socket costing 32¢. However, there doesn't seem to be a 22¢,

70-volt neon-driver transistor, and incandescent drivers can be had for about 10¢, surplus. Sylvania's incandescent display lamps are much easier to use, but cost about 65¢ per bit, with sockets.

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Information on how to age and select neon lamps is contained in "Build This Electronic Computer," in the November, 1966, issue of Electronics Illustrated. The device is actually an accumulator rather than a computer.

Voice Output

One member has a voice output for his computer. Two stereo heads are staggered to provide four tracks. Each track is subdivided into three sub-bands to provide ten channels and a control channel.

CRT Display

For those amateurs interested in cathode-ray-tube display, an informative survey article is contained in the January 1965 issue of Electro-Technology, "Digital-to-Visible Character Generators," by Sherman H. Boyd, pages 77-78, 80, 84, 87-88. The systems most likely to appeal to amateurs are dot generators and vector generators.

Pete Showman believes a crt system to be considerably cheaper than a Nixie-tube readout for more than one register, and infinitely more versatile. He thinks an alpha-numeric display could be built for under $150, and a numeric-only system for about half as much.

An interesting twist is found in "Forming Handwritten-Like Digits on CRT Display," by R.L. White, in Electronics, March 13, 1959, pages 138 to 140. The ten number generators produce the necessary horizontal and vertical waveshapes by a simple shaping of a 60-cycle input.

COMPUTER SCHEMATICS

Control Data has, for $34.50, a maintenance and training manual, containing some diagrams, on the LGP 21 and the RPC 4000, both in the same publication, Pub. No. ESD 10600.

The CDC 160-A Computer System Customer Engineering Diagrams Manual, Pub. No. 600 142 00, is $2.70 per copy.

All inquiries and orders should be sent to:

Literature Distribution Center
Control Data Corporation
1015 South 6th Street
Minneapolis, Minn. 55440

The LGP and RPC were previously sold by the Librascope Division of General Precision; before that, the RPC was sold by the Royal McBee Corp.

The LGP 21 has 460 transistors, 375 diodes and no cores. Still in production, its main frame costs $16,000. Desk-size, it weighs 90 pounds, has a magnetic-disk memory with 4,096 31-bit words, 23 instructions. Single-address, serial arithmetic. Paper tape and typewriter input/output.

The RPC 4000 contains 500 transistors, 4500 diodes, no cores. Original price, $87,000; now, out of production, $28,000. The size of two desks, it weighs 900 lbs, has a drum memory with 8008 words, 32 bits each. Two-address, serial arithmetic, 36 instructions. Paper tape and typewriter input/output.

The 160-A contains 1700 transistors, 11,900 diodes and 402 cores. Original cost, $90,000; now, out of production, $35,000. Desk-size, it weighs 850 pounds, has optional core, drum, disk or tape memory. Single-address, parallel arithmetic, 12-bit words, 130 instructions. Paper tape I/O.

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Although many ACS members write that designing the computer is half the fun, there are just as many who are interested in obtaining schematics. So we'll keep on looking.

INTEGRATED CIRCUITS IN QUANTITY

Pete Showman has volunteered to help ACS members take advantage of the much lower prices of IC's when bought in large quantities. If you want to buy IC's in quantities of 50 or more, write, giving full details of exactly what you want, to:

Peter S. Showman
403 School St.
Watertown, Mass. 02172

ANSWERS TO PREVIOUS PROBLEMS

1-1. Who sells computer parts?

Herbach and Rademan, Inc.
1204 Arch St. (catalog)
Philadelphia, Pa. 19107

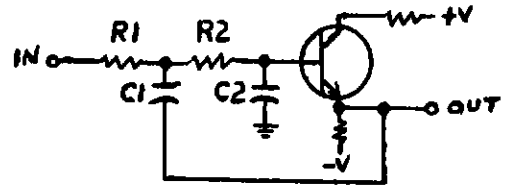
Gadgeteers Surplus Electronics
5300 Vine St. (catalog)
Cincinnati, Ohio 45217

Selectronics
12 South Napa St.
Philadelphia, Pa.

Leeds Radio Co.
75 Vesey St.
New York, N.Y. (no catalog)

1-7. How can a 10-μsec delay line be designed using RC elements?

Jim Haynes doubts that a very practical delay line can be built with RC elements. If one insists, perhaps an active circuit will do:



This is an active low-pass filter, so presumably it produces a pure delay below the cutoff frequency. However, a lot of sections would be needed if a good pulse shape is to be preserved. R1C1 should be made equal to R2C2, and the C1/C2 ratio is a critical parameter.

Pete Showman says delay lines are easy to make, if you don't need large bandwidth and a long delay together. Look in the Radiotron Designer's Handbook under pi-section low-pass LC filters for some data. $Z_o = \sqrt{L/C}$, $f_{co} = 1/(\pi\sqrt{LC})$, delay per stage $\cong 180^o$ @ f_{co}, so $T \cong \frac{1}{2}\pi\sqrt{LC}$ per stage. Try winding the inductors on long polystyrene rods, with spacing about equal to winding length (or more). Choose L and C from cutoff frequency and impedance. The delay time determines the number of stages needed, so, for instance, a 300-ohm, 5-MHz, 1-μsec line needs 30 stages.

Bill Greene says he's found two companies in the New York area that can supply magnetostrictive delay lines for $125 to $156, for 2 to 5-msec types:

Sealectro Corp.
139 Hoyt St.
Mamaroneck, N.Y.

Digital Devices
212 Michael Drive
Syosset, N.Y.

The Amateur Computer Society is open to all who are interested in building and operating a digital computer that can at least perform automatic multiplication and division, or is of a comparative complexity.

For membership in the ACS, and a subscription of at least eight issues of the Newsletter, send $3 (or a check made out to me)to:

Stephen B. Gray
Amateur Computer Society
219 West 81 St
New York, N.Y. 10024

The Newsletter will appear about every eight weeks.

1-8. What are the pros and cons of serial versus parallel operation and associated circuit requirements?

Jim Haynes feels that the pro of serial operation is the small hardware requirement and the con is the slowness, which is why serial operation has all but disappeared from modern commercial computers.

If serial operation is to be used, Jim strongly recommends that negative numbers be represented in two's complement form, which simplifies things enormously. A good write-up on a serial computer is in the book, "Analog and Digital Computer Technology," by Scott.

Serial operation is good with drum or disk or delay-line storage, which is a pretty cheap form of storage. For registers, one could use short delay lines, drum or disk tracks with multiple read heads, or the new IC shift registers that have a lot of bits on one chip. These IC's are rather expensive ($75 or so), but that is cheaper than most brand-new delay lines and is certainly cheaper than a flip-flop register.

PROBLEMS FOR THIS ISSUE

2-1. Is there a book or article on designing memory-core drivers?

2-2. Where can one buy one of the new pushbutton telephone dials?

Herbach and Rademan have a 16-button Western Electric 508 pushbutton switch for $24.95.

See "A Pushbutton Telephone for Alphanumeric Input," in the April 1966 issue of Datamation, pages 27-30. The system described requires 12 pushbuttons.

2-3. Can hams get used Teletype gear from Western Union?

Yes. Through arrangements with the ARRL (American Radio Relay League) surplus teleprinter and related equipment is made available at no charge to licensed radio amateurs.

Western Union is disposing of surplus equipment, including the Model 2B (same as Model 14 narrow tape printer), Model 26 and Model 100 page printers. Later WU expects to dispose of Model 14 reperforators, as well as Model 15 and Model 19 equipment.

Hams desiring more info, write to:
Frank C. White (Coordinator-WUSP)
2706 Harmon Road
Silver Spring, Maryland 20902

NEXT ISSUE will be about computer circuits, mostly about build-your-own and where to get the schematics, also some info on surplus circuits and IC's. If you have any experience with these, or thoughts to share, please send details. Where do you get schematics for surplus circuits? Are homemade printed-wiring boards cheap enough to use? How do you use boards with broken-off terminal contacts?

ACS NEWSLETTER

a publication of the
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COMPUTER CIRCUITS ISSUE

Number 3 December 1966

MEMBERSHIP

The ACS is now intercontinental. We have a new member in Bologna, Italy, who may be known to some of you hams as i1LCF.

COMPUTER SCHEMATICS

Although many ACS members say they find that designing the circuits for their computers is the most interesting part of their hobby, there are just as many members who cannot design their own, and who need help. This issue tells where to get various circuit schematics.

Government Publications

There is a variety of government publications about computers and their circuits, usually much cheaper than commercial publications. One of the best known agencies, in digital work, is the National Bureau of Standards, which has published several Technical Notes of interest to the ACS.

NBS Technical Note 68 (76 pages)

This technical note, "Transistorized Building Blocks for Data Instrumentation," was published in September 1960, and is available for $2.00 from the Clearinghouse for Federal, Scientific and Technical Information, Springfield, Virginia 22151.

These digital modules were developed for the "many data recording and preliminary processing tasks encountered in the scientific operations" of the Bureau. The modules were designed with three factors in mind: reliability, economy and versatility.

Most common is the 2N414 transistor, with a few 2N363 and 2N123 types also used. The diode, a gold-bonded type, is the only expensive item: this DR435 costs $80 per 100. However, possible equivalents are the TI55, 1N4009, 1N698, 1N910, 1N911, 1N497, or 1N695. The 1N911 seems the closest but this needs checking out.

The modules include a flip-flop, NAND gate, one-shot, analog switch, RCD gate, analog voltage comparator, decimal decoder, octal-hexadecimal decoder, power driver, indicator driver, read circuit (for drum or tape), write circuit, and pulse generator. Printed-wiring layouts are also given, for those who wish to make their own.

Supply voltages are -12, +12 for bias, and a reference voltage for the analog circuits. The pulses have a propagation delay averaging 0.5 μsec, and a 6-volt rise in not more than one μsec. The flip-flops operate at a 50-kHz maximum.

NBS Technical Note 168 (112 pages)

Bearing the same title as TN 68, this technical note was published in 1963, and is available for 55 cents from the Supt. of Documents, U.S. Govt. Printing Office, Washington, D.C. 20402.

This TN contains several additional circuits (gated T input, preamplifier, pulse stretcher, sampler, BCD counter), modifications of some TN 68 circuits, and corrections of errors appearing in TN 68.

The flip-flop drawings show that speed-up diodes may be added across the input-gate resistors. Although the text doesn't say so, these diodes increase the maximum flip-flop frequency to 400 kHz.

NBS Technical Note 268 (122 pages)

This technical note has the same title as TN 68 and TN 168, was published in 1966, and is available for 60 cents from the Supt. of Documents, USGPO.

This technical note makes some changes in the previous circuits, because of the special requirements of a particular group at the NBS. The basic logic transistor here is the 2N404; the complementary transistor is the 2N1302. For higher currents, a 2N659 is used; for even higher currents, a 2N1039.

For better temperature performance, a silicon series was also designed, using the 2N3638 instead of the 2N404, and the 1N270 diode, which costs half as much as the DR435. Silicon equivalents are also given for the other transistors.

In the germanium series of TN 268, the change to a 2N404 has meant, with respect to the modules of the two previous notes, only that some base resistors and capacitors have different values.

Several circuits are new: reed-relay card, 16 x 16 matrix, coil driver, comparator gate, ripple shift register, high-impedance amplifier, and oscillator/one-shot. This last circuit can be used in three ways, depending on the outboard wiring.

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According to the author of one of these technical notes, the use of discrete-component modules has recently been abandoned at the NBS in favor of integrated circuits.

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Application Notes

Although there have been many applications of these digital modules in various sections of the NBS, and a variety of application notes, all but one are NBS internal publications, and are not available to the public.

NBS Technical Note 64, "Design and Operation of the Ceilometer Computer," was published in 1960, and is available from the Clearinghouse for $2.00. This concerns the design of AMOS, a special-purpose computer for keeping track of data relating to cloud heights, for automatic weather stations.

Because no computing circuits are involved, this TN is of secondary interest to the ACS, although it does contained detailed schematics that give useful information on various interconnections.

The computer is more of an information storage and retrieval device than a computer. A magnetic drum stores data on varying cloud heights. A few simple comparisons are made between data groups, and various cloud-height data is made available, either as lamp output or through switch contacts for remote display or printing. Some 145 digital modules are used.

Data Systems Technician 3 & 2

This Navy Training Course was published by the Bureau of Naval Personnel as NAVPERS 10201. Available for $3.00 from the Supt. of Documents, USGPO.

This 468-page book, written for Navy men striking for a higher

rating, is highly recommended. It is an excellent source of information, either for the computer expert, or for a novice with a good electronics background.

After three short chapters on introduction and number systems, there are six chapters (122 pages) on basic computer subsystems: control unit, arithmetic unit, memory and storage units, input/output devices, programming, and A-D and D-C conversion.

The next five chapters (203 pages) discuss in detail, with many schematics, the NTDS (Naval Tactical Data System) computer (CP 642A/USQ-20v), which is the Univac 1206. This military general-purpose computer has 30-bit words, 62 instructions, 36,768 words of core storage. The circuits are almost all made up of inverters and indicator drivers; flip-flops are two inverters cross-connected. Add time is 16 μsec, including storage time; 9.6 μsec without. There are 7 index registers, an accumulator, and one other register that can be used as an accumulator. It contains 32,298 diodes and 10,702 transistors, and has a main-frame volume of only 58.6 cubic feet.

As the book says, "the coverage is not all-inclusive," so don't expect a full set of prints. However, the 50 partial schematics go a long way.

The remaining four chapters cover other Navy computers (Control Data 160-A and 1604-A, briefly), test equipment, maintenance information and maintenance procedures.

NOTE: The Navy has informed me that all 2500 copies of the first edition have been sold. However, a second edition should be available in about 12 months. So make your orders next winter. In the meantime, you can take a look at this book (on microfiche) at any full depository of U.S. Government publications, which is usually the largest public library in the state. Ask for U.S. Govt. Publication 18658 (listed in the Nov. 1965 monthly catalog).

Researching computer literature is a subject in itself, which will be covered in a future issue.

Preferred Circuits

The Handbook of Preferred Circuits, Navy Aeronautical Electronic Equipment, is in two volumes: the first is on vacuum-tube circuits; the second on semiconductor device circuits, NAVWEPS 16-1-519-2. Price $1.75, Supt. of Documents, USGPO. The latest date I've seen is April 1962, although it may have been revised.

The 1962 edition contains 22 circuits; 11 are computer-type: two NOR gates, flip-flop, one-shot, pulse shaper, pulse power amplifier, indicator, two more flip-flops, pulse generator and a relay control flip-flop. The first 7 circuits use a 2N404, and require +6, -6 and -18 volts.

The other circuits in this book include five d-c regulators and several video circuits.

Commercial Publications

There are a few commercial publications, and a lot of manufacturers' literature, that give logic-circuit information, other than computer textbooks. Here are some of the best of both:

Computer Logic Circuit Characteristics Tabulation, issued in two complete editions a year, August and February. Each new edition completely updated. Annual subscription $32.50, D.A.T.A., Box 46B, Orange, N.J. 07050.

Contains schematics and major electrical characteristics of 3,200 off-the-shelf commercially available circuits produced by 66 companies. Includes price information.

NOTE: No component values, nor does the company sell outdated editions at lower prices.

D.A.T.A. has a similar service for transistor characteristics, diodes and SCR's, and semiconductor device mounting hardware.

Manufacturers' Literature

Some of these cost money, others are free but often hard to get without a business letterhead.

Digital Logic Handbook, 328 pages, Digital Equipment Corp., Maynard Mass. 01754.

This handbook, which has gone thru several editions, is given away in huge quantities at computer shows, and contains much useful information. The DEC system of drawing circuits is highly stylized and takes awhile to get used to.

Short Cuts to Successful Data Processing Systems, 30 pages, Magnetic Systems Corp., 2000 Calumet St., Clearwater, Florida 33515.

Sections on how to implement logic with NOR-NAND gates, loading, applications, and circuit specs.

Digital Module Application Manual, 114 pages, $1.50, Raytheon Computer, 2700 South Fairview St., Santa Ana, Calif. 92704.

Many types of counters, shift registers, adders, with 13 pages on logic design, 9 on circuit descriptions and symbols, and 9 on application rules.

Digital Application Notes, 68 pages, Interstate Electronics Corp., 707 East Vermont Avenue, Anaheim, Cal.

If still available (my copy is dated 1961), this easy-to-read booklet is well worth getting, with 37 pages on applications.

Standard Products and Circuit Modules, 88 pages, Systems Engineering Laboratories, Inc., P.O. Box 9148, Fort Lauderdale, Florida 33310.

My copy is a preliminary edition, so the final issue may have a different title, and be longer.

Unusual in that it gives all component values: 2N404 (medium-speed series), 2N1499A or 2N962 (high-speed series), using +6, -6, -12 volts. 1N192 diodes. 23 pages of applications.

G-Series. Engineered Electronics Co., 1441 East Chestnut Avenue, Santa Ana, Calif. 56 pages, 5 on applications.

EECo has the largest selection of off-the-shelf digital modules, with half a dozen families of modules. The full catalog, in the EECo looseleaf binder, is 2½ inches thick, with a quarter of an inch of application notes. The series of most interest to amateurs are probably the G, U and Q. There is a separate application-note booklet for the Q series.

Fairchild Microcircuits Handbook. Fairchild Semiconductor, 313 Fairchild Drive, Mountain View, Calif. 94041.

This looseleaf handbook contains sections on the various types of Fairchild micrologic: µL, MWµL, DTµL, TTµL, CTµL, linear circuits, plus application notes and technical articles. Hard to get.

IBM Customer Engineering Manual of Instruction, Transistor Component

Circuits, 223-6889-3. 171 pages.

Gives full schematics and circuit operation descriptions for six series of SMS cards, used in the 7000 series, the 1401, etc. Not all SMS cards are given here, for some reason. A great many of these circuits are level converters, coupling networks and line terminators.

Although published in White Plains, New York, this manual, like nearly all other IBM publications, is available only through an IBM branch office. To get this particular one, of course, is not easy.

COMPUTER SCHEMATICS

DE-60 computer, by Clary Corp., a desk-size machine, 300 pounds, 200 transistors, 2,000 diodes, 14 thyratrons. Drum memory of 32 words, 18 decimal digits per word. Serial arithmetic, 37 instructions. Keyboard input, typewriter output. Tape and card I/O optional. Automatic built-in subroutines are contained in plug-in diode cartridges. Original price, $18,000. Add time, 3 msec; including storage access time, 60 msec. Time includes access to five addresses and automatic alignment of decimal point. Internal numbering system is BCD.

Clary is introducing a new machine line that obsoletes the DE-60. Therefore Clary can make the DE-60 wiring diagrams available to us "in limited quantities, free of charge." I have a set of these schematics, and it would be extremely difficult to build a computer from them. Frankly, I don't think I'd try. If you must, write:

Mr. Duane Langer, Service Mgr.
Clary Datacomp Systems
788 Bloomfield Avenue
West Caldwell, New Jersey 07007

Incidentally, there was very little subroutine cartridge information in the drawings I received.

CURRENT PUBLICATIONS

Scientific American, September, 1966. Special issue on computers. Covers the field fairly well, from describing how a NAND gate works to giving a computer program for playing checkers. Good bibliography for each of the 12 articles.

This issue sold out fast and the publisher has no copies left, so you may have to go to the library.

Computer design series in Electronic Design magazine, by an IBM advisory engineer. First article in the Sept. 27, 1966 issue, pages 86-91, "Digital computers are no mystery," showing some of the basic combinations of circuit blocks. Second article, in the Oct. 25, 1966 issue, pages 72-81, gives a checklist to help evaluate module requirements. Three more articles will appear in this series, but they have not yet been scheduled.

Occupations in Electronic Computing Systems, 72 pages, 30¢ from the Supt. of Documents, USGPO. If your friends and neighbors ask what kind of jobs there are in computers, or if you'd like to know more about the subject, this is an excellent booklet. It describes the history of computing, current status, the digital work-flow process, and 23 computer occupations in detail. Also includes a glossary, a long and good bibliography, and sources of additional information, such as ACM, BEMA and IEEE.

CATALOGS

Among the current catalogs to be recommended are those of two companies that are very useful when you need to order by mail:

The Amateur Computer Society is open to all who are interested in building and operating a digital computer that can at least perform automatic multiplication and division, or is of a comparative complexity.

For membership in the ACS, and a subscription of at least eight issues of the Newsletter, send $3 (or a check made out to me) to:

Stephen B. Gray
Amateur Computer Society
219 West 81 St
New York, N.Y. 10024

The Newsletter will appear about every two months.

Allied Electronics
100 N. Western Avenue
Chicago, Illinois 60690
(Get the Industrial catalog)

Newark Electronics Corp.
500 North Pulaski Road
Chicago, Illinois 60624
(Branches in Inglewood, Calif.; Cincinatti; Grand Rapids; Denver; Detroit and New York)

Both catalogs list semiconductors in two ways: by N numbers and by manufacturer. Using the N list, you can compare prices.

The 1967 Newark catalog has ten pages on ICs, made by Motorola, Texas Instruments, Raytheon, General Electric, General Instrument, Sylvania and Sprague. Nearly all digital. Cheapest J-K flip-flop listed is Motorola's Unibloc MRTL dual FF for $2, 1-999, as noted in the first ACS Newsletter

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ANSWERS TO PREVIOUS PROBLEMS

2-1. Is there a book or article on designing memory-core drivers?

Doesn't seem to be. I've asked several core manufacturers, but none has found anything. Looks like the designers are keeping their secrets to themselves.

PROBLEM FOR THIS ISSUE

3-1. Instead of using a set of pushbuttons for manual input to every register, how can one use one set of pushbuttons and some kind of switching system?

TRADING CORNER

A member wishes to dispose of 20 or 30 magnetostrictive delay lines; all but one is 1848 μsec long. Originally made to operate above 1 Mc, but few seem to operate that fast. May work OK at lower frequencies, or one could rewind the transducers for faster operation (tricky, but has been done). Complete with drive and read electronics, using surface barrier DCTL transistors. Designed for ±3 volts. Asking price, $5, postpaid. James H. Haynes, 1809 W. El Caminito, Phoenix, Ariz. 85021. Also has a few DCTL circuit boards, each with 30 or 40 SB transistors; some have 7 flip-flops each, some have ???. Asking $7 for these, postpaid, with connectors. Power supply for these boards, ±3 V & -10, $25.

Jim Haynes also says that Teletype sells circuit cards, etched but without components mounted, as maintenance parts. Reasonable cost, about 75¢ for a 2½ X 4¼-inch card which goes into a 15-pin edge connector. Jim can supply the Teletype part numbers for various configurations.

NEXT ISSUE will be about memory circuits, with an article on how to check out magnetic cores of unknown origin, along with some general information on surplus. If you have any experience with computer memories, please send details for the next issue. Any ideas on the overall cost per bit for a core memory, including read-write electronics?

A C S NEWSLETTER

MEMORY ISSUE

a publication of the
AMATEUR COMPUTER SOCIETY

Number 4 February 1967

MEMBERSHIP

A letter about the ACS in the January IEEE Spectrum (page 129) has brought a fresh flow of inquiries about membership. The ACS now has members in 20 states, plus Canada, Italy and Switzerland.

WHAT TO DO WITH CORES OF UNKNOWN ORIGIN, by Sal Zuccaro

(Sal has been in memory design for 10 years, and has patents in core-diode logic.)

The used and surplus planes I've seen on the market are real antiques. I tested one originally made by Univac and found the switching time to be about two microseconds. A memory using this 80-mil core wouldn't be able to go faster than a five-microsecond cycle time. The size also would be excessively large.

There are several possible reasons for core planes being in the reject bin. One is that too many cores in the matrix need to be replaced. Another is that too many were replaced to pass the quality-control requirements of some given project. One more is trouble in the manufacturing process where the magnet wires are corroding for some reason. In like manner, a batch of cores could be too weak or brittle and thus subject to breakage.

Sometimes a bunch of cores will have a shifting loop; that is, they have a magnetic bias. Cores in this category used to get well into production before someone discovered the defect. Mechanical damage, such as lifted pads, etc., is a frequent cause for rejects.

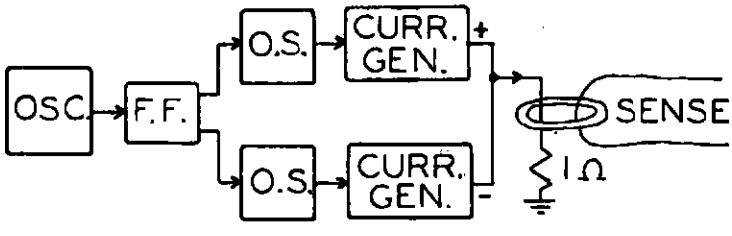
Happily, however, the reject bin also gets good usable frames, from several causes.

Because every computer manufacturer uses a different size memory with any of a number of different cores, any event that stops a large production run in the middle, puts good matrixes into the scrap bin. Nobody wants anybody else's design.

Cores are not going out of style; in fact, the demand is increasing. As for speed, our fast cores are turning over in 75 to 80 nanoseconds. Down in this region, the transition time of the signal along a wire is quite significant. [In one nanosecond, a pulse travels along some 9 inches of wire.]

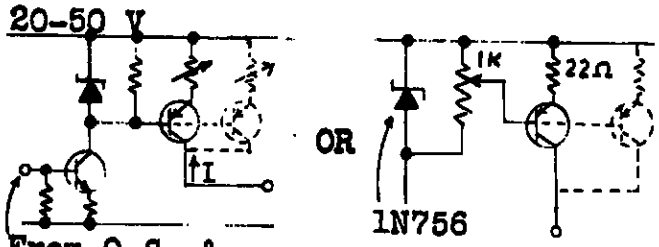
Here is an outline of a few steps to take with a core of unknown origin. You need a bidirectional constant current source, so you can turn the core first in one direction and then in the other.

The simplest setup would be:

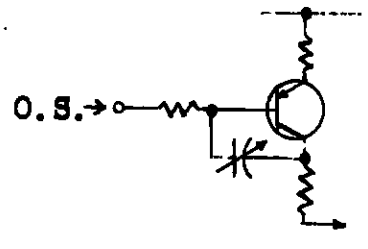


The amplitude of the current is monitored across the one-ohm resistor with an oscilloscope.

Some of the simplest forms of current generators are shown at the top of the next page. Parallel the output transistors as needed to get the required current.

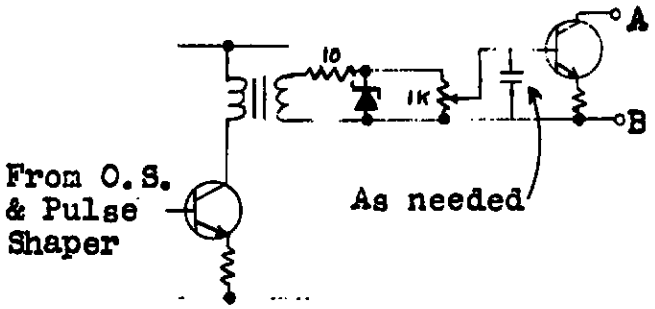


The pulse shaper can be just a Miller circuit:



For the negative, just replace NPN's with PNP's, and invert voltages.

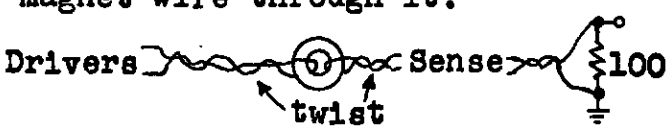
A little simpler system is:



This circuit has the advantage that it can pass a constant current from either the positive or negative voltages. For positive, A goes to a positive voltage and B is the output. For negative, B goes to a negative and A is the output. Any number can be connected to the same output terminal.

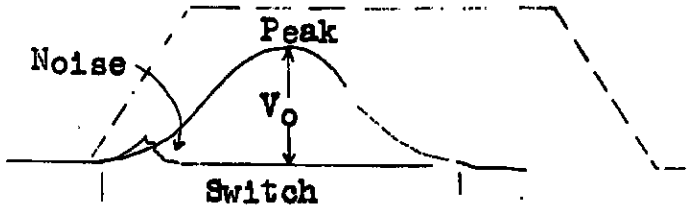
Pulse widths should be around five microseconds. Rise and fall times, around 0.2 microseconds.

To check out a core, put a small magnet wire through it:



This can be done even while it's in the matrix.

Set one pulse around one amp, and sync the scope to the beginning of this pulse. Now, starting at near-zero current, advance the other current until an output is just ready to form on the sense line. This should be the knee. A turn-over signal looks like:



The value of current which, when increased, produces an output (first appearing at the noise position), is the value of the knee.

This, divided by 0.6, should be equal to the maximum current needed to operate the core. This current divided by 2 is what goes down the X and Y lines. A core that has a knee lower than 0.6 is rather shaky. Some have knees much higher. In such a case the second pulse, called the write pulse, is increased to the point where the size of the output signal does not increase.

If you compare this value with the knee, you will get the true value of the disturb ratio.

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Another member, Jon Lax, stresses the need to go to 50- and 30-mil cores. This is because, although 80-mil cores are inexpensive, they are more trouble than they are worth, considering size, heat and drive currents.

Jon says that 80-mil cores take about three times the space, twice the current and about 2½ times the cooling as 50- and 30-mil cores.

Also, they are about half as fast. What with the new, very fast logic available, and trends toward miniaturization and the least upkeep possible, it is possible that you can sacrifice certain parts of the design rather than save a few dollars by using the cheaper planes. It all depends on how you design your machine.

Jon is president of a company, made up of high-school seniors, that sells cores, planes, stacks and magnetic-tape loops, to help finance the computer they're building. The cores sell for $10 to $80 per thousand, up to 10,000, and for $10 to $40 per thousand over 10,000. IBM-style buffer planes, 160 cores each, are sold at cost, $8.50 each. For details:

Jonathan R. Lax, President
The Information Organization
121 Gill Road
Haddonfield, New Jersey 08033

Jon figures that the cost of a core memory ranges from 15¢ to 90¢ a bit, depending on the ingenuity of the designer. The big difference is whether you use transistor or core sensing. The best source of schematics is textbooks, such as "Solid State Magnetic & Dielectric Devices" by Katz and "Information Storage and Retrieval" by Becker and Hayes, both published by Wiley.

The best source of cores is the manufacturers, says Jon. However, if anyone is willing to forego perfect specs, his company can provide cores from their revolving stock of rejects which they obtain from various of the larger houses. Many who do not need the ultimate in uniformity have been able to use them in the past, he adds.

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Pete Showman says that the amount of sophistication needed in a core-memory system seems to depend strongly on the physical size of the memory stack and on the threshold current of the cores. If the memory is small, diode decoding with drivers at each end of the line can be used. Some useful articles on such systems are "Designing a Small Core Memory ..., " by Jimerson, in Solid State Design, April 1964, pages 31-34, a word-select system with partial driver schematics; "A Versatile Magnetic Core Store Driving and Detection System," by J.A. Borrie, Electronic Engineering (British), Jan. 1963, pages 28-31.

When a core stack is big enough to have reflection problems, things get messy. Such memories must be treated as transmission lines, which 1) makes bidirectional drive harder, and 2) means large driver voltage swing: since Z_o is 100 ohms or so, and the half select current for typical surplus cores is $\geq \pm 600$ ma, ± 60 volts are required. Transistors that can handle that much power in 100 nsec are far out of the amateur's price range. The best solution Pete has seen is the load-sharing matrix switch. This multi-turn transformer array allows several (10, for example) smaller transistors to combine their outputs, and to send the pulse to any of several (16, for example) output lines. An article with good references is "Magnetic Core Access Switches," by Minnick and Haynes, EC-11 IRE Trans., June 1962, pp. 352-368. The articles referenced are mainly mathematical theory, not schematics, but are useful if given a little study. Although the matrix switch is expensive, it can reduce overall system cost, since epoxy-cased transistors like the 2N3643 can be used as drivers.

Pete isn't sure where the dividing line between "large" and "small" memories is. The only way to find out is to try a diode-select system

and see if errors occur, he says, adding that a wrong guess could be expensive.

Pete estimates the cost of the electronics for a 16K by 13-bit memory using a load-sharing matrix to be about $800, or about 0.4¢ per bit. The stack is extra, of course. Because cost increases slowly with the number of bits, a 4K system would probably cost $500 or so. A very small memory gets simpler, but diodes with the required rating might be fairly expensive, too.

There are several articles on the gory details of sense-amplifier design, but Pete is not convinced that all the trouble is necessary in coincident-current systems (word-select memories evidently have greater noise problems). So far Pete has had good results with a well-balanced differential amplifier.

In a previous letter, Pete said: In the real world, drum and disk memories are of course the cheapest, but hard to fix if damaged, and hard to find in good condition. Old core planes seem to be numerous, but about six identical ones is the practical minimum for an efficient stack. I estimate minimum driver costs at $1.35 per driver, and sense amplifiers at $3-5. Thus a 1024 by 13-bit memory would be $160, or an effective 8192 by 2 by 13 bits would be $425, both excluding cores and decoding logic.

COMMENTS, ANYONE?

A few comments have been received, all saying they like the ACS Newsletter. Nice to get that kind, but more helpful would be comments on what you don't like about the Newsletter. What should there be more of, or less of?

STANDARD AMATEUR COMPUTER KIT

Amateur computer builders are now much like the early radio amateurs. There's a lot of home-brew equipment, much patchwork, and most commercial stuff is just too expensive.

The ACS can help advance the state of the amateur computer art by designing a standard amateur computer, or at least setting up the specs for one. Although the mere idea of a standard computer makes the true-blue home-brew types shudder, the fact is that amateur radio would not be where it is today without the kits and the off-the-shelf equipment available.

For those who don't believe in conformity, the computer kit can be a jumping-off place, a basic machine on which to build their own variations and special add-ons.

I propose a basic philosophy for the standard machine: it should be designed on the "bit-slice" principle, so that the basic kit can be bought with a minimum word length. Then, as the builder can afford, he buys bit-units, each containing all the cards for adding one bit to the word length throughout the machine. A bare minimum of registers would be used in the bit-slice stages, with further registers to be added on later, one by one (if this is feasible).

Possible optional add-ons might include a printer, character generator, X-Y plotter, card punch, card reader, additional core memory, drum memory, maybe even a Teletype.

Many problems exist; here are some:

1. What is the minimum number of registers for it? Maximum?
2. What should be the price for the basic machine? $500 too much?
3. What should be the maximum word length? And the minimum?

4. What options should be made available for add-ons?
5. Should the basic machine have more than manual input and lamp output? If so, what?
6. Should the contents of all registers be visible on the console? Or should one set of lamps do for all?
7. For the stage after manual input and lamp output, is paper tape okay? Or should we go directly to tape? Or drum?
8. How much assembly work should the kit-builder have to do? Could he solder in the ICs without burning them up, or should sockets be used?

It may be possible to get some kit or IC manufacturer interested in putting the standard amateur computer kit (SACK for short) on the market, if there are enough prospective kit builders so he would not be left holding the bag.

Please give SACK some thought, and let me know what you think about it. A standard amateur computer will probably be on the market by 1970, whether or not we do anything about it. There's no reason why we can't steer the inevitable in the direction we think best.

BOOKS AND MAGAZINES

"Sense Amplifier Fits Any Memory," Electronics, Sept. 5, 1966, pages 89-94, by a Sylvania engineer. New general-purpose amplifier can be used with most coincident-current memories. Designed to be compatible with the Sylvania high-level (SUHL) logic family, for use with Sylvania's MSP-24 microcircuit computer (Electronics, Oct. 18, 1965, page 72).

(There are two models of this sense amplifier, the SA-10, with high fanout, and the SA-11, with a lower fanout. Prices are:

	1	25	100
SA-10	$35.90	28.60	24.20
SA-11	26.10	20.80	17.60

Not cheap, but neither is the SUHL line, in which the cheapest flip-flop costs $5.90 for 1 to 24. However, that's a 20-Mc J-K flip-flop.)

* * * * *

"Linear Pulse Transformers in Core Memory Design," W.G. Rumble (Lockheed), Computer Design, Feb. 1967, pages 48 to 60.

Although pulse transformers are bulky and expensive, and are not amenable to IC techniques, there are some advantages. This survey article discusses the major design problems in four types of memory configurations, without going into the finer details of circuit design; 28 figures, no component values.

* * * * *

Small Computer Handbook, 544 pages, free from Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754. Discusses in detail, from a user's viewpoint, the PDP-8, PDP-8/S and the LINC-8 (PDP-8 and LINC combination). Chapters on computer basics, programming, I/O devices, operation. Almost 100 pages on interface and installation, a variety of basic schematics illustrating programmed data transfers, data break transfers and digital logic circuits. Combines three separate, larger handbooks in one small, 5½ by 8 format. DEC describes it as a "sourcebook of basic computer technology for the computer user and the student."

COMPUTER SCHEMATICS

Build-it-yourself books on the LINC computer are available:

Vols. 1-11, $63. Manufacturing Description (wiring tables, parts list for DEC cards required, etc.)
Vol. 12, $12. Logic Diagrams and

The Amateur Computer Society is open to all who are interested in building and operating a digital computer that can at least perform automatic multiplication and division, or is of a comparative complexity.

For membership in the ACS, and a subscription of at least eight issues of the Newsletter, send $3 (or a check made out to me):

Stephen B. Gray
Amateur Computer Society
219 West 81 St
New York, N.Y. 10024

The Newsletter will appear about every two months.

Timing Diagrams. (This alone is not enough; you need the wiring tables, too.)

Vols. 13-14. Theory of Operation. (Not yet written).

Vol. 15, $8. Assembly and Test Procedures.

The set of 13 available volumes weights about 35 pounds, will be sent postage collect. Send your check to:

Norman Kinch
Computer Research Laboratory
Washington University
700 S. Euclid Avenue
St. Louis, Missouri 63110

LINC is a computer designed to control experiments and to collect and analyze data in biomedical and environmental science research. A single-address, fixed word length, parallel computer, using 12-bit binary arithmetic, LINC contains a crt display, an analog-to-digital converter, a relay register, and dual magnetic tapes (DECtapes, 3½-inch reels, transfer rate 6000 words a second). DEC combines LINC with a PDP-8, so the two share a 4096-word core memory. A LINC costs about $30,000 assembled. Parts can be bought from DEC: cards, cages.

INTEGRATED CIRCUITS IN QUANTITY

Pete Showman reports that only one ACS member has responded to his offer to take charge of buying ICs in quantity (Issue 2, page 5). However, by finding another purchaser outside the ACS, he was able to persuade Fairchild to give the quantity price on 2400 pieces. Pete hopes to place a second order around May.

Anyone interested in ordering at least 50 of the Fairchild RTL ICs, please write to

Peter S. Showman
403 School St.
Watertown, Mass. 02172

Pete notes that using ICs would allow a 2-Mc clock, and figures the cost at about $2.27-2.60 per stage of an "average" arithmetic register, depending on purchase quantities. (Pete's typical register can shift two ways and load in parallel from another register.)

PROBLEMS FOR THIS ISSUE

4-1. A member who bought a Skybolt computer welcomes any information available on this item, especially the core memory. Information sent to the ACS will be forwarded.

4-2. Another member could use a good solution to hardware floating point. Responses will be forwarded.

4-3. A member is looking for a supplier for used or rebuilt electric typewriters with electrical inputs for computer I/O use. Any help?

YOUR ANSWERS TO THESE PROBLEMS WILL APPEAR IN THE NEXT ISSUE. Please look through past issues for unsolved problems and send in your answers.

NEXT ISSUE will be about how and where to look up articles and books on computer subjects of interest to amateurs, including some sources you may not have heard of, such as depositories.

A C S NEWSLETTER

SACK ISSUE

a publication of the
AMATEUR COMPUTER SOCIETY

Number 5 April 1967

MEMBERSHIP

The ACS now has 70 members, in 23 states, Canada, Italy, Japan and Switzerland.

There are ACS members at IBM, GE, RCA, SEL, TRW, Bunker-Ramo, Hughes, Westinghouse, Lockheed, Litton, Hitachi, Bell Labs, Motorola, Goodyear Aerospace, Brookhaven, Western Electric, Teletype, General Radio, Harvard, MIT, Annapolis, Arizona State, Tennessee Tech, Lehigh, and the Universities of Illinois, Michigan and Mississippi.

SACK

This issue was to have told where to look up articles and references about computers. However, the comments received on the proposed Standard Amateur Computer Kit are of a more immediate value, so this issue will be about SACK instead. And there are many miscellaneous items, for which there will be no room in the reference issue.

As expected, comments on the SACK were mixed, both pro and con. Here are excerpts from several letters.

****

From Don Fronek:

A standard computer should have:

1. Plug-in cards (can buy ready-made cards, or cards without components).
2. Frame construction with card receptacles (allows the builder to locate his circuits as he wants them).
3. Power supplies to fit within the frame.
4. Universal front panel (pre-punched holes -- when using the kit-builders approach).
5. Input/output (plugs should be available at rear for additional or special outputs).

I find that plug-in cards are the most desirable, because of uniformity and because they do a good job of reducing the overall space. There are plenty of cards available with and without components mounted. If the circuit boards are purchased in quantity (as by a kit-builder company), they should not be expensive. The frame chassis should have the guides (or slots) and the card receptacles mounted. All the card receptacles I've seen are quite expensive, even in quantity, but if the supplying company riveted a utility-grade type to the frame, I don't think the cost would be too much, and would probably work fine (something on the order of riveted tube sockets on those cheap AM radios you buy for $5.99).

I find that two things are the most important: (1) printed-circuit boards and (2) frame chassis mounting hardware. With little exception, the rest of the machine can be expanded in bits and pieces. The frame chassis could come ready-made in rows, so the builder could buy a row at a time. And cards as needed.

It would be desirable to have some sort of "standard" front for input/output that could be prepunched according to the kit one wishes to build. I think this whole system

could be like "tinker toys," with the emphasis on high fidelity. The more you buy, the more things you are able to do and build, but everybody has his own ideas of mixing units, and perhaps the builder would use the kit idea to complement the equipment that he already has.

I would also use solderless connectors in all the wiring between receptacles. I find that I am continuously changing circuits. With close pin spacing, a soldered connection gets very messy even when you are trying to keep things neat. The wires get burned, the solder slops over onto the adjacent pin, and on and on. This means added cost, but I'll have to vote for solderless connectors.

****

From Jim Haynes:

Seems to be that the essential problem is trying to decide what you want to do with what you have. I guess memory is the pacing item. Anybody who goes in for core, even small core, is talking about money. Depending on the supply of delay lines, that is probably the way to go for a cheap machine.

I can see how one might build a sort of arithmetic unit demonstrator, perhaps with a couple of registers and the ability to add, subtract, shift, etc.; and this might use the bit-slice idea. From this basis, one could exercise a lot of originality in the instruction set and instruction execution control logic -- so this sort of thing would be hard to standardize, unless one wanted to try to market it for educational purposes and build a course around it or something like that, which probably wouldn't appeal to ACS members.

But without some storage, there's little point in building up the instruction execution logic. And I would really hate to see the thing get mixed up in a formalized educational setup, because then a lot of professional education marketers would get into the act, and the price would go skyhigh.

****

From Aubrey Hutchison:

Before embarking on an effort to generate an amateur computer kit, I recommend that serious consideration be given to several items which I feel are a little more basic:

1. With the apparent talent available within the ACS, a set of recommended building blocks (that later could be adapted into a computer kit) possibly should be developed. Examples of building blocks could be shift registers, binary to octal converters, line drivers, sense amplifiers and adder circuits.

2. Consideration also should be given to an amateur standard instruction repertoire that will be versatile enough to allow either wired multiplication and division, or programmed multiplication and division. Also, enough initial consideration should be given to allow the deletion of instructions that an individual feels are not unique to his specific needs.

3. Since the software and hardware are usually related to a great degree, serious consideration should be given to both the hardware and software requirements before determining the word length. In my case, I have chosen a 12-bit word and the instruction repertoire used by Digital Electronics Corp. A word length longer than 12 bits tends to cause the hardware to increase at a rather rapid rate. A

word length less than 12 bits tends to make the programming unnecessarily complex. In my opinion, word lengths ranging between 10 and 14 bits are most suitable for the amateur. One advantage in using the 12-bit word length and the DEC instruction repertoire is the possibility of using programs written for the DEC PDP-8 and PDP-5 series of computers.

4. Most people, so it appears, are concerned with the speed of operation of homemade computers, judging from comments in the Newsletter. It is my opinion that this is an invalid concern; since with the order of speed allowed with Teletype, microsecond equipment seems to be a little on the high side for practical purposes. Milliseconds possibly will be ample in most cases. Therefore, if SACK becomes a reality, it appears that the most practical application would be a four-register serial machine using multi-purpose registers. For example, a buffer-accumulator combination.

****

From Bill Pfeiffer:

The idea of the standard amateur computer is excellent. I don't see where it is incompatible with the home-brew idea. As a starter, just the specs would be enough. Those who can scrounge the necessary stuff can go from there. Those who need the works could get what they want. With the right kind of a beginning, all kinds of possibilities could develop for adding new features. Five hundred dollars seems quite high as a starting point.

I favor trying to track somewhat with a machine like the PDP-8/S with minimum features to reduce hardware and complexities.

****

From Dave Vednor:

I must say that I am against the idea of SACK. By placing a kit of this type on the market, amateur computer builders would not have any major problems, and very few new ideas would result. Amateur radio is a good case in point. Today most of the gear in use is not home-brew, but manufactured to commercial standards. This is great for the hams who don't know how to build, but what is the purpose of amateur radio? The FCC thinks that the U.S. hams should increase radio technology. This is being done, but not to the extent that it could be. If amateur radio gear was not produced commercially, we would not have as many hams, but those hams would make more contributions than all of the hams make today. I might add that I am also a radio amateur (WB6UHM).

****

There they are, five sets of opinions on SACK. They're given here, not to boost the idea of a computer kit, but for the value of their ideas. Further comments welcome.

COMPUTER SCHEMATICS

Build Your Teaching Computer With M.E.L. Sub-Assemblies, 16 pages, free from Amperex Electronic Corp., 230 Duffy Avenue, Hicksville, N.Y. 11802.

This booklet describes a simple computer that can be built in five stages. The first stage performs addition and subtraction on eight-bit words, using one register and an accumulator. Control and data input are manual. Multiplication can be performed by successive addition, and division by succesive subtraction, manually.

The stage two computer can perform

automatic multiplication and division, by use of comparator and auto-restart circuits.

The stage three computer adds extra storage to the stage two computer, by incorporating two 8-bit shift registers, along with circuits for transferring data between these registers and the accumulator or the main register.

Detailed schematics are provided for these three computers. Speeds are 20 Kc, 1 cps, and manual.

For the stage four computer, there is only a block diagram to show how a delay line can be added for extra storage. The stage five block diagram indicates how paper tape might be used for input, and perhaps for output.

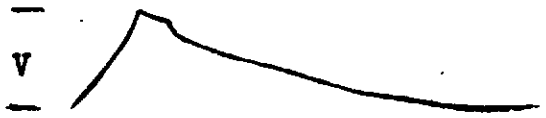
The encapsulated logic modules are the Philips Series 2, sold by M.E.L. in England and by Amperex in the U.S.A. The cost of the circuits for stage 1 is about $230; for stage 2, about $310; and for stage 3, about $600. These prices are for building the entire computer at that stage. The price of the M.E.L. delay line is about $155 without U.S. duty.

MORE ON CORES BY ZUCCARO

Sal writes that, in the last newsletter, when he said "the size of the output signal," he should have said, "the size of the signal when integrated." He continues:

Here, a simple RC integrator is used to sum the $\int i\,dt$. Therefore, as a square-loop core has only a certain amount of flux available, it can only charge a capacitor to some pre-determined value, no matter how fast or hard the core is driven.

The integrated signal looks like this:



Here V X RC(t) = flux in webers.

As to the remarks about 80- and 50-mil cores, the ERMA memory in the Bank of America computer uses 80-mil cores. The half-select current is 180 ma. This is much lower than the half-select current of 410 ma for a 30-mil lithium core. Some of the fast 20-mil cores have half-selects of around 500 ma.

For myself (says Sal), I can't imagine anyone in the ACS needing to operate memory to the point where heating becomes a problem. Almost any memory core will operate at 200 Kc, and most high-speed cores need special attention only above 500 Kc.

We have used load-sharing switches in the past, and now they are just novelties we talk about. For driving a stack of any reasonable size (16K, 40-bit) I would use diode decoding and just take care as to how I placed my current paths.

Incidentally, a single 4K plane can be used as the heart of a swell calculator. By operating one axis serially and the other on diode decode, one has 64 words of 16 decimal digits. A little logic hung on and you're in business.

CURRENT PUBLICATIONS

Glow Lamp Manual, Second Edition, General Electric Co., Miniature Lamp Dept., Nela Park, Cleveland, Ohio 44112. If you write for this neon-lamp manual on company letterhead, it's free. Otherwise it will cost you $1.00. Probably available at GE Miniature Lamp sales offices all over the country. Has 117 pages, including 27 on re-

laxation oscillators, and 24 pages on logic and computer applications. Of those 24, 16 are on the binary system, basic logic operations, basic circuits (AND, OR, NOT) and waveforms; the rest is on a pulse generator, bistable and monostable multivibrators, ring counters and memory circuits. The memory circuit consists of only two resistors, a capacitor and a neon lamp; very simple, but to set the memory circuit requires a positive voltage large enough to fire the lamp; to read it requires a positive voltage less than the firing voltage; to reset it requires a negative voltage low enough to extinguish the lamp.

All About Teletype Equipment, 32 pages. Free from Teletype Corp., 5555 Touhy Ave., Skokie, Ill. 60076. For those who know nothing about TTY, this is a very basic beginning: how it works and what it consists of.

Motorola IC Application Notes. For a list of 47 Motorola IC application notes, see page 53 of the Jan. 9 issue of Electronics. Of interest are (1) AN-234, MRTL Family of ICs, (2) AN-251, Decade Counters Using MRTL ICs (3) AN-252, Choosing RTL Integrated Logic Circuits, (4) AN-253, An Analysis of MRTL Integrated Logic Circuits, (5) AN-254, Using MRTL IC Flip-Flops, (6) AN-264, MRTL IC Shift Registers, (7) AN-279, Setup and Release Times in the RTL J-K Flip-Flop, (8) AN-285, Loading Factors and Paralleling Rules for MRTL ICs. May require a business letterhead to get from:

Motorola Semiconductor Products Inc.
Box 955
Phoenix, Arizona 85001

Of the 8 Notes listed above, only AN-285 is directly concerned with the MC700P series, the Unibloc low-cost elements.

Special Issue on Logic and Switching Devices, Control Engineering issue of January 1967. Of interest to ACS members may be: short article by Kintner on digital switching hardware (pages 64-67), such as DTL, RTL, etc.; reed switches for relay logic (84-88); six ways to make logic circuits, from optical switching to cores (116-119); and a round-up on relays for control applications (78-83) and on digital fluidics (100-104). No break-throughs or really new items, but a good issue to browse thru. $1 from Control Engineering, Circulation Dept., 466 Lexington Ave., New York, N.Y. 10017.

Minotaur, A Relay Computer. Not so new, but if you're interested in relay computers, this is available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151, $3 for hard copy (55 pages), 75¢ for microfiche. The title is misleading, as Minotaur is not a computer, but a fancy relay breadboard, with all relay points and coils brought out to a large 35 X 39 fixed plugboard, to which are also connected 45 lamps, 15 pushbuttons, 35 diodes and five 4PDT lever switches. Of the relays, 14 are 4PDT, and 20 more are 4PDT relays combined with 20 4-pole ratchet relays. The ratchet wheel holds four relay swingers in the make position on every other pulse. This two-relay combination is the basis of counters. The report describes the set-up of logic circuits, binary counter, binary arithmetic, accumulator, and branch functions. Rather simple, but of interest for relay fans.

Large-Scale Integration, special report in Electronics, Feb. 20, pages 123-182. Reprint available at $1.50; 330 West 42 St, New York, N.Y. 10036. Six articles on LSI: system design, memory, customizing by interconnection, computer design of LSI, isolation, MOS versus bi-

The Amateur Computer Society is open to all who are interested in building and operating a digital computer than can at least perform automatic multiplication and division, or is of a comparable complexity.

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Stephen B. Gray
Amateur Computer Society
219 West 81 St
New York, N.Y. 10024

The Newsletter will appear about every two months.

polar ICs. Well worth reading, most of it, even if only for familiarization.

Computers Self-Taught Through Experiments, by Jack Brayton, 192 pages, $4.25, Howard W. Sams & Co. Uses 2N107 throughout, 2N322 for lamp driver, 1N34 diode. There are 28 projects. After building 13 gates, procedes to adders, diode matrix, counters, registers, lamp circuits, ends with a 10-stage adder/subtractor, with pushbutton input and lamp output. Simple circuits, but well presented.

Fairchild Technical Data Manuals are no longer free. The Microcircuit binder, plus updating for a year (12 mailings) costs $5. The updating alone is $2 a year, for data sheets, application notes and technical information.

Fairchild Semiconductor
P.O. Box 1058
Mountain View, Calif. 94040

SURPLUS INTEGRATED CIRCUITS?

The June issue of Electronics World has two ads offering ICs. On page 93, flat-packs for $1-$1.15 each, "guaranteed to work." On page 95, TI "untested flat packs," 6 for $1.89. Has anybody bought these?

ANSWER TO A PREVIOUS PROBLEM

4-3. A member is looking for a supplier for used or rebuilt electric typewriters with electrical inputs for computer I/O use. Any help?

Bob Shostak says 4-3 should forget about electric typewriter I/O. "Thorough investigation reveals that Teletype equipment is much easier to obtain, and much cheaper than typewriters with a non-mechanical triggering system. Teletype equipment is advertised regularly in the ham-ads at the back of QST for as low as $25. Also, it isn't necessary to use the 5-bit system. You can easily invent your own magnet-selector system, or change the character codes."

PROBLEM FOR THIS ISSUE.

5-1. How does one calculate the component values for an RC filter decoupler to keep pulses from circulating through the power-supply wiring and thus showing up where they're not wanted? Does this filter have to be on every circuit board?

TRADING CORNER

A member wishes to acquire either 4K words of 13 bits of core memory, or the equivalent number of core necessary to build his own stacks. He has a TT4A Teletype, 60 and 100 wpm gears; a Hewlett Packard 100D frequency standard that can be used as a computer clock, with outputs of 100 cps, 1 Kc, 10 Kc or 100 Kc; and a General Radio 1304A BFO. He also needs three 7- to 9-track tape heads. Write:

Aubrey B. Hutchinson, Jr.
533 Barksdale Drive
Raleigh, N. Carolina 27604
(K4ANV)

ACS NEWSLETTER

a publication of the
AMATEUR COMPUTER SOCIETY

Number 6 June 1967

READING & REFERENCE ISSUE

READING AND REFERENCE

Although there are a great many publications dealing with computers, few are of interest to the amateur, for whom the IEEE Transactions on Electronic Computers are too sophisticated, and the occasional computer in Electronics World, too simple.

Let's look at a few magazines that lie between these two extremes, and then at the indexes and abstract journals that consist of items from these magazines. The publishers' addresses that follow are handy for getting tearsheets or reprints of referenced articles.

First, there are some publications that are worth reading to keep up with the news of the world of computers and, to some extent, the state of the art. In order of preference (my own, that is), they are:

A1. Electronic News
A2. EDP Weekly
A3. Computers & Automation
A4. Data Processing Digest
A5. Datamation
A6. Data Processing
A7. Business Automation
A8. Automation

For circuits and technical information, these publications are useful, in this order:

B1. EEE
B2. Electronic Design
B3. Electronics
B4. EDN
B5. Electro-Technology
B6. Control Engineering
B7. The Electronic Engineer
B8. Computer Design

These British technical publications, all of which are available in the U.S., are of interest to the amateur, in this order:

C1. Electronic Engineering
C2. Radio and Electronic Engineer
C3. Wireless World
C4. Industrial Electronics
C5. Plessey Communications Journal
C6. Control

Most of these three groups of publications are known to many ACS members. However, there are indexes and abstract journals that aren't nearly as well known, but which can be very useful to amateurs, in this order of preference:

D1. Information Processing Journal
D2. Electrical and Electronic Abstracts
D3. Computer Abstracts
D4. IEEE Computer Group News
D5. Engineering Index
D6. ACM Computing Reviews
D7. Monthly U.S. Government Publications
D8. U.S. Government Research & Development Reports
D9. Government-Wide Index to Federal R&D Reports
D10. STAR-NASA
D11. Applied Science & Technology Index
D12. Union Serials
D13. Technical Translations

For those who aren't familiar with the publications listed in these four groups, here's a listing of publishers, addresses and subscription information. But first, a word about readers' service, which can be a great help.

READERS' SERVICE

Most technical magazines provide tearsheets (pages taken from issues) or reprints, through a Readers' Service Department. Tearsheets are usually available for two or three years back; reprints are often available for five or more years back.

Tearsheets and reprints are usually free, although there is often a charge when a reprint contains many pages. Some magazines will provide Xerox copies of articles no longer available in tearsheets, for as little as 10¢ a page.

A few magazines that do not have a tearsheet service will send you the entire issue free, if available, or will sell it to you.

PUBLISHERS AND PRICES

A1. Electronic News
Fairchild Publications
7 East 12th Street
New York, N.Y. 10003

Weekly, $3 for 1 year, $5 for two years, $6 for three.

News tabloid with several pages on computers. Late news, some technical articles on new developments.

A2. EDP Weekly
Industry Reports, Inc.
514 Tenth St., N.W.
Washington, D.C. 20004

Weekly, $60 a year. $45 to educational and non-profit institutions, Federal, State, County and City governments.

Contains a good amount of inside information.

A3. Computers & Automation
Berkeley Enterprises, Inc.
815 Washington St.
Newtonville, Mass. 02160

Monthly, $15 a year.

Good for new-product photos and new-development items.

A4. Data Processing Digest
1140 S. Robertson Blvd.
Los Angeles, Calif.

Monthly, $24 a year.

Excerpts from articles on data processing.

A5. Datamation
1830 West Olympic Blvd.
Los Angeles, Calif. 90006

Monthly, $15 a year. Free to certain qualified individuals employed by companies involved with automatic information handling equipment.

Highly regarded, many good articles.

A6. Data Processing
American Data Processing, Inc.
22nd Floor, Book Tower
Detroit, Michigan

Monthly, $8.50 a year.

A7. Business Automation
288 Park Avenue West
Elmhurst, Illinois 60126

Monthly, $5 a year, $8 for two.

A8. Automation
Penton Publishing Co.
1213 W. Third St.
Cleveland, Ohio 44113

Monthly, $10 a year. Free to those involved with automatic production equipment and components.

B1. EEE
Mactier Publishing Corp.
820 Second Avenue
New York, N.Y. 10017

Monthly, free to engineers en-

gaged in the electronic circuit design engineering function. Others write for prices.

Circuit Design Award Program, with 4 to 6 circuits in each issue, such as "Pulse Generator with Variable Rate and Width" (Feb. 1967). Frequent specifying guides for devices such as unijunction transistors (Feb. 1967).

B2. Electronic Design
Hayden Publishing Co., Inc.
850 Third Avenue
New York, N.Y. 10022

Every two weeks, free to qualified subscribers.

Good design articles, such as "IC Bidirectional Counters Cost Less" (Jan. 18, 1967). Also good circuits in "Ideas for Design" section.

B3. Electronics
McGraw-Hill Publishing Co.
330 West 42 St
New York, N.Y. 10036

Every two weeks, $8 a year to those actively engaged in the field of the publication.

Four to six pages of good circuit ideas in the "Circuit Design" section, some good technical articles and tutorials.

B4. EDN
Cahners Publishing Co., Inc.
3375 S. Bannock St
Englewood, Colorado 80110

Monthly, $10 a year, free to electronic/electrical designers and engineers in the electronic original equipment manufacturing market, consulting firms, and government research and development labs.

Good design articles, such as "Bidirectional Counting, A Snap for ICs" (Feb. 1967).

B5. Electro-Technology
Conover-Mast Publications, Inc.
205 East 42 St
New York, N.Y. 10017

Monthly, free to qualified personnel engaged in development or design of electrical/electronic equipment; to others, $15 a year.

Some good tutorials.

B6. Control Engineering
R.H. Donnelley Corp.
466 Lexington Avenue
New York, N.Y. 10017

Monthly. Free to qualified U.S.-based individuals. Non-qualified rate, $10 a year.

Mostly about automatic control systems, occasionally items of interest, usually low-frequency circuits.

B7. The Electronic Engineer
(Was Electronic Industries)
Chilton Co.
Chestnut & 56 Sts.
Philadelphia, Pa. 19139

Monthly, $12 a year.

Occasionally a good article, such as "Applications of Collector Logic" (Aug. 1965).

B8. Computer Design
Professional Bldg.
Baker Avenue
West Concord, Mass.

Monthly. Free to qualified individuals, $15 a year to the non-qualified.

Some interesting technical articles, such as "Magnetic Drum Clock Track Writer" (Mar. 1966). Lists government reports in the computer field, has a good new-products section of interest.

C1. Electronic Engineering
Morgan Brothers (Publishers) Ltd.
28 Essex Street
Strand
London, W.C. 2, England

Monthly, $8 a year in USA.

Excellent system articles, such as "A Small Transistorized Digital Computer -- Arithmetic and Control Sections" (June 1965).

C2. Radio and Electronic Engineer
Institute of Electronic and Radio Engineers
8-9 Bedford Square
London, W.S. 1, England

Monthly, $20 a year to members in the USA.

Fine system articles, such as "A Technique for the Transmission of Digital Information over Short Distances using Infra-Red Radiation" (June 1965).

C3. Wireless World
Iliffe Electrical Publications Ltd.
Dorset House
Stamford St
London, S.E. 1, England

Monthly, $8 a year in USA.

Some good articles, such as "Data Transmission Demonstrations" (January 1967).

C4. Industrial Electronics
Iliffe Electrical Publications Ltd.
Dorset House
Stamford St
London, S.E. 1, England

Monthly, $10 a year in USA.

Interesting automatic control articles, such as "The Evolution of TTL Integrated Circuits," describing Texas Instruments circuits (Feb. 1967).

C5. Plessey Communications Journal
(Was A.T.E. Journal)
Automatic Telephone & Electric Co., Ltd.
Strowger Works
Liverpool 7, England

Monthly. Distributed free to organizations and companies, no individuals except in their capacity as senior officials of an organization.

Good system and circuit articles, such as "A Universal Binary Pulse Counter" (Oct. 1964).

C6. Control
Morgan Brothers (Publishers) Ltd.
28 Essex Street
Strand
London, W.C. 2, England

Monthly, $6 a year in USA.

D1. Information Processing Journal
Cambridge Communications Corp.
238 Main Street
Cambridge, Mass. 02142

$60 a year, appearance very irregular, often several monthly issues combined into one.

Excellent abstracts of U.S. and foreign (mainly U.S.) journal articles, patents, research reports, and dissertations.

D2. Electrical & Electronic Abstracts
The Institute of Electrical Engineers
Savoy Place
London, W.C. 2, England

Monthly, £30 a year, £10 10s to members.

Worldwide abstracts (22,000 annually), including Communist-bloc publications. Look under the headings Electronic Cir-

cuits & Devices (Pulse Circuits) and under Computers.

D3. Computer Abstracts
Technical Information Co.
Martins Bank Chambers
P.O. Box 59, St. Helier
Jersey, British Channel Islands

Monthly, $96 a year.

Excellent abstracts, patent digests, book reviews, covering a large part of the Western world.

D4. IEEE Computer Group News
IEEE Order Dept.
345 East 47 St
New York, N.Y. 10017

Free to members of IEEE Computer Group and to non-member subscribers to that group's transactions. To non-members of the IEEE, $12 a year.

Each issue contains a dozen pages of abstracts of papers not usually indexed elsewhere, and a permuted title index to current computer literature. Copies of the abstracted papers are available at reasonable prices from the Computer Group Repository, at IEEE Headquarters.

A permuted title index means that the key words in the titles are lined up in a vertical column. The March 1967 News contains a listing of 500 titles from 20 journals and magazines published from April to December, 1966.

D5. Engineering Index
345 East 47 St
New York, N.Y. 10017

Monthly, $350 a year; $250 a year to educational and non-profit organizations.

Indexes U.S. and foreign magazines and journals. Look under Computers, where you'll find a list of other headings under which to look. See also Memory Devices.

D6. ACM Computing Reviews
211 East 43 St
New York, N.Y. 10017

Twice a month, subscription included in $18 annual dues. To non-members, $15.

Reviews and abstracts of magazine articles, books, newspaper articles. Excellent reviews. Mostly software, but has a section on Design & Construction.

D7. Monthly Catalog of U.S. Govt. Publications.
Supt. of Documents
U.S. Govt. Printing Office
Washington, D.C. 20402

Monthly, $4.50 a year.

Few items of interest to amateurs, nearly all of them publications of the National Bureau of Standards and the Bureau of Naval Personnel.

Contains over 20,000 items a year, listed according to the issuing governmental agency and in an alphabetic index. Most items are for sale by the Supt. of Documents, some are for sale by the Clearinghouse. Others are for official use only, and not available to the public. Still others are sent to depository libraries, which are public and university libraries all over the country. Most are partial depositories, meaning that they receive only selected items. The full depositories get all items. Among the full depositories are:

New York- Public Library, Main
Chicago - Public Library
John Crerar Library

Boston - Public Library
State Library
Los Angeles - Public Library
Each September issue of the Catalog contains a full list of all the depository libraries.

Many of the depository items, including all these for official use, are on microfiche cards and must be viewed with a special enlarging viewer, which is not very bright and is therefore a strain on the eyes. A full depository will also have many non-depository items, on microfiche or in hard copy. (A microfiche is a card on which a great many pages of a book have been printed in highly reduced size. Fiche is the French word for a small card.)

If you find a government publication that looks interesting in a catalog, you may wish to take a look at it before ordering. The depository files are the only way of looking at many items.

The December issue of the Monthly Catalog includes a complete index for the whole year, so for 1966 and earlier, you need go through only one index per year. For computers, look under Electronic Computer, Electronic Data Processing, Electronic Circuits, Logic, and Computers.

D8. U.S. Government Research & Development Reports
Clearinghouse for Federal Scientific and Technical Information
Springfield, Virginia 22151

Twice a month, $30 a year.

Occasionally contains items of interest. Computers are under category 9B, in the current volumes. An example is "Digital Computer User's Manual for EE Students and Faculty," $3 in hard copy, 56 pages, AD-638-023.

Starting in 1967, the volume number is the same as the year. Effective 1-1-67, the Clearinghouse changed its pricing policy for document sales from a sliding price scale based on the number of pages, to a single price. The new price is $3.00 for a paper copy (hard copy - HC); 65¢ per document for microfiche (MF). The single price does not apply to multiple copy orders of a single document. These prices also apply to documents announced before 1-1-67.

D9. Government-Wide Index to Federal R&D Reports
Clearinghouse

Twice a month, $22 a year.

Produced by computer from records generated by four Federal agencies that announce R&D reports: AEC (Atomic Energy Commission), NASA, DDC (Defense Documentation Center), and CFSTI (Clearinghouse). GWI indexes all the reports announced in the U.S. Government R&D Reports.

Alphabetical; look under Computer, Data Processing, Logical Design, Memory. Example: "Memory Storage Unit, Theory and Design Techniques for Magnetic-Core Memories," Vol. II, HC $3 MF $0.65

D10. STAR-NASA
(Scientific and Technical Aerospace Reports, published by NASA)
Supt. of Documents, USGPO

Twice a month, $33 a year.

Look under Category 8, Computers. Inside the back cover is a list of the 10 university libraries and 35 public libraries in 24 states, where

NASA documents may be studied.

D11. Applied Science & Technology Index
The H.W. Wilson Co.
950 University Avenue
Bronx, New York 10452

Monthly (except August), $25 a year.

Contains abstracts of articles from a great many U.S. publications and a few British ones. Look under Computers, Electronic Data Processing, etc.

D12. Union List of Serials in Libraries of the United States and Canada
The H.W. Wilson Co.
950 University Avenue
Bronx, New York 10452

Third Edition, $120.

Lists, by publication, the libraries in the USA and Canada that have the listed magazines, both US and foreign. The third edition goes up to Dec. 31, 1949, includes 956 cooperating libraries.

Handy place to find out where you can look at a magazine. For example, the Digital Computer Newsletter can be seen at 41 libraries in the USA and 3 in Canada.

D12A. New Serial Titles
Card Division
Library of Congress
Washington 25, D.C.

Monthly issues and cumulative annual volume, $75 a year.

Updating supplements to the Union List of Serials. The annual cumulative volumes are in turn cumulated over 5- or 10-year periods, such as 1950-1960, in 2 volumes.

D13. Technical Translations Clearinghouse

Twice a month, $12 a year.

Mostly translations of Soviet and Communist Chinese publications. Very few items of interest. Computers are under category 9B in these abstracts.

CURRENT PUBLICATIONS

M.E.L. Teaching Computer. If any of you have had trouble getting from Amperex the M.E.L. booklet described in ACS Newsletter 5, page 3, write to Al Cerne in the Components Division of Amperex.

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Design of a Low-Cost Character Generator for Remote Computer Displays, by T.B. Cheek, Project MAC, at MIT. Ask for AD-631-269, from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151, $3.00.

Uses a 5-by-7 dot matrix raster and a resistor-array read-only character memory for 96 symbols.

Drawback is that a standard CRT is not used, as regeneration would be necessary, requiring a high-speed memory. A storage CRT is used; in this case, a Tektronix 564 Storage Oscilloscope.

Parts costs are estimated to be under $200. Parts include Fairchild Micrologic ICs (923 JK flip-flop, 914 dual NOR, 900 driver), 2N2923 and 2N3569 transistors.

****

Jim Sutherland's ECHO-4 computer is described on page 36 of the March issue of EE (The Electronic Engineer). Jim's computer, 7 feet long, 2 feet deep and 6 feet high,

The Amateur Computer Society is open to all who are interested in building and operating a digital computer that can at least perform automatic multiplication and division, or is of comparable complexity.

For membership in the ACS, and a subscription of at least eight issues of the Newsletter, send $3 (or a check made out to me):

Stephen B. Gray
Amateur Computer Society
219 West 81 St
New York, N.Y. 10024

The Newsletter will appear about every two months.

took a year to build and will take 10 years to program.

LOGIC TEMPLATE

At the last IEEE Show in New York, the Semiconductor Division of Sprague Electric Company (Worcester, Mass.) gave away a logic template containing MIL Standard 806 logic symbols. The template may be available from Sprague even without a letterhead. Worth a try. Has 18 symbols, from AND to read/write head.

TAPE, ANYBODY?

Computer tape, made by Scotch, Ampex and Memorex, 250' to 3000' spools, ½", 3/4" and 1" widths, from Autometics and North American, and priced at $3 and up, will be sent to you COD by

Pat Killmer
3442 Montair Avenue
Long Beach, Calif. 90808

if you let him know your needs.

INCIDENTAL INFORMATION

One estimate of IBM's manufacturing costs for the 360: 12-15% of sales price. The same source guesses RCA's costs to be 30-35%. (From Datamation, Dec. 1966, page 113.)

HOW FAR ALONG IS YOUR COMPUTER?

Jim Haynes notes that my mention, in the first Newsletter, about some ACS members being halfway or two-thirds of the way toward completing their computers, is incorrect. He says, "I believe it is in the 1956 or maybe the 1955 WJCC (Western Joint Computer Conference) Proceedings that you will find that all computers which are not completed are 80% complete." Therefore, the computers of all ACS members are officially 80% complete.

CHEAP PUSHBUTTON SWITCH

Most pushbuttons are too expensive to be bought new. However, Centralab has been licensed by Isostat of France to produce a new line of pushbutton switches that are simple enough to be cheap enough for the amateur, if bought in quantity.

A DPDT switch costs $2.68 for one, 75¢ in quantities of 100. An 8PDT switch is about $4.50 for one, about $1.22 in quantities of 100.

Write Centralab, P.O. Box 591, Milwaukee, Wisc. 53201.

NUTZ TO HERTZ

As of Newsletter #4, I've gone back to Kc and family, leaving Hz in the lurch, where he belongs.

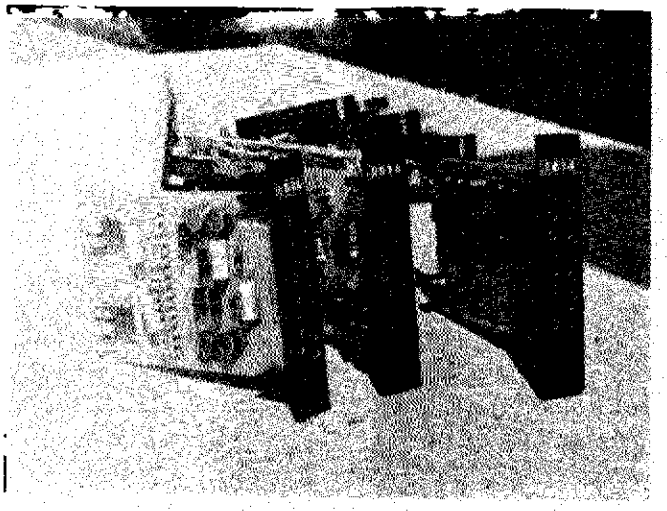
NEXT ISSUE will be about mounting circuit boards and ICs, and about interconnections. If you have any experience with these and haven't written in yet, please send details.

ACS NEWSLETTER

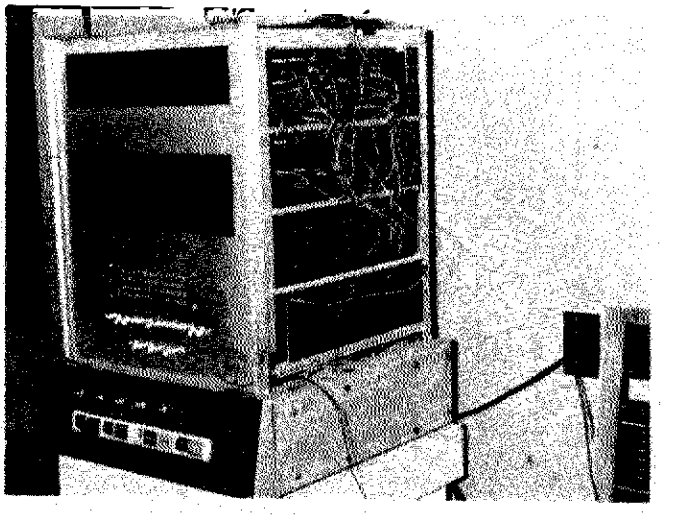
a publication of the
AMATEUR COMPUTER SOCIETY

Number 7 November 1967

MOUNTING AND INTERCONNECTIONS ISSUE



These IBM cards are part of ...



... Allan Sinclair's computer.

CHANGE OF ADDRESS

The new address of the ACS is

Amateur Computer Society
260 Noroton Avenue
Darien, Conn. 06820

Because of this move, and because of a new job (and a new computer to learn), there has been no Newsletter since Number 6 in June.

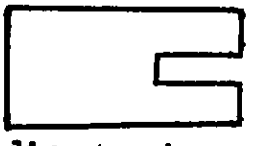
MOUNTING CIRCUIT BOARDS

Because it's seldom possible to buy used circuit cards with matching card cages, mounting such cards is usually a problem. Especially if they are IBM SMS cards, with the contacts broken off.

Card cages are usually expensive, as are printed-circuit connectors. So, unless you've got a lot of money to spend, you'll probably have to invent a mounting system of your own.

The photo at left above shows how Allan Sinclair mounted a number of SMS cards. The front panel is Bakelite, with 16 long brass eyelets pressed into undersize holes, and with wire soldered to the rear of the eyelets. These eyelets will take an AMP terminal (the eyelets I use will also take IBM patch cords).

The SMS card is held to the panel with 2 pieces of Bakelite, as shown at right.



Allan uses General Radio service cement. He says epoxy would no doubt be better, but the cement seems to work, as no strain is involved.

For larger (Univac) cards, Allan bought similar panels, 4" by 5", with 54 jacks already installed, and cut them down. These larger cards are epoxied into either blocks or cylinders of Bakelite, which are then screwed to the front panel. Some of the large

panels hold three cards, giving 12 flip-flops for a register.

Another mount for the SMS cards is a 15-contact Amphenol plug (which Allan bought for 5¢ each!), which is glued to the card.

Allan uses Dymo tape to put the last four digits of the 37---- IBM number on each panel, for identification.

The photo at right on the first page shows Allan's computer. The permanent stainless-steel front panel is off at the right. The computer operates on 12-bit words, with a 100-word 2½D core memory.

The mounting racks are made from heavy-duty aluminum shaped like this →  One side is bent down to look like this →  The aluminum is then turned and mounted as shown at right. By grinding this part nearly off, the cards can be inserted and dropped into the groove to keep them in place. By not using screws, the cards can be slid along to obtain different arrangements.

****

Using screws, a cheaper (but less flexible) mounting system can be set up, with similar Bakelite panels that have holes drilled at top and bottom. The panels are screwed to a simple horizontal bar that is drilled and threaded to receive the screws. The bar has two lines of holes: one for the bottom holes of one row of panels; the other for the top holes of the other row. For rack mounting, the two horizontal bars at top and bottom need have only one row of holes. With this system, the full height of the rack is made use of.

****

Jim Haynes uses Amphenol 15-pin connectors obtained from junk. When he runs out of junk ones, the new ones are only about 65¢ each, in lots of 100. Jim says there's a very inexpensive edge connector that is not very well known, made by Cinch, and called (as he remembers) the 257 series.

Bill Pfeiffer has found that the most usable female connectors are the bifurcated-edge-type PC variety, made by Cinch-Jones, Amphenol (series 143 and 133 for single and double), and USC type UPCR. Bill has been using the 22- and 44-contact types, mostly. Cost at surplus ranges from 25¢ on down.

MOUNTING INTEGRATED CIRCUITS

Mounting ICs is an even bigger problem than mounting circuit boards. There are several IC mounting boards available commercially, but they cost several times the price of the ICs they mount: $140 for a Motorola 16-IC breadboard; $21 for a Campion PC board that mounts 8 flat packs permanently.

Individual dual in-line sockets are expensive, too. Augat's #314 costs from 40¢ to 90¢, depending on quantity. Texas Instruments has an MPC18A socket in 14- and 16-pin DIL styles, solder-tail and wire-wrap types, for about $1.10 each, or 52¢ in quantities of 100-999.

Fred Strother has come up with a clever and very cheap method of mounting flat-pack ICs. He uses a perforated board with 0.05" hole spacing, and threads thin wires through the holes, in the desired circuit arrangements. The flat packs are then soldered to the wire "pads." The in-line packs have 0.1"

pin spacing, so they fit the same perforated board, which is available from Allied Radio (47R509 Micro-Vectorbord, 6½" x 4", $2.92, made by Vector), 100 N. Western Ave., Chicago, Illinois 60680. The wire can be single strands from regular stranded wire. Of course, this system requires that the inter-circuit wiring be laid out completely beforehand, and later changes are difficult. Also, a steady hand is needed for soldering, as the contacts are only 0.05 inch apart. This method could be used for breadboarding, by connecting the wire "pads" of a single IC (or group of ICs) to eyelet panel jacks.

The largest size of Micro-Vectorbord is 17" x 6", smallest is 4" x 2". An 0.1" hole-spacing is also available. Vector also makes a "D.I.P. Plugboard," with pads for mounting 12 dual in-line types, with or without sockets. The plugboards are pre-punched, pre-etched and pre-tinned, in an x-y matrix, with parallel copper lines running horizontally on one side and vertically on the other. Pins are inserted where an x-to-y connection is desired. The copper lines can be broken with a pad-cutter, to make a variety of interconnections. Connections to the pin contacts at the end of the board are made as desired. Several types are available, and cost about $10 each. A similar x-y matrix board for DIL circuits, without pads, is made by Vero, and sells for $8 for a 5" x 8" board; a single-sided 5" x 8" board is $5.31.

Vector Electronics Co., Inc.
1100 Flower St.
Glendale, Calif. 91201

Vero Electronics Inc.
176 Central Avenue, Box 26
Farmingdale, N.Y. 11736

Vero has an IC breadboarding kit for $40, consisting of a single-sided 18" board, a plug-in single-sided board, a double-sided plug-in board, an epoxy glass plain board, 500 terminal pins, a pin insertion tool, a spot face cutter, design sheet, and an edge connector. The holes in these Vero boards are on 0.1" centers, whereas the holes in the similar Micro-Circuit Veroboard kit, for $23, are punched with holes on 0.05" centers, for IC mounting.

INTERCONNECTIONS

There are, as most of you have found out, problems with either fixed wiring or with plugwires. Fixed wiring, of course, is cheapest. But, as Don Fronek pointed out in ACS Newsletter 5 (page 2), when you have close pin spacing, a soldered connection gets very messy when you're trying to keep things neat. The wires get burned, the solder slops over onto the adjacent pin, etc. Because Don finds himself changing circuits all the time, he prefers solderless connectors.

On the other hand, plugwires are expensive. Sometimes they can be bought surplus, such as the Hubbell plugs and plugwires I have. I bought some card cages that had a number of these miniature, automatic-locking, quick-disconnect plugs and jacks attached. The plugs cost $11.60 for 500 if you buy them from Hubbell; the eyelet panel jacks are $2 for 500. Jacks are also available in terminal-post adapter and screw binding-post types, as are crimp-terminal connectors and plug splices. The eyelet setting punch is $1.25, from Harvey Hubbell, Inc., Bridgeport, Conn. 06602. Crimping pliers are $2.40; minimum charge is $5.00.

Eyelets, by the way, are about the cheapest way of mounting anything. Drill holes in a plastic board,

press in eyelets and set them with a punch, and solder the item to the eyelets.

IBM plugwires (or patch cords, if you prefer) are plentiful, and are sometimes available cheaply when a punched-card installation is being changed over to a computer and is getting rid of all plugboards and wires. The plugboards can be used for mounting circuits; the only drawback is that it's often hard to solder to the large plugboard contacts, and the contacts are so close to each other that some can't be used and are therefore wasted. Be sure to get the type of plugboard that has contacts on it; the self-contacting type of plugboard has no contacts on the board itself, and is of little or no use to the experimenter. Plugboards are sometimes sold by surplus houses such as Olden and Meshna.

Jim Haynes uses fixed wiring, says plug wiring in a project the size of his would be impractical. However, he notes, one type of Cinch connector has taper-tab terminals, so that one could make up a sort of semi-fixed wiring, using plugwires with the taper tab clips.

Bill Pfeiffer's plugwires cost about 5¢ for each good double-plug type. His plugboard is an IBM 22 x 34-hole type, to the rear of which he solders his fixed wiring. Several rows are used for bunching purposes.

COMPUTER PC SALVAGE

A one-page item on salvaging computer PCs appeared in Popular Electronics (page 66, June 1966). The main item discussed is the type of desoldering iron with a rubber suction bulb attached. Also, five companies are listed as sources of PC boards: Arrow Sales, in Chicago, Radio Shack, Meshna, Poly Paks, and Transistors Unlimited.

BREADBOARDING ICS

An item in Electronics (page 103, July 25, 1966) shows how to breadboard ICs by plugging dual in-line packages directly into the type of connector used as edge connectors for PC boards. The specified connector is the Hughes EMS048DJ000, which has contact rows the right distance apart, and the 0.1" spacing that matches the DIP lead spacing. Pins inserted in the wiring side of the connectors permit connecting the ICs to each other and to external circuits. The cost of the Hughes connector and pins for 54 ICs is about $120, which gets more expensive than the ICs, so perhaps other, cheaper connectors can be found.

TAPEHEAD AND TRANSPORT

A tapehead and transport assembly is offered by Denson Electronics Corp., P.O. Box 85, Rockville, Conn. 06066. Made by ITT, the assembly is 6½" wide (five assemblies were mounted side by side on a rack, on slides), 45" high, 26" deep. Looks like a tape-loop arrangement. The head has 22 tracks, used with one-inch computer tape. Cost: $245.

The Denson 1967 catalog is 90% closed-circuit and amateur tv used gear, some RTTY stuff. Also a page on instrumentation tape and a 20-track recording head.

IBM TO SELL SLT MODULES

IBM has announced that it will market SLT modules, which are the hybrid ICs used in the 360 computers.

Fifty diode-transistor types are available, at $1 to $1.50 each; minimum order $25. The DTL

modules include a NAND, NAND/NOR, flip-flop, exclusive OR, transmission-line receivers, line amplifiers and indicator drivers. Switching speeds are from 700 to 5 nanoseconds.

These modules are fallouts from the computer-grade types, and are called "industrial grade." Tolerances are about 3% wider than for computer-grade modules.

Information is available from IBM Corp., Industrial Products Marketing Dept., 1000 Westchester Avenue, White Plains, N.Y. 10604.

SHIFT REGISTERS

National Semiconductor Corp., 2975 San Ysidro Way, Santa Clara, Calif. 95051, is selling a 50-bit shift register for $9.85 in lots of 100, and a 100-bit shift register for $14.80 in 100 lots. Supply voltage is -10 volts, clock amplitudes are 16 volts. Model numbers are MM500 and MM502, respectively.

PORTABLE ELECTRONIC KEYBOARD FOR COMPUTER INPUT BY TELEPHONE

An interesting article by the above name appeared in the June 1967 IEEE Transactions on Electronic Computers (pp 332-334), by Lewin of RCA. Although few if any of us are anywhere near being able to use this type of input, the article makes interesting reading.

The device, which is acoustically coupled to an ordinary telephone handset, generates coded tone sequences representing the full ASCII character set. The characters are input, one at a time, by a stylus, touching the symbols on an electronic keyboard. The tone sequences correspond to those in most Teletype-Dataphone terminals in typical time-sharing systems. The device is intended for communication with a machine that has voice answer-back.

Production cost is estimated "in the $50 range." The device contains a decade counter, pulser, two-bit analog-to-digital converter, decoder, two-frequency voltage-controlled oscillator, a few logic gates, and a resistor encoder. The transistor types are 2N1307 (2N404) and 2N1306 (2N585); diodes are 1N34.

FAR-OUT MEMORY

The same issue of IEEE Transactions contains a short note (pp 370-371) on an optical-fiber memory, by Filippazzi of Olivetti-GE. The optical fiber is used as a delay line, which is much faster than most of us will ever need, as a light pulse travels through it at over 11 inches per nanosecond. But it is simple.

WIRELESS WORLD DIGITAL COMPUTER

The British magazine, Wireless World, has had a four-part article on building a small computer, in its 1967 issues for August (366-372), Sept. (416-423), Oct. (488-494) and Nov. (543-548).

The WW computer will add, subtract, multiply and divide. There are 28 instructions: 7 for arithmetic, 9 for transfer to store, 6 for transfer from store, and 6 various resets. Multiplication is by repeated addition, without shifting. Two 8-bit numbers can be added at slow speed (4 seconds), high speed (3.2 msec), or bit-by-bit.

Input of instructions is by toggle switches; input of data is by push-buttons; output is by neon lamps.

The prototype was built for about $160, without cabinet. The transistors were reject germanium types that cost less than 14¢ each (2G371/

The Amateur Computer Society is open to all who are interested in building and operating a digital computer that can at least performautomatic multiplication and division, or is of a comparable complexity.

For membership in the ACS, and a subscription of at least eight issues of the Newsletter, send $3 (or a check) to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Avenue
Darien, Conn. 06820

The Newsletter will appear about every eight weeks.

D1476, Texas Instruments). Diodes are 1N130 types. The front panel contains 53 neon lamps, with 6 groups of 8 lamps each, for three arithmetic registers and three storage registers.

Basic circuits are NOT, NOR, AND (diode-transistor), OR (diode), comparator and flip-flop.

A subroutine store is described briefly for those those who wish to add it to the computer. It provides 64 words of data or instructions, using wired-in diodes or diode "pegs" in a matrix programming board, or in a stepping switch or a stepping drum. With this store, series of instructions could be carried out.

UNIVAC MEMORY UNIT

Gadgeteers Surplus Electronics, 5300 Vine St., Cincinnati, Ohio 45217, has one Univac memory unit for $75. No information is available other than that the unit weighs 40 pounds, is "high density stacked," has muffin fans, and cost $40,000 when new. A photo from Ken Hanson shows two stacks mounted one above the other, like a figure 8, attached to a panel 2 feet high. Money back if not satisfied.

BUFFER MEMORIES FOR SALE

Sal Zuccaro has some buffer memories for sale. They are from Collins Radio gear, and were made by General Ceramics (now Indiana General) and by Telemeter Magnetics (now Ampex). Sal has three sizes, from 144 words of 4 bits each to 2048 words of 8 bits each. The memories are complete with core stacks, drive electronics, power supplies, logic, etc., and with Amphenol Blue Ribbon connectors for input/output. The smallest models take up about 10" of rack space, the largest take about 21".

Sal will provide copies of the instruction manuals, which contain specs, schematics, operating procedures, and timing diagrams.

The price per memory is $200 to $300, depending on size, plus the shipping charges. Sal's address is 14442 Elmhurst Circle, Huntington Beach, Calif. 92647.

Sal may also know where to get 75-ips Potter mag tape handlers for $50-60, if there are any left by the time you read this.

ACS COMPUTER SURVEY

The next page is a questionnaire for the ACS survey. Please fill it out (skip the personal data if you'd rather) and mail it in. Results of the survey will be in the next Newsletter if enough are received soon.

NEXT ISSUE will contain, among other things, comments by you on mounting circuits and interconnecting them; that is, if you send them to me as soon as you finish reading this issue. And send along any other information, comments and photographs that other ACS members might like to read or look at.

ACS COMPUTER SURVEY

Serial ___ Parallel ___ Number of registers _____

Transistor types _____

Integrated-circuit types _____

Card types: IBM ___ Univac ___ Other _____

Memory type _____ Number of words in memory _____

Input _____ Output _____

Number of instructions _____ Word length _____ Clock speed _____

Add speed _____ Instruction length _____

Special features: _____

_____

_____

_____

Estimated cost when complete _____ Cost so far _____

Estimated size when complete _____ Present size _____

How long working on it? _____ Fixed __ or non-fixed __ wiring?

In planning __, begun __ or completed _____?

Source of circuit schematics: Self-designed __ Other _____

Source of system schematics: Self-designed __ Other _____

Any other information?

Name _____

Position _____

Company _____

Education _____

Interested in computers since age _____

ACS NEWSLETTER

a publication of the
AMATEUR COMPUTER SOCIETY

Number 8 January 1968

ACS COMPUTER SURVEY RESULTS

Although not many ACS members sent in the computer survey forms, those who did are, not surprisingly, the furthest along with their machines. Two have finished.

Memory

Most of those who answered the survey are using core memory, with sizes ranging from 4K to 20K words; the majority are equally divided between 4K and 8K.

One member uses a delay line for memory, containing 512 words. Another uses a delay line (2K bytes), drum (8K bytes) and core memory (4K bytes); 4-bit bytes.

For his small machine, one member uses flip-flops for memory. Another uses punched paper tape, having convinced himself that "tape would eliminate the memory limit."

Input

Teletype is the most common input device. One member, however, uses a Flexowriter. Another uses punched cards, keyboard, magnetic tape, paper tape, and keyboard switches.

Output

Again, Teletype is the most common output device. Others include a Kleinschmidt printer, paper tape punch, IBM Selectric typewriter, lamps, and Nixie tubes. One member uses magnetic tape, paper tape, Selectric typewriter, printer and lamps. And the member with the Flexowriter also uses it for output.

Clock

Clock speeds include 100K, 160K, 250K, 500K, and 1Mc, with one given as 10-100K. The average is 500K.

Serial or Parallel

The situation is about equally divided into thirds: one-third serial; one-third parallel; one-third combinations such as serial character, parallel bit.

Transistor Types

A wide range here, of course. One uses only 2N404. Another, 2N2923, 2N3721, 2N2711 (npn) planar. A third, 2N2923, 2N2925, 2N3906. A fourth, MPS3640, MPS3646, and 2N3641 in core drivers.

Integrated-Circuit Types

(1) uses Fairchild RTL (67¢ FF, 36¢ dual 2-input gate, 36¢ buffer). (2) Fairchild RTμL and CTμL. (3) Motorola RTL (700P series). (4) Motorola and Fairchild RTL.

Card Types

None of those replying use surplus IBM or Univac cards, although one uses surplus Westinghouse RTL NOR gates. Another is considering Wyle modules. A third designs and etches his own PC cards. A fourth makes his cards from Vector boards. A fifth uses Ransom, SEI and Autonetics cards. A sixth uses Teletype etched boards, with his own circuits.

Number of Instructions

Generally speaking, beginning com-

puter amateurs hope to use a large number of instructions, from 50 to 100. Those who have gotten fairly well into the construction use no more than between 11 and 34. The one exception is a member who has spent $1,000 and two years on his machine, and has (or has projected) 67 instructions. The average number, counting all those reported, is 44. Leaving out those over 50, the average is 22.

Data-Word and Instruction Lengths

The data-word lengths specified range from 4 to 32 bits, with the average around 12 bits.

The instruction lengths also range from 4 to 32 bits, with an average of about 12 bits also.

Add Speed

The range of add speeds is from 8 μsec to 10 msec, with in-betweens of (1) 24 μsec, (2) 216 μsec, (3) 100-500 μsec, depending on the length of the binary number, (4) 8 μsec for one memory reference, but circuitry will operate in 1 μsec, (5) 30 μsec add speed, 4 msec memory cycle time with a magnetostrictive delay line, (6) 20 μsec with one number in accumulator, 25 μsec with both numbers in memory, (7) 32 μsec per pair of decimal digits, (8) 1 to 10 msec.

Number of Registers

The range of number of registers is from 2 to 11, with 3 the most popular. One member has 2 memory, 2 data, 1 op code and 5 address registers.

Special Features

Here are some of the special features reported. Not all of these features have yet been translated into hardware; some are only in the planning stage, or partially breadboarded.

(1) Over 100 Sylvania bulbs in strip sockets will monitor the major registers, etc. CRT displays planned. When completed it will be far more versatile than DEC's PDP8 line.

(2) Data-word length 16-32 bits (32-64 for floating). Planning modular op-code decoders (i.e., basic repertoire plus floating arithmetic, hardware stack operations, etc.). Basic structure is bus-oriented.

(3) Has D/A converted output to drive motor position. Machine has two 8-bit registers, one 15-bit accumulator.

(4) Variable-length instructions, variable-length indirect address fields.

(5) Contents of memory address zero and A register are swapped every cycle (inhibited on some instructions). Therefore one register serves as accumulator and program counter. Memory address 1 serves as index register.

(6) Double precision arithmetic; fixed and floating-point numbers; link on all arithmetic registers; full comparator; AND, OR, Exclusive OR registers for logical computations; data bus allows bi-directional transfer between any two registers.

(7) Will use IBM 1620 software, modified to use USASCII code and to get around unimplemented instructions.

Cost

As to "Cost so far," the range is from 0 to $1500, with an average (among those reporting a cost) of $650.

For "Estimated cost when complete,"

the range is from $300 to "over $10,000." with an average of $2,100. Without that "over $10,000" estimate, the average is $1,100.

Wiring

The large majority, over 80 percent, use fixed wiring.

How Long Working On It?

The range of time spent so far ranges from "one month on the present model" to 4 years, with an average of 2 years.

Size

Here are some present sizes: 3-foot relay rack; 6' x 7' x 18"; 35" x 23" x 20"; 1 work bench; 1 board complete; 30" x 36" x 40"; three 19" five-foot racks; 38" x 60" x 12" & TTY. The "Estimated size when complete" is usually just the same.

Education

Most of those responding have at least one technical degree, including BSEE, MEE, BA in Math, PhD EE, "BA and BS and working on MS," and several students.

Because the great majority of those sending in the survey have technical degrees, and because those who sent it in are among those who have advanced the most with their computers, it seems that lack of a technical education is holding back many ACS members from pushing ahead with their machines, or perhaps from just getting started. Unlike amateur radio, there just isn't enough circuit-level information available on how to build computers.

Other Information

(1) Presently supervising 5 Explorer scouts who are doing much of the construction work, such as building PC cards. I became an Explorer advisor at my company's post to get more hands on the project and to force me to get on the ball and make some progress.... I am going to debug the power supply transients and add a line filter. RTL has low noise immunity and my first wired-up register is dropping and gaining extra bits.

(2) Wish disks and line printers were cheaper! Fortunately, I can build my own software -- assembler, compiler (FORTRAN and/or ALGOL) and operating system.

(3) Teletype controller and memory operational. Can presently transfer data from TTY to register to memory and back. Delay-line memory stability problems solved -- successfully retrieved data after eight hours. Using 8½" x 17" Vectorboard with AA pattern, strengthened by chrome-plated angle. Dual Inlines mounted by alternately bending pin pairs inward and outward. Wiring directly soldered to ICs, using #22 wire with high-temperature-resistant insulation.

(4) This has been an evolutionary process without a fixed idea of exactly what the final product would be. Now I have outrun myself in some ways. For example, I know how to get back and forth from memory to TTY. Also, how to add binary numbers. I don't know how to turn TTY characters into binary numbers in any simple manner. I would appreciate any clues you might have on the subject. (ANY MEMBERS ABLE TO HELP HIM ON THIS?)

Interested in Computers Since...

Those who put down a date gave: 1951, 1955, 1957, 1965. Those who put down an age gave: 13, 14, 15, 18, 20, 21. Those who gave the number of years gave 3, 3, 9 and 17 years.

COMPLETED COMPUTERS

Only two ACS members have reported being anywhere near completing their computers:

ECHO-4

Jim Sutherland's ECHO-4 computer, reported briefly in ACS Newsletter 6, is 7 feet long, 1½ feet deep and 6 feet high. It took Jim a year to build it and will take 10 years to program. He says the CPU is complete, but the input/output system is still growing.

ECHO-4 uses 2N404 transistors and RTL NOR logic elements. The NOR gates were used in process control systems built by Westinghouse about 8 to 10 years ago and were declared scrap. They are mounted on etched circuit boards with 35-pin Elco connectors. A total of 120 boards were used in the entire system (input/output control, arithmetic units) but only 16 types of boards were used, so spare boards do not take up much room.

The memory unit, an Ampex 4096-RQ-30A, came from an obsolete process control computer. Memory cycle is 6 usec, but since the NORs require from 1 to 3 usec to switch, the add time suffers (add speed is 216 μsec).

Between instruction accesses, the memory is available as a refreshing buffer for a CRT display, which is planned but not built yet.

Jim says a story about ECHO-4 is tentatively scheduled for the April 1968 issue of Popular Mechanics. He says it doesn't go into much construction detail, "but the pictures should be interesting."

ECHO-4 has 4 flip-flop registers, and three (P, A and X) in core memory. There are 8,192 words in core memory, each 15 bits long. Clock speed is 160 Kc. There are 18 instructions, 4 bits long.

Special features: one's complement adder with end-around carry. Overflow and carry designators are stored in upper two bits of Program counter (location 0 of core memory). Interrupt automatically stores P and takes next instruction from specified SAVE routine entry. Using 15-pps sync derived from real-time clock. One index register, and also indirect addressing, can be specified by setting flags in the instruction word.

Input: alphanumeric keyboard, six control keyboards, 8-channel paper tape reader, 15 interrupts, 75 contact closures.

Output: Kleinschmidt printer, 60 contact closures, 8-channel paper tape punch, 4 digital clocks.

Interconnections are wire-wrapped.

By the way, ECHO stands for Electronic Computing Home Operator.

EL-65

Hans Ellenberger, who lives in Switzerland, worked a year on his computer and finished it in 1965. A small desk-top machine, looking a little like a Wang calculator with a separate keyboard, EL-65 has a keyboard input and Nixie-tube readout. Size is 40 by 40 by 20 centimeters.

A serial-type computer, EL-65 has 3 registers, 30 words in flip-flop memory, and 15 instructions. The transistors are AC122 (AF pnp germanium) "because of price."

Addition and subtraction times are 1/50 second. The longest multiplication and division times require 1.3 seconds. In addition to these four basic functions, EL-65 can also perform negative multiplica-

tion, and accumulate products.

The cost of materials alone was 1500 Swiss francs, which is about $345. Hans tried to market his computer, calling it "der erste Schweizer Pult-Elektronenrechner," meaning the first Swiss desk-top electronic calculator. But the sales price of 6000 SF ($1380) seems to have put it beyond the means of most Swiss and also it may have been too much of a novelty on the market. As Hans notes, "It seems almost impossible for an amateur to build a computer that can compete with commercial machines. (The amateur who can do that would be, before long, employed by a computer company.)"

Hans is working on a new model, with 16 registers, using Philips LTC cores, and ICs by Fairchild (RTL epoxy), TI and Philips.

MAGAZINE ARTICLES

Low-Cost Counters

The February Popular Electronics contains a construction article (pp 27-32) on a decimal counter with readout, which the magazine believes to be a price breakthrough, as the decade costs only $12, complete with counter, drivers and ten lamps. Parts are available from a Texas company at $12 a decade, including a PC board. A power-supply schematic is given. The maximum rate is 10 Mc, although the unit has been used up to 18 Mc.

Later issues will feature items based on the counter: an "Electronic Stop Watch," which is an EPUT (events per unit time) counter; a digital voltmeter; digital multimeter; and a frequency counter.

The ICs used are all Motorola: two MC790P dual JK flip-flops, and one each of the MC724P (quad, two-input) and MC715P (dual, three-input) NAND/NOR gates. And seven transistors.

An interesting coincidence is the appearance by the same author of an Electronics article (Jan. 22, pp 74-76), "For low cost, count on RTL," which compares the $12 decade with a $10 digital display that uses a milliameter with a special scale, calibrated from 0 to 9, and a biquinary 1-2-2-4 code.

The authors says in his last paragraph that the in-line counter is superior in readability, but the meter design is cheaper and smaller.

Basic Digital IC Circuits

Over a dozen simple digital circuits are given in "30 Basic IC Projects," in Radio-Electronics (Jan. 1968, pp 50-53). This second part of a two-part article uses the Fairchild µL914 as the basis for inverters, pulse-enabling and disabling gates, NOR/NAND and OR/AND gates, square-wave generators, one-shot, Schmitt trigger, flip-flop, and others. All that's needed is a 914 and a few resistors and capacitors, plus diodes for the generator.

The article on the following pages (pp 54, 55, 62) describes how to "Build a Low-Cost IC Signal Generator," with the same µL914, to provide square waves from 5 cps to 50 Kc.

The first part of the IC article appeared in the December 1967 issue (pp 43-45), and covered the basic description of the µL914, giving circuits for linear applications such as emitter followers and amplifiers.

Wireless World Digital Computer

The four-part article on building a small computer, described in the

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Stephen B. Gray
Amateur Computer Society
260 Noroton Avenue
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The Newsletter will appear about every eight weeks.

previous Newsletter, has a fifth part now, completing the series. The December Wireless World (pp 601-605) covers the operation of the machine, with coding examples.

Using Miniature Relays?

An interesting comparison of major characteristics of miniature relays appeared in a new-product item in the January 8 Electronics (pp 171-172). Comparisons are made between crystal-case relays, mercury-wetted and dry reed relays, and solid-state switching devices. Each of the four types is said to provide certain advantages. "If speed is needed more than isolation, solid-state switches should be used. When cost is the prime factor and high isolation is also required, the reed relay is the best choice." The new product is a line of dry reed relays, made by Hi-G Inc. (Windsor Locks, Conn.) which sell for about $2, compared with about $8 for solid-state switches.

Would you believe a relay in a TO-5 transistor can? They're described in the January EEE (pp 20 & 24). Not cheap, though; over $20.

BREADBOARDING INTEGRATED CIRCUITS

Wade White says he breadboards in-line ICs with a board that holds 15 of the 14-pin packs, from J.R. Anderson Enterprises, Inc. 3691 Lee Road, Cleveland, Ohio 44120. The board, type MC-1, costs $4.85 for 1-9, $4.50 for 10-24, and $4.25 for 25-49.

No holes are drilled in the board. The components are soldered to the top, for easy removal or change. Size is 3/32" x 8-5/8" x 5-49/64".

For permanent mounting of 12 of the 14- or 16-pin ICs, Wade uses an M-96003-PG board from Dyna Sales Co., 962½ S. Atlantic Blvd., Los Angeles, Calif. 90022. Phone (213) 268-1175, ask for Milt Hollingsworth.

For TO-5 and flat-pack ICs, use board M-96002-PG. The boards have holes drilled for mounting components, and pins to fit a 22-contact connector (Amphenol series 143). The connector costs about $1.55 new, but can be bought surplus for much less.

Price for either board is $6.95, with a discount of 5% for 5-14, 10% for 15 or more.

Wade also notes that the Vero IC board kit listed in Newsletter 7 at $40, is available from Dyna Sales for $29.95, as item MC-10.

NEXT ISSUE

If any of you who have gotten into the construction of your machines fairly well would like to write up your experiences for the Newsletter, several pages are available for the gory details. Tell us all about your problems, solutions, discoveries, failures, components, and your future plans.

ACS NEWSLETTER

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MORE ACS COMPUTER SURVEY RESULTS

Several survey forms were received too late to be included in the last issue. Here is the data:

1. From Long Island: a decimal, variable-word-length computer, with software similar to that of the IBM 1620. Will make extensive use of read-only storage to hold micro-programs by which regular machine instructions will be implemented. The decimal add and multiply tables will also be stored in read-only memory. Hopes are that the "1620 Model III" will be about 25% faster than the 1620 Mod II and will have its complete instruction repertoire (about 60).

Main memory so far consists of 20K decimal digits (10K X 12 bits), with 10-μsec cycle time, using straight IBM circuits, and semiconductors mounted on PC boards of own design.

There are four two-digit data registers and 32 memory address registers (high-speed core).

"My only consolation in attempting to improve on the IBM 1620 is that if my machine doesn't work right, at least I know that I have software that will."

"It should be emphasized that the popular analogy between the amateur computer builder and a radio ham is simply not valid. The complexity of even a small computer outweighs by at least an order of magnitude [ten times] the design effort necessary to construct an amateur transmitter. This is doubly compounded by the fact that: the nature of basic building blocks is changing at a rapid rate; many commercial designs are proprietary; there does not exist 40 years of computer design history to draw upon."

2. From a Harvard sophomore: 200-Kc machine, with 13-bit words, and instructions two words long. Teletype (Model 19) input/output includes paper tape. Memory is Honeywell TC-M30, 8K words. Add speed 20 μsec. Six registers.

Built with Motorola 700P series of ICs, and npn silicon transistors from IBM SMS boards.

"Although there are well over 150 instructions, only around 16 are basic. The others come about as follows:

a) Each basic instruction may use a literal operand, or an indirect operand; e.g., ADD1 50 means add the contents of address 50 to the AC, whereas ADD2 50 means add the number itself.

b) Each basic instruction has 5 conditional variations. For example, in addition to the conventional CLA, we have

CLA on AC = 0
CLA on AC less than 0
CLA on AC greater than 0
CLA on overflow
CLA on least order bit of AC.

These are, of course, the conventional transfer conditions. I found that they could be implemented for the entire instruction set with almost no additional hardware: three bits of the OP code, which comprises 13

bits, are devoted just for this purpose. Just before the execution of any instruction, the control checks whether or not the condition is satisfied; if not, the instruction is skipped. (This is one of the advantages of a long op code: certain bits may be devoted to specific functions.)"

"Here are some ideas I found useful in my design. Firstly, if core is used, one can kill two birds with one stone by using the selection matrix decoder as the instruction interpretation decoder; if the memory selection decoder were for a 4K (12 x 12) memory plane, then one 12-bit decoder could be used to hold the op code, while the other could generate the timing signals."

"The scheme of making every instruction conditional extends the effective instruction set, and is cheap to implement. Conditional instructions make the set much more powerful."

"The cheapest SMS cards are sold by Brooks Radio in NYC (Brooks Radio & TV Corp., 487 Columbus Ave., New York, N.Y. 10024). They sell at 100 cards for $10. There are an average of 4 transistors per card, in addition to other goodies."

"Someone should design parallel-serial and vice-versa converters for TTY from integrated circuits; that's one thing a goodly portion of ACS members could use. The converters could be standardized to the point where the ACS could manufacture pre-drilled PC boards."

3. From California: another 200-Kc machine, but with 36-bit words, and instruction lengths the same as the IBM 7090. Input/output: Teletype, paper and magnetic tape. Also X-Y recorder for output.

Memory is 3D core, 32K. Add speed is less than 5 μsec. Over 100 instructions.

"The majority of the logic will be core-diode, which is slow in some respects, but has great flexibility, reliability and power savings."

DO-IT-YOURSELF PROBLEMS

A one-page item on the advantage of buying digital modules instead of building them appears on page 42 of the April EEE. It points out some dandy little problems, including:

1. After final assembly, noise is found in the back-panel wiring and the noise amplitude is greater than the noise rejection of the circuitry.

2. Power-supply specs prove inadequate.

3. Signal reflections appear on back-panel wiring and intercabinet cabling. Unplanned signal delays violate timing requirements.

4. Logic-output current drives are too low to charge and discharge parasitic capacitances fast enough to meet clock-speed requirements. When fan-outs are reduced to compensate for charge and discharge times, the number of logic circuits must be increased, necessitating redesign.

COMPUTER HARDWARE

IC Breadboard

Cambion has announced an IC breadboard for 16, 32 or 64 of the 14-lead DIP ICs. Although too expensive for amateur use, it can be adapted by anyone with enough patience to set 14 small eyelets for each IC, plus 14 larger eyelets just outside the smaller ones, and connected to them, for jumpers.

For a look-see at the pattern, see page 112 of the March EEE.

1024-Bit Memory on a Chip

A 1024-bit MOS read-only memory is now available from Philco-Ford's Microelectronics division, according to Electronics (Feb. 19, page 45). The memory array consists of 128 eight-bit words on a chip, on which is also the decoding circuitry, using 216 more MOS transistors.

Once a customer has paid the initial $750 tooling charge for the coating and etching required for his particular interconnection needs, the chip will be available to anyone for the chip price alone, which will be about $70 in small quantities, and $50 in larger quantities.

A 2048-bit memory is in the works. The read-only memory has applications in subroutine storage, and table-lookup operations such as sine and code conversion.

Adder on A Chip

An article by this title, subtitled "LSI helps reduce cost of small machine," appeared in the March 18 Electronics (pp 119-124).

This 8-bit integrated MOS arithmetic, measuring 86 by 116 mils and containing 200 gates, will be introduced by Fairchild Semiconductor as the 3800. On one chip is an input register, an adder-subtracter, accumulator register, and output buffer. No price given.

Electronic Pocket Calculator

Hayakawa Electric hopes to introduce an 8-digit IC pocket calculator this fall. It will use miniature Digitron readout tubes, circuits with about 250 elements on a chip, total of 8 to 10 chips, and cost about $280, Electronics says.

Photo-Transistor

Fred Strother calls our attention to the General Electric L14B phototransistor, which GE calls a planar silicon photo-darlington amplifier, as well as an Economy Light Detector.

Priced at 97¢ in lots of 100-199, this high-sensitivity device is described by GE as having applications in card and tape readers. Fred says it makes a fine interface.

For many applications, only the collector and emitter leads are used. A base lead is provided to control sensitivity and the gain of the device. The L14B is packaged in clear epoxy encapsulant.

Packaging Hardware

Wade White sent a catalog of packaging hardware (Bulletin 10000B) sent from:

Plug-In Instruments, Inc.
1416 Lebanon Road
Nashville, Tenn. 37210

An interesting variety of hardware. Plug-in cans with transistor circuit blanks, from $3.45 up. Two dozen models of plug-in blanks, such as a board that will accomodate six 14-pin flat-packs, for $2.60 without drilled holes, or $6.55 with. Several types of card-mounting files, and various other hardware.

PUBLICATIONS

Digital Design Aid

A method of designing the detailed logic of a digital system is given in "Flow Chart Methods of Logic Design" in the February Computer Design (pp 72-75). It shows how to make a flow chart from the basic considerations, then develop the

chart up to the point where it can be used for deriving equations for the logic.

The author says this method helps keep track of all the different sequences of operation, and minimizes redundancy.

Understanding Logic

"Electronic Digital Components and Circuits," by R.K. Richards (D. Van Nostrand Co., 526 pp, $15), explains how various components and circuits work. It gives the advantages and disadvantages of the major designs, provides alternate approaches, and compares the merits of diodes, transistors, tunnel diodes and super-conducting devices. Amond the topics included are speedup capacitors, DTL components and functions, core structures and accessing methods, film-storage units, magnetic drums, discs, tapes, cards, and various switching methods.

Binary Logarithms

In the March 1968 issue of the British Computer Bulletin (pp 282-285) is an article on "Some Applications of Controlled Shift Registers." No circuits; theory only.

The author shows how to control shift registers in such a way that they perform multiplication, division, and code conversion. The process involves various combinations of shifting, adding (or subtracting) 1 and shifting, and shifting without adding (or subtracting).

One paragraph about binary-logarithm converters may be of interest to several who have inquired about the process involved:

"The use of logarithmic computation eases the extraction of powers and roots and simplifies multiplication and division. Mitchell has shown that the logarithms to the base 2 of binary integers may be derived approximately by a simple shift register and a counter. This can be extended to deal with non-integral numbers as shown in the following example:

Calculate $\log_2 13.625$

Binary $13.625_{10} = 1101.101$

Count number of digits to the left of binary point commencing from zero and write this as the characteristic. Ignore most significant bit of original number and place remainder of number to right of binary point as the mantissa. Thus $\log_2 1101.101 = 11.101101$.

This result is an approximation and techniques are available to reduce the error involved."

The reference to Mitchell is his article, "Computer multiplication and division using binary logarithms," in the August 1962 IEEE Computer Transactions, page 512.

A Computer in the Basement?

A four-page article with this title appeared in the April 1968 issue of Popular Mechanics (pp 77-79, 209, 229), describing the ECHO computer built by ACS member Jim Sutherland, and described in Newsletter 8 (page 4).

ECHO IV will be used for family bookkeeping, by keeping track of monthly budgets and expenditures, so that when tax time comes, deductions can be identified and grouped to simplify filling out the tax forms.

ECHO will also be programmed to keep track of real time, so that events can be scheduled up to a year ahead, with one-second accuracy. It could be used in the kitchen, to increase or decrease proportions for recipes, and print out shopping lists. Jim plans to modify the kitchen cabinets to allow ECHO to take inventory automatically.

ECHO has been connected to the TV set for eventually regulating the schedule of watching. It may also be used to control the house temperature, by first querying the weather instruments outside, then adjusting temperature and humidity inside the house.

What Will You Do With Your Computer?

Even if some of the planned uses for ECHO don't prove practical, Jim Sutherland has obviously thought a good deal about what to do with a computer once it's built.

And that's a question that a great many of us may not have given much thought to. What kind of problems will we run on our machines? Matrix inversion? Hardly. But just what? One non-member is using his for stock-market analysis. It may turn out that finding uses for our computers will be even harder than building them. Unless you've got your own business, there isn't much you'll want to program in the way of business applications. And you'd soon get tired of most of the scientific types of programs, if you have no real use for the output.

If you've done any hard thinking about what to do with your computer when it's finished, let's hear about it.

HOOKUP WIRE

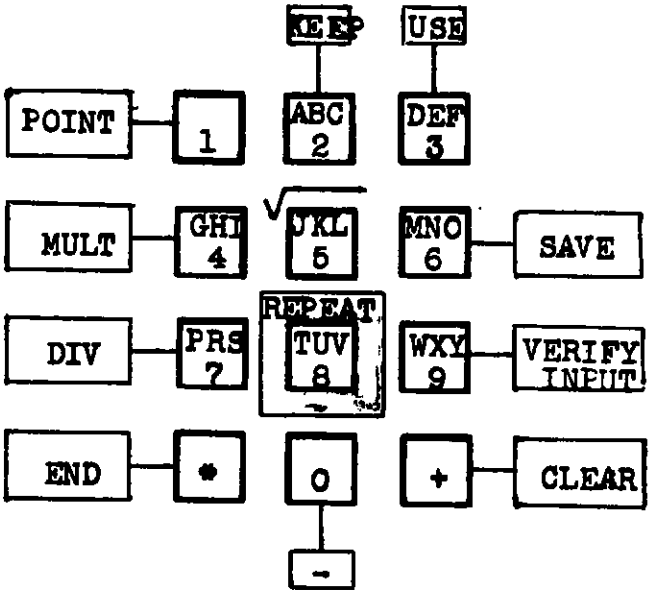
The telephone company uses a multi-conductor cable that is perfect for amateur computer wiring. The next time telephones are being installed where you work, try to get some of the short lengths of cable that are thrown away. Some of these "short" pieces are 20 feet long, and not worth splicing.

Some cables contain only a dozen of these solid 18-gage wires, in twisted pairs; some cables contain 30 or 40. In some cables, the wire insulation is solid-color, with the same 10 colors as used for resistor coding. Other cables contain parti-colored wires, which have a body of one color, and stripes of another, every inch or so, in several dozen combinations.

MINIMUM KEYBOARD

For those of you interested in a minimum input keyboard, IBM has an "Experimental Home Calculator" that uses a 12-button telephone attachment. At present, the pushbutton attachement is connected to the telephones of six Brooklyn high-school students, who do their math homework on an IBM 1710 computer 50 miles away, in Yorktown Heights, N.Y. The computer's output is voice answerback, from a magnetic-drum prerecorded vocabulary. If a mistake is made in entering the problem, the computer's voice tells the student he's made an error.

There are several versions of the touch-tone coding; here is one:



The mathematical operations are programmed by:

ADD press + only

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SUB	press 9	and *
MULT		4 and *
DIV		7 and *
SQ RT		5 and *
END MESSAGE		* and *
MINUS		0 and *
CLEAR		+ and **

For example, to multiply 2 times 8, press 2 4 * 8 * *, and listen for the answer.

Pressing VERIFY INPUT will make the computer repeat the entry, by voice answerback.

PLASTICS

There are times when you may want to mount lamps a certain way, such as in a minimum-space decade, and the kind of mounting hardware you want is too expensive, or it just doesn't exist. One solution is to make the lamp-holder yourself, using some of the modern plastics that cure at room temperature.

First, make a model of the holder, from plastic or wood. Then make a mold of it, using something like General Electric's RTV-41 silicone plastic. This is recommended, as it has a "high modulus of elasticity," meaning that it's easy to separate from the original model.

Next best is GE RTV-30, with a lower modulus. At one time you could get samples of both of these silicones with a letterhead. Perhaps you still can, from the GE Silicone Products Dept., Waterford, N.Y.

Several plastics are available for pouring into the mold, to make the holder. A good one is Shell Epon Resin 828, which is mixed with Epon Curing Agent V-40, with a minimum of trouble. The result is an amber-colored plastic. For minimum light loss, the plastic can be colored black by mixing in some carbon black before pouring; other colors could also be used. You might try your local Shell plastics dealer for a sample, by using a company letterhead.

Pour-your-own plastics might also be a cheap way to make segmented readouts, either 7-segment for numeric, or up to 14 or more segments for alphanumeric. You could pour black plastic around long Lucite strips arranged in the segmented pattern, then cut the finished bar into slices and make another mold for a lamp holder that channels the light to the individual segments. Or you could mold the entire segmented display as one piece, Lucite strips and lamp-holder all together.

HELP!

Your assistance is needed to help fill these pages. Please send me:

1. Answers to any of the problems in the early Newsletters.
2. Details of your computer, including problems and solutions.
3. Ideas about what you intend doing with your computer when it's finished. What programs are you going to run?

ACS NEWSLETTER

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THE PDP-8 ROUTE

Fred Sias likes the Digital Equipment Corporation's PDP-8/S computer enough to borrow a lot of ideas from it. He writes:

"It is a little difficult for me to see a computer sitting around doing nothing. There are plenty of chances to use a machine to teach highschoolers. A number of PDP-8/S are in use for this purpose already. I think there is opportunity to develop low-cost inventory systems for small businesses. These ideas are in the line of income-producing sidelines, but computer time is valuable and anyone with a machine should be able to produce income with it. A particularly fruitful area should be in software development. At the present state of technology, practically any company with an engineer or two can market a computer. Software support is the costly and time-consuming requirement for success in the computer business, however. This suggests that amateur-built machines could provide support to the vast software needs of the computer industry. To do this, an amateur machine would only need the same order structure as some commonly used commercial machine. There are over 2,000 machines in use of the PDP-5, 8, 8/S and 8/I series. These machines vary considerably, but share a common order structure.

The software problem is a two-way street, also. DECUS is a users' society for DEC machines that provides a medium for the exchange of programs and ideas. Probably an amateur computer builder could become a non-voting member of the society. Interested persons might approach their local DEC sales representative. User-developed assemblers, statistical packages, arithmetic subroutines, and special software for peripheral devices is available to any member. For instance, I just recently obtained a software symbol generator for displaying text on an oscilloscope. Text output by this route is very inexpensive. Keyboard input and scope output is probably the most inexpensive I/O system for an amateur computer.

I'd like to present some of the features of the PDP-8 series of computers that make them worth looking at for ideas for amateur construction. Should I eventually construct a machine, it will start out looking like a PDP-8/S and may eventually be changed to a PDP-8. The difference is that the 8/S is a serial machine. That is, all transfer between registers is done through the adder, bit by bit. A serial adder has much less logic than a full parallel adder. Consequently the complete PDP-8/S has the following complement of logic:

92	flip-flops
2	clock multivibrators
2	one-shot delays
52	pulse amplifiers
161	inverters
160	NAND gates
62	diode gates
70	drivers for displays
1	Schmitt trigger
1	4K, 12-bit memory, and decoding and driving logic.

The commercial unit uses a 6-micro-

second parallel core memory even though the rest of the machine is serial. Data is transferred into the memory buffer register serially and then into the memory in parallel. Consequently, two separate clocks are needed, and run independently, depending on the phase of the word timing. Incidentally, I understand the original design of the PDP-8/S was to use a drum or disc, but the cost of core memories dropped so radically that the machine was marketed with a core memory. That core is available from DEC for $2000. Application notes and driving logic are available, too.

If I were starting to build a machine from surplus parts, I think I would choose the PDP-8 instruction set, construct the serial logic with a disc memory first, later convert to a parallel core memory, and finally convert to full parallel logic. Even using serial logic, the slow version has a respectable 28 to 54-microsecond operation time.

Some other features of the PDP-8 are worth mentioning. The machine has a 12-bit word size. Where analog devices are to be attached to the machine, 12 bits is a natural precision. A-to-D converters are usually 12 or less bits in precision (for a number of reasons) and a resolution of 1 part in 4096 is more than adequate for devices like scope displays. Multi-precision arithmetic software, both fixed-point and floating-point, is readily available, so a longer word length is unnecessary for anyone except a professional computer person who has a requiement demanding higher-speed, multi-precision arithmetic. In support of this statement, one might note that the IBM 360 series equipment has turned to the small basic word size with multiple-byte memory accessing to gain speed. Early machines required large word size due to the slowness of memory access.

The PDP-8 has only eight basic instructions, but the set can be expanded to a hundred or more by micro-programming the operate and input/output instructions. This permits one to use a simple octal decoder for decoding instructions.

Basic input/output transfer on the PDP-8 is via the accumulator. Transfer is in parallel, both for the standard and serial machines. A party-line bus system is used, with each peripheral device recognizing its own microprogrammed device-select code. The logic to do this is simple, with the commercial device-select logic costing only about $50. This is one of the simplest input/output systems that I have seen, and it is thoroughly described in the DEC "Small Computer Handbook," available free from any DEC salesman. I endorse this handbook as a liberal education in computer design.

Do you think there would be any interest in approaching DEC about supplying a basic kit for amateur construction of a version of the 8/S computer?

The parallel-to-serial conversion device mentioned in your last newsletter is available from DEC for $150. I recommend the free DEC "Logic Handbook" as a second liberal education.

Incidentally, one does not need a separate device for parallel-to-serial conversion. One merely needs to shift the data word out of the accumulator, testing the link bit each shift, and outputting a pulse if a one is present in the link bit. ("The link is a 1-bit flip-flop register attached to the accumulator, and is used primarily in calculations in which 12 bits

are not enough to represent the numbers involved," according to the Small Computer Handbook.) See an article by Park and Ohkuma in the Fall 1967 DECUS Proceedings. The article, by the way, describes a magnetic-tape system using an ordinary unaltered audio-tape transport for recording digital data. Cost of the interface is about $200, using commercial logic modules. This is one of the cleverest designs that I have seen for a digital magnetic-tape system at minimum cost.

Perhaps I have over-sold the virtues of the PDP-8 series of machines, but I think they have a number of minimum-cost design features that would benefit an amateur who does not have special reasons for using other, possibly more complicated, approaches.

Here are a few hardware ideas. For a control panel: Drill holes for all register indicator bits. Cover the whole panel with solid translucent plastic, with decals for labels. Insert lamps in holes in back of panel with only wires for connections to a backup mother board. Take a look at the PDP-8/S to see result.

We use strands from telephone cables in our wirewrap tool. The $50-or-so hand wirewrap tool from Gardner-Denver (Part No. 14H-1C with No. 26263 bit and No. 18840 sleeve) is well worth the expense. Wire wrapping is a fantastic improvement over soldering connections. An unwrapping tool for $10 makes changing connections very simple. I would suggest that these are essential investments to ease much future pain.

The ACS member with the TTY code-conversion problem undoubtedly has a five-level Baudot code instead of ASCII. The simplest procedure for input would be to re-label T, CR, O. SP, H, N, M to represent the octal numbers 0 through 7. Larger binary numbers can then be assembled by shifting in the accumulator in the standard way. A hardware Baudot-to-octal conversion matrix could be constructed fairly easily, but once his computer can execute a few simple instructions, a table look-up program is simple to write and won't use up much memory. Output to the TTY would be via table look-up also. Only the 8 numbers in the octal number system need be converted, since text would be stored as is, and an assembler could be constructed by merely changing the symbol table definitions to Baudot, if his instruction set matches some commercial computer sold by a helpful salesman.

Several months ago I noticed IBM 1620 core stacks and drivers available for around $200. It happens that the 1620 accesses 12 bits per memory cycle, even though it is a decimal machine. That is, the memory is a 10K, 12-bit word size, and two BCD characters are accessed each memory cycle. Perfect core for a 12-bit machine. The PDP-8/S uses a 13-bit core, but the parity bit is really unnecessary since the machine comes to a screeching halt if a sense amplifier goes out and the machine starts getting incorrect parity. The 13th bit is probably a carry-over from its serial-memory ancestry. The 1620 memory has a 20-microsecond cycle time, which resulted in a relatively slow decimal machine, but would provide respectable speed in a binary configuration. Converting the decoding and core-driving logic might require some ingenuity.

Where one has some money to spend, I highly recommend the new Tektronix storage scope display Type 601 at $1050. I have just constructed an inexpensive interface, and find

it a joy to get text output on the scope instead of waiting for the slow TTY to pound out results. Analog displays with a 35-mm camera for permanent records make this a very general-purpose interface.

Have thought about getting cheap logic cards. Of course, IBM SMS cards are readily available, but the connector is usually cut off. (Does anyone know where to get intact SMS cards?) Anyway, cut SMS cards probably could be most easily used by cementing on a short extension with an etched male PC connector. [For a cheaper way, see page 1 of the November 1967 ACS Newsletter.] A silk-screen outfit from your local art store is cheaper than the kit from Allied. Silk-screened and etched connectors for dozens of SMS cards could be made in a few hours.

This has been a rather rambling letter, but perhaps there are some ideas that will be of use to ACS members. I will be pleased to communicate with anyone who has chosen to use the PDP-8 instruction set and has programming or interfacing problems."

Fred R. Sias, Jr.
University of Miss. Med. Ctr.
School of Medicine
Department of Medicine
Division of Neurology
2500 North State Street
Jackson 6, Mississippi

* * * * * * * * * * * * * * * *

Fred also sent along a short piece of paper tape to show why he chose those particular keys to be relabeled:

DEC recently announced the PDP-8/L, a stripped-down model of the PDP-8. The interfacing circuits have been removed, and only a TTY can be used for I/O. The memory is 4K, with a maximum of 8K. Price is $8500, or $1500 less than the PDP-8.

As to a PDP-8/S kit, DEC says that there is the question of their responsability to the kit buyer. What happens if he can't make the kit work? Does he ship it back to the manufacturer, like a Heathkit, and get it fixed up for a price? Also, if the back panel is furnished pre-wired, how can the kit cost much below the assembled and tested price, because there isn't much to the assembly. And if the back-panel weren't pre-wired, how long would it take a man to go crazy trying to wire it all himself? DEC says the only practical place for a kit is the power supply, which is handwired.

HEATH MODULAR DIGITAL SYSTEMS

Speaking of Heath, if anybody has been patiently waiting for Heath to come out with a reasonably priced computer kit — forget it.

Recent Heath Company ads show the new 805 Universal Digital Instrument, which can be used as a frequency meter, events counter, digital voltmeter, time interval meter, etc. The same ads show the 801 Digital Analog System Modules, which include a power module, binary information module (10 neon lamps, 8 SPDT switches, 2 SPDT spring-return switches), timing module (0.1 cps to 10 Kc), and plug-in circuit cards (NANDs, dual JK flip-flops, dual one-shot, relay card, etc).

The 805 sells for $940 without the digital voltmeter function; $1250 with it, assembled. The 801 sells for $435 with a fixed set of 13

circuit cards. Other cards may be bought, at $10 to $40 each. Note that this is not a kit.

The 801 is for breadboarding circuits, using patch-wires that plug into the special connector boards on top of each card, which uses TTL integrated circuits.

At these prices, whatever more sophisticated digital circuits Heath may offer in the future will be quite expensive.

MOUNTING DIL ICS

Don Tarbell writes:

"I noticed some members are having trouble mounting dual in-line packages. A friend and I have gone together to form a small company which, among other things, manufactures a board for mounting the DIP's. You push the IC into the board from one side and solder to pads on the other side. There are two extra pads (also with holes) for interconnection to each pin. I use small telephone wire for interconnection, and find that a wire may easily be soldered and unsoldered many times without lifting a pad. A whole IC may be unsoldered by wicking the pads and prying it out, although I have found this not often necessary."

For a spec sheet on these IC breadboards, write:

Advanced Digital Design
P.O. Box 4409
Huntsville, Alabama 35802

The boards hold 32 of the 14-pin DIL ICs, cost $8 each.

Don continues: "In reference to Newsletter Number 7 (November 1967), page 5, SHIFT REGISTERS (by National Semiconductor), I wish to warn members that these shift registers are of the dynamic type, which require a continuous two-phase clock at a minimum of 10 Kc. This means that if the register is used to store data for future use, one must keep track of where it is in the continuous loop by an associated counter. I have done this, and have found that it loses no data if the power supply is adequately filtered. National also makes a dual 100-bit (200-bit) dynamic shift register which sells for $36 in single quantities; part number MM506."

Incidentally, Ungar now has an IC desoldering tip, No. 859, designed to "remove ICs rapidly without causing delamination." The desolderer melts all 16 solder pads at the terminals simultaneously. The device is designed for use with the Ungar 47½-watt heat unit, No. 4045, which fits the 777 or 776 handle. The Lafayette Radio price for the desoldering tip is $1.65; for the heat unit, $2.97.

WIRE-WRAP AND TERMI-POINT

For more information on tool-applied terminations, such as the wire-wrap discussed by Fred Sias earlier in this issue, see the February 1968 EEE article, "Packaging/Interconnections, Part 1: Tool-Applied Terminations," pages 66 through 74.

BOOKS AND ARTICLES

"How to Build a Working Digital Computer," by Alcosser, Phillips and Wolk, Hayden Book Co., N.Y., 175 pages, $3.75.

The blurb on the back cover notes that the book "shows the reader how to construct a working model of a digital computer, using simple, inexpensive components." The six basic units are "encoder,

The Amateur Computer Society is open to all who are interested in building and operating a digital computer that can at least perform automatic multiplication and division, or is of a comparable complexity.

For membership in the ACS, and a subscription of at least eight issues of the Newsletter, send $3 (or a check) to:

Stephen B. Gray
Amateur Computer Society
265 Noroton Avenue
Darien, Conn. 06820

The Newsletter will appear about every eight weeks or so.

arithmetic unit, control panel, drum memory, core memory, and decoder."

The blurb is misleading, but the computer, although manually operated, is quite ingenious. The core memory is really a read-only memory made of paper clips, bent to form switches. The drum is also read-only, made of a large juice can and 29 paper clips that make contact with the drum through holes cut in graph paper wrapped around the can. The drum contains the program steps, using 26-bit instruction words.

The arithmetic unit consists of 39 DPDT switches and 5 SPST ones; the Appendix shows how you can build ycur own switches with paper clips and dowels.

This book may be of interest if you're working with a grade-school group or perhaps even a high-school bunch that's low on funds.

SQUARE ROOT

IC's Generate Instant Square Root, (EDN, March 1968, pp 26, 27), by Graham of Fairchild, gives a nice circuit for square root: To the 10's complement of the number is added 1, 3, 5, 7 ....., until the most significant bit changes to 0, at which point the total number of additions to the complement is the square root.

UNUSED LEADS

Q&A from the "Test Your IC IQ" page in Electronic Design (page 198, March 14, 1968):

Is there a rule of thumb to help us decide what to do with "extra" leads on digital ICs?

What is done with unused leads often depends on the particular circuit application. In general, it is safe to leave unused output leads open. Unused input leads, on the other hand, should be tied to ground or some other potential point to prevent parasitic transistor action or leakage under any possible signal combination. The best potential point to use will depend upon the circuit geometry, and in most cases will be apparent from the circuit schematic, which can be obtained from the manufacturer.

IC SOCKETS

An EEE survey on "Sockets for Integrated Circuits" appears in the July 1968 issue (pp 56, 58, 60, 61), and discusses packaging sockets, test sockets, contact problems and dielectric materials.

APPLICATION NOTES

The latest Application Note Catalog from Motorola, dated April 1968, lists 43 on digital circuits. Some are of little amateur interest, such as on IC reliability, but most give worthwhile design info, such as "Designing Integrated Serial Counters," or are about particular Motorola digital ICs.

ACS NEWSLETTER

a publication of the
AMATEUR COMPUTER SOCIETY

Number 11 December 1968

LAST ISSUE OF THIS SERIES

IT'S SUBSCRIPTION RENEWAL TIME

The money has finally run out, and so this is the last issue in this series of ACS Newsletters. For a new subscription, please send in $3.00 ($3.50 if you live in Italy, Japan or Switzerland).

If your name is Fronek, Gantner, Gruner, Hanson, Harrold, Haynes, Pfeiffer, Sundstrom, Van Ornum, Young or Zuccaro, you don't need to send any more money now, as you're already paid up, by virtue of previous contributions.

As of this issue, there are 91 ACS members, in 27 states and 5 countries. I hope most of you will continue to be members, because the more of you there are, the more issues there will be in the new series of Newsletters.

Along with your renewal checks, please send me a few words about what you intend to do with your computer when it's finished.

One of the first Newsletters in the new series will be a roundup of the basic circuits used in ACS computers. So, if you buy ICs, please let me know in your renewal letter what make and types you use for lamp drivers, memory drivers, flip-flops and gates. If you build your own, please send schematics of these circuits.

IBM SMS CARDS

According to IBM Industrial Products, there are about 3800 different SMS circuit cards. Some of the cards are used in several pre-360 machines; others are in families of cards used in only one computer or group of computers, such as the 1400 series.

There is no list of code numbers and corresponding circuit types for these cards, according to IBM. The tabs are broken off because they are gold-plated, and Federal law requires that the gold be recovered, even though there is only a few cents' worth on each board.

SAVE THE MOSFETS

Walk across a rug, touch an unmounted MOSFET, and it's shot. Even less electrostatic potential than that is enough to destroy a MOS field-effect transistor. To get around this problem, some vendors ship MOSFETs with the leads soldered together, or shorted with a piece of metal foil.

That's fine until you're ready to mount the transistor in a circuit. But when you separate the leads for assembly, you can wreck the transistor by building up static charges.

Page 66 of the Dec, EEE shows how some NASA engineers use a loop of flexible nickel wire, attached to a music-wire spring, which is slipped over the transistor case and then around all the transistor leads, shorting them together and allowing them to be handled without damage to the transistor. The device is removed after the transistor is soldered into a circuit. If there's enough space, it can be removed and used again, but the wire can be cut and replaced if necessary.

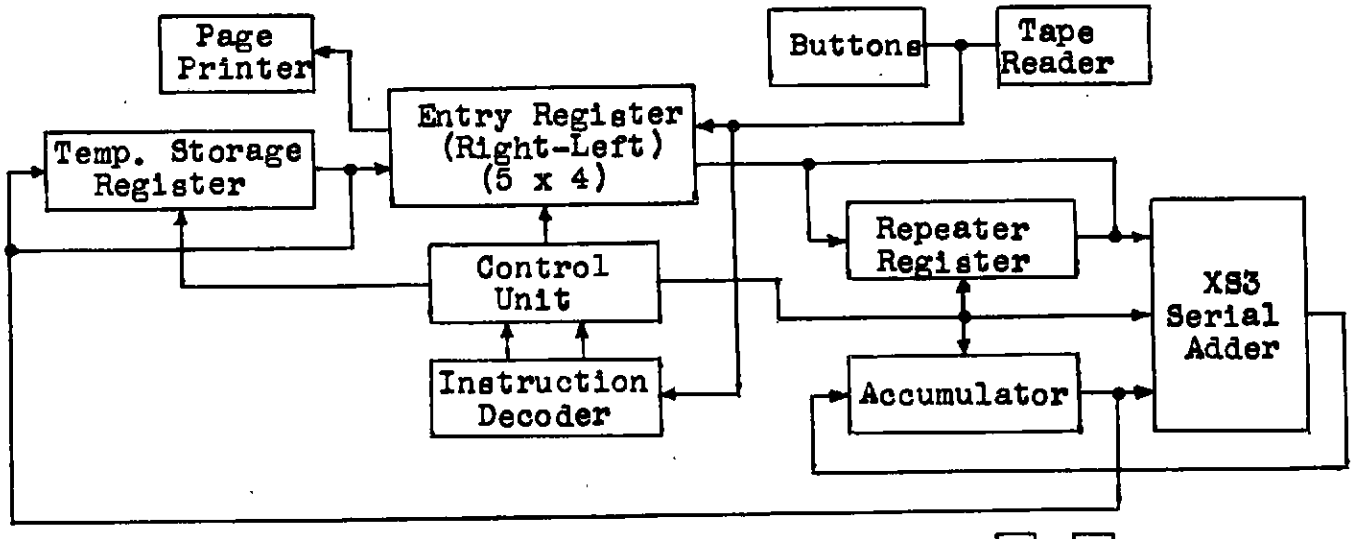
AN XS3 COMPUTER

Don Tarbell, who was last mentioned in the August 1968 Newsletter (page 5) writes that his computer uses the excess-3 code, and its 4 registers are each 5 digits by 4 bits. Clock speed is 10 Kc at this time, but will probably be speeded up to 100 Kc or 1 Mc later on. He is using mainly the Motorola MC700P line of ICs.

Don's computer at this time consists of the processor, a Teletype tape reader, TTY tape punch/printer, Western Union page printer, and two code-conversion boxes. It has add, subtract and hardware multiply, and will soon have a hardware divide. He can run programs from the paper-tape reader or from a magnetic-tape recorder. A 4K memory will soon be added to the system.

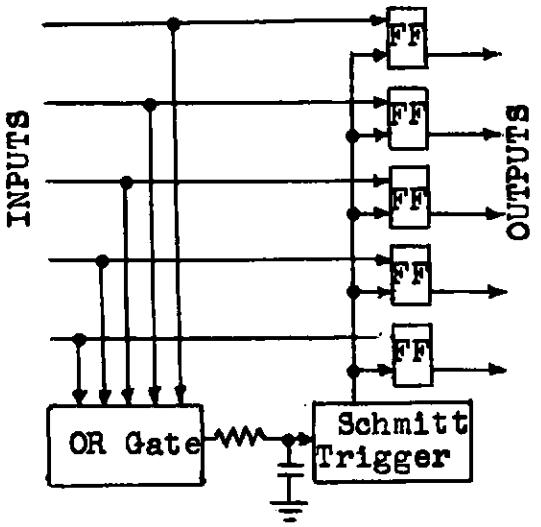
His sources of hardware are Allied Radio, Airwork Gulf, Lafayette Radio, Ampex Computer Products, Western Union, and friends. All the schematics came from his own design, or from fragmentary sources.

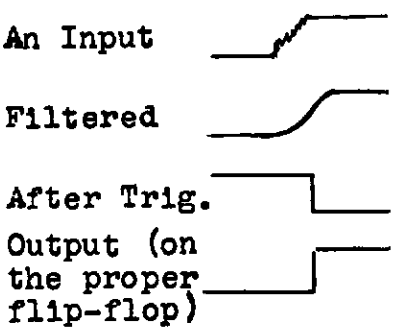
Here is a block diagram of Don's computer; most of the lines are actually several wires, and most of the junction points are 4-line digital switches:



The instruction set at this time is: 0,1,2,3,4,5,6,7,8,9, ADD, SUBTRACT, ENT MULT, MULT, STORE, RECALL, SHIFT, STOP, SHIFT IF POSITIVE, RESUME, COPY INPUT, RUN, PRINT OUTPUT.

Following is a solution Don had for the problem of filtering five inputs that were full of contact bounce from buttons or tape reader.





Don says his present problems are:

(1) Find suitable drivers and sense amplifiers for a memory that requires 190-ma drive current and has min. 30 mv output to 200 ohms.

(2) Understand how present-day computer compilers and assemblers perform translation functions.

(3) Find equal and plus signs for his printer.

P-S AND S-P CONVERTERS FOR TTY

Back in the May 1968 ACS Newsletter, a member noted that someone should design parallel-serial and vice-versa converters for TTY from ICs, and which he believes a "good numer of ACS members could use."

Jim Haynes writes that there are two such items in existence. One is a set of boards for 5-level TTY intended for amateur radio use for selective calling, and produced by Harold Quinn of St. Louis. But Jim didn't have Quinn's address at the time. The other item is a Teletype send-receive converter that uses ICs. Another ACS member, who is with Teletype, says the only card that seems to be applicable is one used as the sending distributor on the Model 37. However, "it would be difficult to get these cards, since production at present is needed for sets being built." The card uses 21 ICs, three of which are Motorola MC853P dual JK flip-flops, or equivalents made by ITT or Fairchild.

SCRAP IBM EQUIPMENT

According to a special section on "Computer Trends" in the Dec. 9 issue (pages 44-45) of Electronic News, IBM now has a policy which says that, as of July 16, 1968, no scrap will be sold whose source of origin is IBM. The policy is said to be that such parts will be junked and melted down for salvage. The new policy came about because of a junk dealer in Boulder, Colorado, to whom IBM was selling worn-out tape drives. The first models sold were old tube models "not worth much to anyone." Newer models, such as the 727 and 2400, began appearing, and salvage hunters had a field day, at 25 to 30 cents a pound. Competition soon sent the prices up to 35 or 50 cents. But then some people began using the surplus parts in supposedly new equipment, even selling some of it back to IBM. IBM doesn't want old parts sold to the public; they carry its label and "might compromise IBM's image."

Whether the new policy is country-wide, or applies only to tape drives, is not known at this moment.

CRT NUMERIC CHARACTER GENERATOR

For those interested in CRT display, Fairchild Semiconductor has a seven-segment numeric character generator that is a MOS/LSI circuit with 150 gates on a chip.

The 3250 DIP accepts four-bit binary-coded words, and generates four deflection pulses synchronized with a serial train of video pulses that subsequently control the CRT beam. About 550 characters (the 10 numerals and a few special symbols) can be displayed at a 60-cycle refresher rate.

The 3250 DIP sells for $60 each in quantities of 1-24, operating at -55°C to +85°C. A limited-range unit (0°C to +70°C) sells for $42, in quantities of 1-24.

NEW FREE BOOK FROM DEC

A new 425-page book, "Introduction to Programming," is available free from DEC as the latest in their Small Computer Handbook Series. It

is oriented toward the PDP-8 family of computers, of which over 3500 are in operation.

Single copies may be obtained free by writing Dept. P, Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754.

S-P CONVERSION FOR TTY

Don Tarbell, noting that someone was looking for circuits to convert from Teletype to their computer, enclosed a circuit he uses for serial-to-parallel conversion from his Teletype tape reader. The capacitors in the schematic opposite may need to be adjusted somewhat, depending on the transistors used and the frequency desired. His unit runs at 60 words a minute.

Don says the best IC sense amplifier he's seen yet is Texas Instruments' SN7525N. This dual inline package has two sense amplifiers in it, and costs about $13 in single quantities. He has tested some samples, and they work OK.

When he gets his memory hooked into the computer, Don intends to work on three software packages:

(1) A simple version of Fortran.

(2) A compiler for solving special math problems such as higher order equations, differential equations, and many simultaneous equations.

(3) An English conversational program to solve logical questions depending on previous input statements.

PRINTED CIRCUIT KIT

Kit #500 contains PC boards and all chemicals and supplied needed to manufacture printed circuits. Each kit contains two PC boards, 4-3/4 by 3-3/4 inches; a resist-ink pen; one 6-oz bottle of resist-ink solvent; and one 1/16-inch drill bit. The kit is packed in an acrylic box which serves as a developing tray. Costs $5.95 from Injectorall Electronics Corp., 4 North Road., Great Neck, NY 11024

ONE REASON FOR BUILDING A COMPUTER

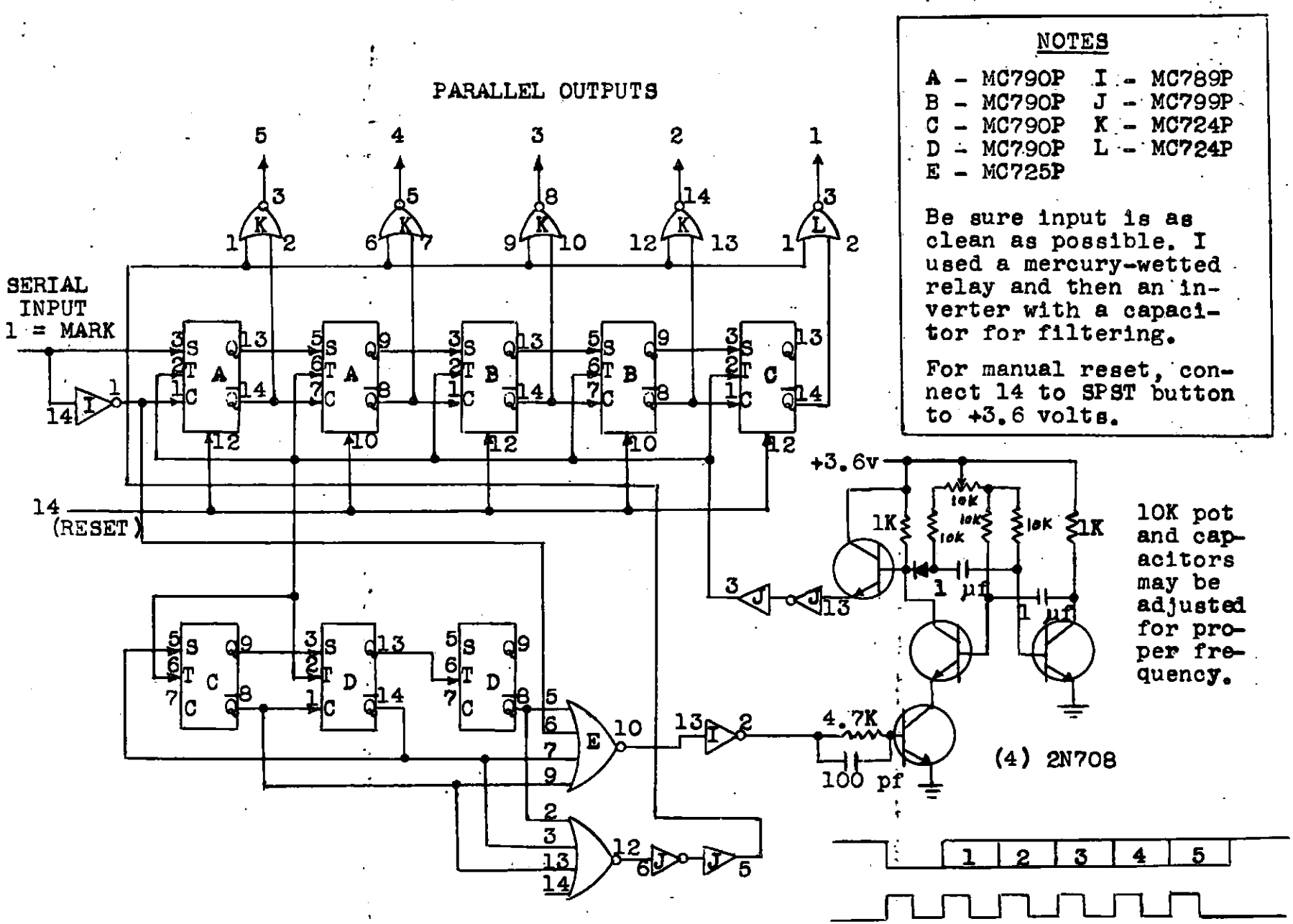
One of the newest ACS members has an unusual reason for wanting to build a computer. Some years ago he had cerebral meningitis. Among other things, the accompanying fever damaged his memory considerably, both in the ability to remember things, and the memories that were already in it, back to when he was 11. As he puts it:

"Since I had never previously had much difficulty remembering things, it took quite a while for the new condition to be recognized. The trouble masked itself, as it were, since I couldn't keep in mind the fact that I couldn't remember things. Eventually I simply learned it."

"The first solution was to keep a journal of my activities and copies of everything I wrote (letters, orders, etc.). This worked for a while (10 years), but now I'm being driven out of the house by the mountains of accumulated paperwork. I am similarly obliged to keep all bills, recepts, canceled checks, etc., for years back. Simply finding the stuff is becoming a problem."

"So the second solution is to put it all on mag tape and let a computer keep track of it. Obviously, such a computer will be more business-type than scientific. (Of course, if it can do math problems as well, so much the better.)

"My real problem, of course, is the computer's enormous complexity, with many different things going on simultaneously. A poor memory is



NOTES

A - MC790P
B - MC790P
C - MC790P
D - MC790P
E - MC725P
I - MC789P
J - MC799P
K - MC724P
L - MC724P

Be sure input is as clean as possible. I used a mercury-wetted relay and then an inverter with a capacitor for filtering.

For manual reset, connect 14 to SPST button to +3.6 volts.

obviously a great handicap here. While I concentrate on what's going on in one area, the activity elsewhere escapes from me. For this reason, I am obliged, much more than most people, to depend on circuit diagrams. The diagram serves as a memory and I can switch my attention back and forth without any part getting away."

"But all the computers I have had anything to do with, have been far too big to get onto one circuit diagram, or even several, and I still get lost in the pages and pages of circuitry. However, it seems possible that the type of limited-scope, single-purpose computer I have in mind might be encompassed in only a few drawings that I could eventually comprehend.

"Some of the computer's functions might be of some use once it is built (such as listing), but there might also be things I could do right now that haven't occured to me. I will appreciate anything anyone can do."

Any suggestions? He has 30 reels of one-inch instrumentation tape, two 120Kb core memories from the IBM 1620, a 32Kb core memory, and some 4Kb frames.

THREE LOGIC PROBES

Within several weeks of each other, three logic probes were put on the market. Because ACS members may be interested in debugging digital circuits without having to use a scope, details of the three probes are given here. Is there an ACS member who will design us a probe using the best features of all 3?

A hand-held probe for detecting the presence and polarity of digital pulses as fast as 25 nsec is available at $89 from Pulse Monitors, Inc., 351 New Albany Road, Moorestown, N.J. 08057.

The Digi-Probe model 1210 uses ICs, operates from a 5-volt 75-ma source, and has red and green indicator lights "to allow non-technical personnel to perform most digital circuit production-line checks with the probe, in lieu of a scope."

A second such probe is marketed by Automated Control Technology, 3452 Kenneth Dr., Palo Alto, Cal. 94303. A lamp at the end of the probe will light for logic 1 (+2.0 to +6.0 V), and remain off for logic 0 (zero to 0.8 V). High input impedance prevents upsetting flip-flops and one-shots.

Hewlett-Packard has a logic probe with a lamp at the tip that flashes for 0.1 second for a positive pulse, goes out for momentarily for a negative pulse, turns on low for a pulse train, burns brightly for a high logic state, and turns off for a low logic state.

Overload protection is from -50 to +200 V continuous; 120 V AC for 10 sec. Input impedance is 10 kohms.

Pulses as short as 30 nsec will cause a flash. Price of the HP 10525A Logic Probe is $95.

The probes are all small: the Digi-Probe is 1" x 1¼" x 2½", with the probe extending 1-3/4" beyond the case. Weight is 2½ ounces.

REMEMBER TO RENEW

If you'd like to subscribe to Volume II of the ACS Newsletter, please send a check or money order for $3.00 to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Avenue
Darien, Conn. 06820

ACS NEWSLETTER

Volume II, Number 1
(Serial Issue 12)
April, 1969

a publication of the
AMATEUR COMPUTER SOCIETY

FIRST ISSUE OF
VOLUME TWO

HERE WE GO AGAIN

Enough money has finally been sent in to guarantee publication of at least eight issues of Volume II of the ACS Newsletter.

A LETTER OF COMMENT

Along with his check, Allyn Rothman writes that he "thought he might add some comments and observations concerning the ACS Newsletter and members' activities." What he adds is quite constructive:

"Let me preface my remarks by stating that I can't help getting the impression that many members are having considerable trouble with their machines mainly because they don't seem to be aware of the huge work effort involved. Commercial computer manufacturers expend tens of thousands of manhours designing their products, and with all their engineering talent, computer aided design, etc., they still have problems! I think that for anyone without advanced technical training, knowledge about (or even access to) computers and programming, designing a computer may prove impossible altogether. This leaves, in order of decreasing difficulty, improving on the design of an existing computer, copying an existing computer, or depending on some type of computer kit. I also think that, in general, members ought to concentrate more on technique, organization, and planning instead of diddling around a flip-flop at a time and considering the soldering of an IC into a circuit a "real" accomplishment as far as the progress of their machine is concerned. A computer is considerably more than the sum of all its hardware. Getting a particular shift register to function is not the major stumbling block; integrating the system is the problem. Now some more specific comments.

In past issues of the Newsletter, some rather ingenious instruction sets have been devised which either simplify hardware, decoding, or subsequent programming. It should be borne in mind, however, that the use of an instruction set which is already implemented on a commercial machine means a great reduction in problems with software, which would then be readily available. Remember that commercial manufacturers also look for instruction sets which tend to optimize both hardware and software, and many machines have instructions worth copying. If you've never written an assembler or Fortran compiler, don't just laugh it off as an easy project; it may well take you longer than to build the machine itself. Coming up with a new, unique instruction set may be a thrilling idea, but getting someone else's instruction set to function with your hardware is no small feat either.

The report on the PDP/8 in issue #10 of the Newsletter was most informative. As to the feasibility of a PDP/8 kit, you laughed off the possibility of having to do the back panel wiring yourself as being an invitation to insanity. It seems to me that this is what amateur computer building is all about (the wiring and the insanity). Furthermore, I think that some important points were missed in the discussion. The implication was that a kit would contain the standard DEC circuit boards and components. The savings in cost would certainly not accrue from the ama-

teur merely completing the back-panel wiring for a bunch of commercial (and expensive) circuit boards. The list of logical components which was provided was impressively small. Implementing this logic with, say Fairchild Micrologic would mean:

a) a real money saving—like you would be talking about a few hundred dollars for all the ICs required;
b) a large saving in space, since the PDP/8S, small enough as it is, is still not an IC machine;
c) not merely copying an existing machine, but turning a good second-generation one into an improved third-generation model.

I think that the PDP/8S is an excellent machine to either improve or consider as a basis for a kit. While on the subject of kits, I will also add that the concept of a modularly expandable kit is completely unfeasible since, again, it does not solve the major problem, which is system integration; not just implementing a particular register. For those who do not have the background or the test equipment to design their machine, just the logic schematic of a small computer consisting of a few hundred cheap ICs would be more than a start. Provide a few circuit boards, and there's a kit. The PDP/8S is small, serial, and slow, but I think that none of us would mind having one, finished, working, and usable for whatever limited capabilities it would have.

As for the question of "what to do with your machine when it is completed," I would like to state that if I had no use in mind for it, I wouldn't be wasting my time trying to build one. First of all, I am already using a computer to help me with both my logic design and my circuit-board layout. I am also attempting to simulate my entire micro-instruction sequences for my read-only memory on a computer to make sure that the machine's logic will really work. By the time I start plugging in actual components, I want my only problem to be noise, not logic organization. Anyone in the electronic design business, as any computer builder must be to some extent, would much rather substitute a few minutes of computer button-pushing for hours of slide-rule pushing. With all due respect (honest!), anyone who would have his home-built machine control his house's heating system is insulting his own creation. When I have programs which will enable my machine to completely design its successor, then I will wonder what to do with it (including whether or not to pull its plug out in a hurry to be on the safe side). Software development alone ought to keep most of our machines pretty busy.

A few odds and ends now. I am seriously dabbling with the idea of a PDP/8S kit, since the logic for the machine is rather simple, and thousands of PDP/8's are being used in industry for data collection and process control, and they all use the same software. Someday it might serve as a useful auxiliary computer for my main CPU, but it still is a very "spare" time project. If anyone else is interested in pursuing this, it might be fun; it certainly will be easier than anything else anyone is building.

Members may find the following manual very useful: "A Pocket Guide to Hewlett-Packard Computers," available from H-P, 395 Page Mill Road, Palo Alto, Calif. 94306. It contains detailed hardware descriptions of the H-P series of small computers (detailed logical organization, that is), as well as complete specifications for H-P Assem-

bly language, Fortran, and Basic, programming techniques, algorithms, etc. Well worth the $3.00 they're asking for it. I am interested in obtaining any information that is available on CRT displays. Are any members working on them? A kit for one of those wouldn't be a bad idea. They can be built cheaply.

What I'm trying to do now is to get a computer to design my computer. It doesn't seem to be saving time, but it sure does save energy, not to mention hardware."

* * * * * * * *

Incidentally, DEC now manufactures the PDP-8/S only on order, with a 4-month lead time. As a DEC salesman put it, "The 8/L is cheaper and does more than the 8/S."

COMPUTER SCHEMATICS?

A quick check with half a dozen IC manufacturers (Motorola, Signetics, Amperex, National, TI and Fairchild) showed that not one of them has a demonstration IC computer of any size, and thus no schematics for any such machine.

For one reason, these IC manufacturers don't have CPU designers. The computer manufacturers design their own circuits, often with computer-aided design that is beyond the means of IC makers.

Signetics says the most they do is try a little component-count reduction. In a couple of years, Signetics intends to market LSI building blocks, about 6 inches square, with a complete subsystem on each, so that a computer could be built by connecting several together. But right now Signetics is concentrating on bringing out MSI circuits, to keep up with the competition.

Amperex has no more copies of "Build Your Teaching Computer With M.E.L. Subassemblies," mentioned in an early Newsletter. Although there were requests for the booklet (which Amperex bought from M.E.L. in England), nobody was buying the subassemblies.

CURRENT MAGAZINE ARTICLES

Quite a few magazine articles of interest to ACS members have come out lately.

Customer Engineering Clinic

For some months now, EDN has been running a department by this name, presenting problems that customer engineers have had, and showing how to solve them. So far, most of the problems have been with digital ICs. Examples of problems are "One-Shot Circuits Driven from Decade Counter Give Multiple Pulses," (Feb. 1, 1969, p 59-60); "8-Bit Serial Register Shifts Unpredictably (Apr. 15, 1969, pp 73-74).

Power Supplies

A design article, "Power Supplies for Solid-State Circuits -- a Quick Method for Designers in a Hurry," appears in the April 15, 1969 EDN (pp 61-68).

Universal Frequency Counter

The most ambitious digital construction article Popular Electronics will probably ever print was given in two parts (Mar. 1969, pp 33-47; Apr. 1969, pp 41-45).

As is often the case with PE, a kit of parts (26 ICs, 43 transistors, 14 diodes, etc.) is available; this runs to over $200, for a 2-Mc counter, typical accuracy of 0.1%.

The decimal counting units are not

described in either article, but only in the Winter 1969 edition of Electronic Experimenter's Handbook.

Segmented Digital Readout

Also in Popular Electronics (Feb. 1969, pp 43-49) is a construction article on the Dialco 7-segment readout, "Third-Generation DCU." The article shows how to use the Dialco segmented display panel ($5.46) with an IC decade counter and decoder (kit of parts, $13.50), and how to make a similar segmented display panel yourself.

Program Loading

"Read-Only Memory Loads Process Computer," by Marcon and Rosborough (Control Engineering, Feb. 1969, pp 89-91), shows how one group of users solved the problem of setting the initiating code by building a read-only memory (ROM) to enter the read-in mode (RIM) instructions into a PDP-8 or 8/S.

You probably aren't in a position to really need this ROM, but the details are interesting, and "readers are invited to contact the authors for more detail."

Solid-State Optoelectronics in '69

Want to know more about phototransistors, laser arrays and photo SCRs? Read the special report with the above name in EDN (Feb. 15, 1969, pp 49-64), available as a reprint.

Output Circuits

"Which Output Circuitry Should You Use?" (EEE, Feb. 1969, pp 68-71), discusses briefly five types of output circuits: resistor pull-up; complementary; totem-pole; diode-clamped totem pole; and transistor-clamped totem pole.

Universal Digital Interface

This very brief circuit-design item is in the Jan. 1969 EEE (pp 115-6), and shows how to use the two halves of a 914 IC to "interface with many different types of logic, both positive and negative."

Tutorial 1

"Single building block proves logical choice for custom ICs" (Electronics, Apr. 28, 1969, pp 88-93) contains good tutorial information on logic. It is part of a study made by NCR to "determine some of the characteristics desired in the design of the IC used in the single building block for its Century Computer series."

Tutorial 2

"A Primer on Priority Interrupt Systems," by Van Gelder and England of SDS (Control Engineering, Mar. 1969, pp 101-105), is an excellent tutorial, with four logic diagrams, to show interrupt hardware.

Delay Line

"Ultrasonic delay line needs no power supply," (Electronic Design, Aug. 15, 1968, pp 231-232), shows a 64-μsec delay line using a seven-inch glass rod driven by an r-f oscillator, designed by an AEG-Telefunken engineer.

Design Aid

"Bond Graphs for Designing Logic Circuits," by Krigman of Battelle (Control Engineering, Feb. 1968, pp 91-92), gives an interesting and seemingly useful graphical method for designing logic circuits.

How to Delay

"5 Ways to Delay a Signal," by Bauer of Digital Devices (Control Engineering, April 1968, pp 92-94), briefly discusses magnetostrictive delay lines, torsional delay lines,

glass and quartz delay lines, distributed and lumped-constant transmission lines, and mechanical methods (tape loops, etc.).

No Bounce

"Get Bounce-Free Digital Inputs From Switches," by Walker of Fairchild Semiconductor (Control Engineering, Mar. 1969, p 65), shows four simple circuits for eliminating switch bounce, using IC# such as the 9946.

Arithmetic Hardware

"Arithmetic Functions Using MOS Registers" is the title of MOS Brief 6 in the National Semiconductor series of ads (Electronic Design, Apr. 26, 1969, among many others), and shows very briefly how to use the MM515 triple 64-bit MOS shift register (a 16-pin DIP) in three arithmetic circuits.

Driver

"Use a voltage regulator as a lamp/relay driver," (Electronic Engineer, Apr. 1969, p 81) is a very short item on using, for example, the General Instrument NC531 voltage regulator as a lamp, relay or motor driver.

Logic Probe 1

Newsletter #11 mentioned three commercial logic probes. A construction article on such a probe, "IC Telltale," appears in the Apr. 1969 Popular Electronics (pp 69-74).

The probe actually consists of two assemblies: a probe and a test set. The probe is a simple two-transistor lamp driver. The test set has a 2-cps and 10-cps trigger pulse generator, with 14-pin DIL and 8-pin round sockets. The socket pins are brought out to spring-clip test terminals.

The probe will test, in or out of circuit, "RTL ICs such as the Motorola MC700P and the Fairchild µL900 series."

Logic Probe 2

An inexpensive logic-level test probe is described in the Jan. 1969 Electronic Engineer (p 96). It uses a TI 14-pin DIL, SN15 844N, and a lamp, mounted in the body of a felt-tip marking pen.

Small-Scale Integration

"New Logic Meets Needs of Advanced Integration," (EEE, Apr. 1969, p 52), describes some really indescribable SSI circuits such as the flop-flop, unigate, NON gate, make-shift register, and the half-fast adder. Some of the chips used are so small that they can include no more than half a diode.

Computer Simulation of Logic

"Computer-Aided Design: Simulation of Digital Design Logic," by Gwendolyn G. Hays (blond, 26, and married), in the IEEE Computer Transactions (Jan. 1969, pp 1-10) gives details of a program (written in Fortran IV and used on a Univac 1108) that can simulate around 3000 logic elements, for debugging digital designs.

Building Your Own Acoustic Coupler

Few if any of us will ever need to couple a Model 33 or 35 Teletype with a time-shared computer, but the article with the above title makes interesting reading, in the Mar. 1, 1969 Electronic Design (pp 68-73).

Delay-Line Memory for CRT Display

"Standard Glass Memory Modules For Low-Cost Computer-Driven Displays," (Computer Design, Apr. 1969, pp 118-122) is really an ad for a Cor-

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Stephen B. Gray
Amateur Computer Society
260 Noroton Avenue
Darien, Conn. 06820

The Newsletter will appear about every two months.

ning Electronics product.

The glass memory (maximum capacity, 4K bits) is used to store all the characters to be displayed in a single horizontal row, and is input to a character generator that controls the Z axis by brightening the proper parts of the raster display.

The computer places a frame of data in the display-system buffer memory. One full row of characters is then transferred from the buffer to the delay line; this data recirculates in the "single line storage device" to refresh the display.

HARDWARE ON THE MARKET

IC Breadboard

Although this IC breadboard (by EL Instruments Inc, 61 First St., Derby, Conn. 06418) is too expensive ($650) for any of us, the brochure is something to drool over. The breadboard will accept DILs of any size (14, 16, 24 or 36 pins) and will also accomodate resistors, capacitors, TO-5 cans, etc.; it contains a pulse generator, power supply, a dozen lamps, 9 switches. Interconnections can be made by plugging in lengths of #22 hookup wire.

IC Pliers

Techni-Tool, of 1216 Arch St., Philadelphia, Pa. 19107, has pliers for removing 10- and 14-lead flatpacks when desoldering. The coated jaws allow use with live circuits.

Phototransistor Array

Fairchild has a "low-cost" array, the FPA-700, with 9 npn phototransistors in an 18-lead package for electronically reading standard 8-channel punched paper tape. Cost: $12.50 (1000 up).

HELP!

One of our newest members is a math teacher whose school is gathering components for a computer. They have a Remington Synchro Tape from an early Univac. Sperry seems to have run out of schematics and operation manuals. The 8-level paper-tape punch and reader work fine, but the information is needed just in case of trouble.

If any ACS member has access to a schematic and/or manual, and would sell it or let it be copied, please write to: Richard P. Filchock
Box 124
Hiller, Pa. 15444

The school also has a core memory from an IBM 1401. A number of ACS members have also acquired one of these; no doubt many of them could also use help. If any of you have worked out drivers and sense amplifiers and so on for this particular 16-plane, 4K memory, then please send in details.

ACS NEWSLETTER

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PDP-8/L
ISSUE

THE PDP-8/L

Many ACS members are interested in the PDP-8 family, so let's look into these best-selling small computers.

The PDP-8 and 8/S are no longer made on a production basis. The current models are the 8/L and the 8/I, both built with Texas Instruments TTL integrated circuits, by Digital Equipment Corp.

The 8/L is the cheaper model, at $8500 for 4K of memory and ASR33 Teletype. Maximum core is 8K. The 8/I has the same capability plus an internal peripheral control and data-break panel for plug-in expansion. The 8/I is faster, costs $12,800 (in rack-mounted version) for 4K of memory and ASR33 TTY, and is more flexible than the 8/L. The 8/L was "designed for those who don't need plug-in expansion."

Maintenance Manuals

To obtain the two-volume maintenance manuals (containing schematics) for either the 8/L or 8/I, send $50 to the Field Service Department, Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754.

The 8/L contains 360 TI TTL DIP ICs, if no options are included, and if my count is right. These 360 ICs, if bought from Texas Instruments in the quantities for building one computer, would cost $1243.

One big problem is the core memory; DEC will sell you one for $2,000. Nobody in the ACS has reported any success in hooking up drivers and sense amplifiers to any suitable used IBM (or other) core stack.

The sense amplifiers in the 8/L are Motorola MC1540G types, at $31.50 each for 12 of them. This is the full count, as I figure it:

81	SN7400N	4 NAND 2-input
26	SN7402N	4 NAND 2-input driver
17	SN7410N	3 NAND 3-input
13	SN7420N	2 NAND 4-input
8	SN7430N	1 NAND 8-input
52	SN7440N	2 NAND 4-input driver
5	SN7450N	2 AND-NOR
53	SN7453N	4 AND-NOR
29	SN7460N	2 Gate expanders
58	SN7474N	2 D-type flip-flops
6	SN7482N	1 Adder
12	MC1540G	Core Memory Sense Ampl

Another big problem is the "undefined" components, such as the DEC-3009B transistors and the D664 diodes, as well as a few transformers. The 8/L uses about 314 transistors and 959 diodes, of half a dozen different types each.

The 8/L contains four card racks, with 22 slots each, holding one double-height or two single-height cards in each slot. Total number of cards: 104. There is room for option cards, which are needed for the high-speed reader, power-fail circuits, memory parity, and data-break options.

Half the 8/L cards are standard DEC M-series cards, as described in recent DEC Logic Handbooks. These include:

5	M111 Inverter
6	M113 NAND 2-input
5	M115 NAND 3-input
2	M117 NAND 4-input
2	M119 NAND 8-input
5	M160 AND-NOR

6	M310	Delay line
1	M360	Variable delay
1	M452	Variable clock
5	M617	NAND 4-input driver
2	M660	Positive level driver
1	M706	Teletype receiver
1	M707	Teletype transmitter
1	M901	Flexprint cable conn.
7	M903	Flexprint connector
3	M906	Cable terminator
1	M002	Logic source
54		

The other cards seem to be special for the 8/L model:

5	M216	D-type flipflops
6	M220	Major registers
2	M516	Positive bus receiver
3	M623	Bus driver
1	M700	Manual timing generator
6	G020	Sense amplifier
8	G221	Memory selector
5	G228	Inhibit driver
1	G610	Diode board
1	G611	Diode board
4	G624	RC board
1	G785	Power connector
1	G826	Regulator control
2	G921	Control panel
2	W025	Cable connector
1	W076	Teletype connector
1	----	Memory stack
50		

These 104 PC cards contain the 360 ICs, 314 transistors, 959 diodes, some transformers, etc.

ICs Cheaper than TI 74N

Several members have expressed an interest in the Motorola MC700P series of ICs. There are 45 different circuits in this RTL line. However, the M series of DEC logic modules, used in the PDP-8/L and 8/I, are built with the Texas Instruments 74N series, which has only 19 circuits in it.

Eleven other manufacturers have a TTL series similar to TI's 74N: Amperex, Hughes, ITT, Motorola (MC7400P), National, Nucleonic Products, Philco-Ford, Raytheon, Signetics, Sprague, and Transitron. However, although the type numbers may be the same (or about the same), the circuits are not always electronically equivalent. For example, the Sprague ICs are said to have differences in clamping and fanout.

Texas Instruments recently announced a price cut of about 30% in the 74N line, which may bring the cost of those 360 ICs for an 8/L down to just below $1,000. But Motorola has also cut the cost of the MC7400P line, for a Motorola total cost of $932, but still using the TI adder, which has no Motorola equivalent, and using the prices for 100 of each DIP. (DIP, for Dual In-line Package, seems to be more universally used than the DIL we've been using up to now.)

PDP-8 Simulation

If you have access to Applied Logic Corporation's AL/COM timesharing system, their SIM-8 program simulates the PDP-8, as well as the PDP-5.

NOTES FROM ACS MEMBERS

Here are what a number of members have to say about their current efforts:

Millard McVay, Illinois

"So far I'm sticking to discrete circuitry, using DTL NOR gates of very standard design. I originally bought (from Meshna) 2N706's at 7 for $1.00, less 20% in quantities of 1000, but they graded out at just under 50% good enough for the job, so I'm looking for something better here. I bought diodes from Solid State Sales at 30 for $1.00, less 30% in 1000 quantities, and they graded out about 87% good, which isn't bad. I'm etching my own circuit cards, and use Amphenol 15-contact card sockets. I've decided that silk-screen process is

much simpler than Kodak photoresist techniques for my purpose, where very many cards of the same type have to be made.

"My logic levels were chosen to be compatible with integrated circuits so they can be mixed if I decide to later. In fact, I already have purchased a couple hundred Fairchild type 914 gates, a hundred 923 flipflops, and some 900 buffers to play with when I find time."

Al Sinclair, Ontario, Canada

"I recently acquired three IBM back panels with almost 500 SMS sockets, and some 250 SMS cards complete with contacts (mostly 3 and 4 gates per card), also a considerable number of broken cards with contacts. I have been cutting the contacts off these latter cards and epoxying them onto other cards, mostly double height. Removing all the wiring off the back panels was a heart-breaking job, but I could not make use of it.

"This acquisiting resulted in a complete rebuild of my computer to eliminate all the plugs and jacks, and complete the conversion to the SMS system, soldering all connections. As you can imagine, this is a monstrous job, and it will be many months before I can use my machine again. I also took some damaged core-memory frames and rewired them to 1024 words of 14 bits, which took two months of steady work. So now my machine will be 14 bits (4 instruction, 10 address), all parallel operation, clock speed 1 Mc. I have also made a new front panel to spread out the indicating lamps for easier reading. The socket panels swing out like the PDP-8 for easier working on."

Norman Saunders, Mass.

"I've just spent 30 hours getting the last bugs out of the modem (modulator-demodulator) for going to and from magnetic tape and the Teletype. The original design probably took about as long to work out. This is a good device and probably ought to be used by others. But how to recover part of my costs so that I can eat while I go about developing other goodies? [Norm is a consultant in circuit engineering.] Even if all the ACS members bought copies of the paperwork (schematics, theory, layouts, etc.) to reproduce the modem, it would take about $10 a set to recover costs. I could supply printed circuit boards, raw but etched, but this would run about another $10 apiece; and for parts, another $10. If someone were to take over the last two items, they would each be half as much.

"I have a 33 Teletype TD, with one 11-part character every 100 msec. The modem uses the Teletype supply, and typing is normal without switching when the magnetic-tape recorder is not playing back. If it is playing back, the keyboard can be used to intersperse characters, but if the keyed and played-back characters overlap, you get gibberish. The computer itself is required also to get the lockout function. If the recorder is recording while keying is done, a record of the keying is made, which can then be played back to give machine operation identical to that which was caused by the keying. For time compression, to have the retyping at maximum machine rate, and/or for editing, etc., the computer itself must also be called into play.

"Even though the modem is limited to literal key-to-magnetic-tape and magnetic-tape-to-print, it is quite useful. It also serves to clean up the keyboard pulse-train output, which is horrible in noise and hash for one used to electronic signals. Another feature of this modem is

that it requires a bandwidth of only about one kilohertz at one or two kilohertz, which is all that the recorder I've assigned to the job has, being one of the earliest tape recorders sold for the home market. Any recorder using a capstan would probably be all right, and those without might do if the tape were not cut or spliced, and were always played back on the same recorder."

Myron Calhoun, California

"At Fairchild R&D we have quite complete and complex CAD (computer-aided design). Interested ACS members might be able to get a copy of FAIRSIM (Fairchild Simulator) User's Manual by writing to:

Fairchild Semiconductor
Distribution Services
440 Middlefield Road
Mountain View, Calif.

"We can go from equations to finished PC boards without touching anything more "hardware" than a keypunch (and I let the keypunch service do most of that). Unfortunately, most of our CAD is proprietary.

"As for software: a compiler can get quite complex, but assemblers are easy. My dissertation, "Machine-Independent Assemblers for Computing Systems," (order number 68-1647 from University Microfilms, 300 N. Zeeb Rd., P.O. Box 1346, Ann Arbor, Mich. 48106; microfilm $3.20, Xerox $11.05) describes how to produce an assembler fast (using another computer -- by hand it would take a little longer). It gives complete flowcharts, listings, etc.

"I still have my original source decks around (as run on the GE-225 computer at Arizona State University) and will send tape copies made on a 360/44 if anybody wants to pay our computer center fee of $25.00 (includes tape and mailing) for the reproduction.

Out here the dual inline package is called a DIP, not DIL. For what it is worth, the DIP is generally acknowledged to have been developed in my department (back before I got here, to be sure).

"I notice that Fairchild does not now actively sell RTL (or even make it, unless a large order is received), so don't plan on using it forever. It was nice stuff, though; low power, etc.

"I have shown your comment about 'these IC manufacturers don't have CPU designers...' to my boss. It amused him, since my department is full of engineers who either have worked, or are working, on advanced computer designs. Normally, however, our efforts are either proprietary or else directed to the manufacture of better components, LSI, etc."

Lt. Cdr. Lyle Pellock, New York, NY

"I am afraid my projects have come to a halt with the needs of my new assignment. Being the executive officer of a destroyer is a full-time job plus. However, maybe one of these days I can get moving again."

Bill Mitchell, Ontario, Canada

"The most interesting idea for the central processor I've seen lately is 'A Proposed Minimum Hardware Central Processor with General Purpose Computation Capability,' by Robert W. Ehmann of Airborne Systems, which was obtained as memo #R-68-155 from the Computer Repository of the IEEE (345 East 47 St, New York, N.Y. 10017).

"Basically, the idea is that a 16K 24-bit computer could be built by using some of the memory (128-256 words) to store data, which would

be used as microprogram instructions for the sequencing of the processor. The resulting design, the logic equations of which are spelt out in the 23-page memo, would be quite complete with interrupt capability, normalizing logic for handling floating point, indirect and index addressing.

"Another article worth a mention is "Causes and Cures of Noise in Digital Systems," which was published in three parts in Computer Design, Sept. - Nov. 1964. It has also been reprinted as a separate booklet by Computer Design for $1.75."

(The IEEE memo costs $1.50 for microfiche, $3 for photocopy.)

Wade White, California

(Wade is now working for a new company, Electronic Arrays, in Woodland Hills; they make MOS devices such as dynamic registers; their latest is a 2560-bit read-only memory containing the basic 64 characters of ASCII format, for CRT display.)

"I plan to use my company's products, as they are introduced, in the construction of my computer. The first project is a memory employing high-speed shift registers. After the memory I'll tackle the control logic, then the arithmetic unit, and last the I/O. With the availability of MOS devices and the assistance I can obtain from the rest of the company, I hope to develop a modular computer kit as a result of my playing around.

"I want to use the computer for stock analysis, game-playing and automated logic design. I am working at present on an interface for use with a cassette tape recorder (a Sony 124) to allow my computer some easy and inexpensive means of bulk storage."

QUERIES AND ITEMS FOR SALE

Buffer Memory and Readout

Dave Vednor offers for sale a Telemeter Magnetics 144-B buffer memory; and a Sylvania electroluminescent 7-digit, 7-segment readout. Write:

David Vednor
2801 Willow Avenue
Fullerton, Calif. 92631

Dave also says: "I have been using Signetics JK flip-flops at work, and they have proven far superior to the Motorola MRTL with respect to noise immunity. The DCL line is not that much more expensive, and more functions are offered.

"Have any members had any luck with the MOS registers or other MSI MOS devices? I would like to try some, but the cost is a big high at this time."

Memory and Decimal-Point Query

Ted Naydan writes from New York State: "The availability of Motorola ICs encouraged me to get away from paper studies to hardware. Still, memory systems were not available to me.

"An opportunity to get my feet wet with a complete memory system, purchased from John Meshna of Lynn, Mass. for $25, has kept me busy for some 3 months. It is a 64-word, 7-bit random-access unit, with no schematics available. It consists of 3 boards, containing all of the X, Y and Z select functions. The core plane is a Univac C-164. Anybody have any information on these units?

"Anyone have any ideas on how decimal point is selected in the electronic desk calculators now appearing on the market?

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Amateur Computer Society
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Darien, Conn. 06820

The Newsletter will appear about every two months.

I'd like to hear more from Don Tarbell, as his activity parallels mine, as far as complexity is concerned. In addition, details on his 4K memory, as he implements it, would be appreciated."

Patchcords for Sale

A member has about 3000 patchcords for sale, in lengths of 4, 7, 9, 12 and 15 inches. They are IBM types, of two kinds: one is the self-contacting type, with plugs an inch long and more than 1/8" in diameter; the other is the fixed-wiring type, with plugs 5/8" long and about 3/32" in diameter. Cost is 5¢ each, minimum order $10, postage extra, from:

Johan Svanholm
Svanholm Research Laboratories
3205 Stanford St.
Hyattsville, Md. 20782

Help Offered on SMS Cards

Don Paddock writes: "I've drawn about 100 circuits of the IBM SMS cards to date, and have identified about 30 of these in the manual (see Issue 3, page 4).

"If I could help any of the members in identifying their cards, I would be happy to do so. I would need the two or three letters given at the lower left-hand corner of the card on the side the parts are mounted.

"The letters definitely do not identify the use of the card. For example, a CW and a JZ card are triggers, with the same components and circuit, except that one has two more diodes for the S&T function; the other has a direct connection to the bases for use as extender leads."

For help, write: Donald Paddock, Rt. #2, Box 54, Vero Beach, Fla. 32960.

THE WANG LOGARITHMIC CIRCUIT

Several members have asked about the log circuit used in the Wang calculators. The patent was issued to An Wang last Fall, and is number 3,402,285, "Calculating Apparatus." For a copy, send 50¢ to the Commissioner of Patents, Washington, D.C. 20231.

The calculator generates the log of numbers by a series of successive approximations, using stored constants of the log to the base e of 10, 2, 0.9, 1.01, 0.999, and 1.0001. The antilog conversion works in the same manner, by successive approximations, using the same stored constants.

According to one of the top men at Wang, the log conversion technique is original with Dr. Wang, and was not known previously.

If anybody figures out how to make that log circuit work, how about telling the rest of us?

SENSE AMPLIFIERS

The July EEE (pp 64-75) has three articles on sense amplifiers and comparators, used with core memory.

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a publication of the
AMATEUR COMPUTER SOCIETY

MORE ON TELETYPE

One of our newest members is Gordon White, who edits the Surplus Sidelights column in CQ magazine. Gordon writes:

"After a quick skim through Vol. I, I can offer these observations: I doubt if there are many model 12 Teletypes still around. I've never seen one in amateur hands, although they were the first RTTY machines, 23 years back.

Models 14, 15 and 19 are still very common, and if usable (60 wpm is pretty slow and they are not very flexible in other ways), are the cheapest good machines now available. I'm going to sell my complete #19 (tape perf, keyboard, reader, printer, table and power supply, pretty fair shape) for $65, as I go to all #28 and later gear.

The 28, 33 and 35 models are of course faster -- to 107 wpm, and 150 wpm on the model 37. Most of the latter are pretty costly for amateurs, however. A complete 28 ASR (roughly equal to the 19) is commercial-surplus priced at $1300 up, though some MARS members get them free, and I have been able to provide some reassembled out of parts and surplus stuff for rather less.

The RTTY amateur wants serial machines, and parallel units are no use to him. On the other hand, I can see that for ACS use, parallel units are more easily used. This is fortunate, since the parallel units are a drug on the market most of the time.

For example, there is a parallel-fed tape perforator (LARP) by Teletype that will perf to 100 wpm (1200 opm). It might be possible to parallel-feed a unit which prints on the tape, though I doubt the mechanism would take much more than 100-wpm speed. These LARPs were recently selling for $5 each, plus motors. There are 8-level LARPS too, though the 8-level gear is newer and more rare than 5-level.

There are several Western Union readers for parallel operation, most of them going cheaply. There is a Teletype LBXD reader which offers serial or parallel output, but has 7.00 unit serial code cams (Western Union type) which make it less useful to hams. I doubt an ACS member would care if the serial stop pulses were .00, .42 or .50, so these ought to be useful.

If one had a complete model 28 printer, he could put contacts on the code bars to generate parallel signals at the same time he gets hard copy from the serial keyboard (or parallel contacts could be put on the keyboard itself).

Further, you can code the "stunt box" of the 28 printer to give multi-wire output; that is, open or close a contact for up to 36 different characters (72 characters considering upper case/lower case). This might make the computer design easier -- read-in multi-wire, and read-out parallel to a 1200-opm perf, using the tape loop as buffer storage, reading from tape to the printer where 5-level parallel signals would be generated or, again, multi-wire.

I doubt that anyone would want to invest in the model 37 PC boards, as prices are rather astronomical."

Gordon has a Frederick 670B Morse-to-Teletype translator, and "some 5:8 storage gear for communications handling." He adds:

"Using the model 28 typing unit, you could get a modified ASCII parallel input rather easily by using code-reading contacts and a latching contact on the letters-figure stunt level. ASCII, of course, uses five levels for character identification and level 7 for US (spacing) and LC (marking), which could be derived from contacts on the 28.

You would not get even-parity on the 8th bit (you would have to be content with steady mark), nor the non-printing control functions on the 6th bit, but this might still be useful. It would be possible to arrange a separate button on the 28 keyboard to provide the 6th-bit information, I suppose.

On printout, you would have to provide a parallel-to-serial conversion to drive the printer, or use parallel-fed punches and a serial printer, as suggested previously. You'd have to rearrange the type-box if you used the actual ASCII coding as, for example, A in Baudot is bit 1 and 2 marking, the rest spacing, and in ASCII, A is bit 1 marking and the rest spacing. You'd have to put the A type-pallet in the place where the E normally is found.

This could be done in outrigger fashion on older stuff like the model 15, but I shudder to think of the haywire involved; the 28 is designed for that sort of thing -- the 15 was not.

There are several military surplus units which contain rather straightforward serial-to-parallel and parallel-to-serial modules. The AN/FGC-5 and AN/UGC-1 multiplex sets (the former built with tubes; the latter virtually the same set-up with transistors) are coming into surplus, and contain these units. The FGC-5 is larger, but its components are really a drug on the market -- useful for little else than the small parts. The UGC-1 is later, but is also becoming available.

There are sources here which have a lot of identified, undamaged computer parts: SASCO Electronics, 1009 King St., Alexandria, Va. and Ritco Electronics, Box 156, Annandale, Va. have this material. I have seen flip-flops, matrixes, PC card racks, etc. in quantity. Also, I have a man who wants to sell computer DC power supplies, 100, 180, 210, 280 volts, etc. -- anyone have any interest? I will supply the address on request. (Write to Gordon White, 5716 N. Kings Highway, Alexandria, Virginia 22303.)

I'd like to hear reaction from members on my suggestions for the model 28, as I am a Teletype man, not a computer expert, and I may not have made myself clear."

Gordon also sent a notice of a sale of government property, by sealed bids, several months ago in New York. The item was a Philco 2000 computer. If, by some odd chance, a bidder managed to get this at some low price, he'd have to have quite a bit of room to put it in, as there were 21 tape transports with it, two printers, etc.

The 2000 was offered on an "as is, where is" basis, located at Westinghouse Electric in West Mifflin Borough, Pa. (the Bettis Atomic Power Lab.).

A MEMBER'S PROGRESS

Bill Greene of New Jersey reports on his progress:

Last summer I made the decision to

switch from delay-line memory to core, after fighting long-term temperature stability problems and marginal operation for about six months. I have discovered that to start with a surplus core plane and end up with a working memory is no minor undertaking, especially on a spare-time basis. I am using a 16K plane with four sense windings and will go through a double cycle to end up with a 2K byte memory. The complete unit is on five 8-by-8-inch Vero boards. One board contains the core plane, two contain the drivers, one contains the address registers, data registers, packing and unpacking logic and level shifters to drive the drivers, and the last board contains the sense amplifiers and timing logic. At the moment it looks like it will take about two more months of spare time to completion.

I still feel that a delay line is the best answer to many amateur memory needs, if the line is purchased from the manufacturer, rather than relying on surplus lines that were produced several years ago, before the state of the art improved.

With the switch to core and the exposure to more and better machines in the line of duty, came a change in system design for my computer. I will use an 8-bit instruction format, of which four bits are set aside for the op-code, one of which is sub-coded, allowing a total of 31 instructions. The key is in using four 8-bit registers that are selectable by the instruction. One of these serves as the program counter. Two of the remaining four bits in the instruction select one of these registers, which at the time contains the memory address to be accessed by the instruction. The remaining two bits select which of these registers contain the data to be transferred. By allowing the register selected by the memory address bits in the instruction to be incremented during the instruction, transfers of blocks of data become simple. Furthermore, if this register is #3 (the program counter), the program will skip one byte and its contents can be transferred from memory to one of the registers, thereby giving a double word instruction capability and a means of loading a constant by program.

I have written several programs using this instruction set, and find that a program that takes 100 12-bit instructions in PDP-8 language can be written using 100 8-bit instructions in this format. Since 8 bits allow us to address only 256 addresses, a scheme of using a field register (as per PDP-8) of four bits gives a maximum memory size of 4096 locations. Two double-word instructions, namely a Jump to Subroutine and a Jump Indirect, allow simple access to all of memory.

I guess you can conclude from the preceeding paragraphs that I have become convinced that the smallest feasible computer for amateur purposes is not a 12-bit machine, but that it can be squeezed down to 8 bits.

Like many others, I am using Motorola RTL for all logic, and have found an excellent transistor for all-around use: the Motorola MPS 2923. Although it is listed in the category of a small-signal amplifier, I have found that it can switch over 500 ma at one microsecond with no apparent harmful effects. It makes an excellent lamp driver, since you can put a 6.3-volt 50-ma lamp on the collector side and connect the base thru a 610-ohm resistor to the RTL element or even directly to an inverter output, if that inverter drives nothing else. Best of all, it is

priced at 43¢ in small quantities, or 29¢ if you buy more than 100.

I have also found a good buy on teletypewriter page printers. Atlantic Surplus Sales, 300 7th St., Brooklyn, N.Y. 11215, has on hand some model 10-15 machines built in West Germany. Many parts are interchangeable with the model 15; it is set up for the European standard of 63 wpm, although gears are available for conversion to 60 wpm. The unit is of much more recent vintage than the standard model 15 and is of lighter and more attractive construction. The price is $80, and when I purchased mine in the middle of January, it was the tenth one sold within a week, out of a lot of 46.

ANOTHER RESPONSE TO THE SURVEY

Dave Digby recently sent in the ACS computer survey, from Texas. The computer he has planned will have two registers, and will be built with RTL MC700P DIPs. The memory: 512- to 1024-word wire delay line. I/O: Teletype model 26 printer, MXD tape reader, RPE-26 tape punch. There will be 64 instructions, 6 to 10 bits long. Data words, 16 to 20 bits long, 1.6-Mc clock. Add speed, 10 to 20 msec (he must mean usec). Special features: lowest cost for off-the-shelf components (except for surplus I/O); plans to develop it into a construction kit if there is any demand for it. Includes indirect addressing and one or more index registers (in memory); automatic multiply and divide optional at extra cost. Estimated complete cost less than $1,000, total of 50 to 75 DIPs.

Dave's four-register relay computer uses U and Y types from surplus telephone equipment, plus multicontact and stepping switches. The relay memory holds 16 words, of 15 bits each. I/O: switches and lamps, and maybe TTY. Add speed, 1/5 sec, clock speed 1/10 sec, about 50 instructions, programmed by plugboard only. Present size, about 50 relays; 400 when complete.

Dave also says, "I ran a 'free hamshop' ad in CQ to survey interest in a computer kit. The enclosed letter is what I sent the dozen replies I received (in late 1967):

"Thank you for your interest. I hope the early state of my project will not discourage you. This is what you might call a 'market survey' -- I hope to get as much information from you as I have to give you right now. And the ad was published a month earlier than expected, so the following data leaves much to be desired. But here is the basic story and some tentative specifications...

"A few years ago, some computer fans indulged in fanciful speculation as to whether one could build a 'kilobuck computer,' a real digital computer to cost less than a thousand dollars. It was naturally assumed that all sorts of surplus and homemade parts would have to be used at that price. But today there is a tempting possibility that it can be done with new, off-the-shelf components.

"I have toyed with the idea of building my own computer for several years, but until recently I stuck to using free relays and helping to design computers for others to build. Early this year, stimulated by the trends in component prices, I sat down with a simple serial computer plan, and tried to further reduce it, throwing out every feature that could possibly be spared or substituted for. The only active registers I retained, for instance, were those clearly required in order to get information into and out of memory.

Then I devised means for substituting memory storage for most of the remaining registers required for useful computing. The result was so promising that I embarked on the current project to actually build such a machine.

"Subsequent work, although agonizingly slow as a part-time effort, has been even more encouraging. It would appear now that our kilobuck will buy the materials to build quite a respectable little computer. With luck we might have enough change left over to buy a surplus Teletype for I/O.

"Having acquired a great deal of my computer education through direct access to a modest-sized computer, and having subsequently taught programming to students with similar privileges, I am convinced that even a very small computer, close at hand, can be a very large asset to the learning process. And, although I recognize that any computer buff worth his salt will aspire to bigger and more glorious gadgets, I also believe that small machines can perform many useful tasks.

"If you and/or enough other people agree with me as to the utility of such a small, slow but cheap computer, then there is every reason to expect that a kit for home or school construction of this design can be produced. It should be no more difficult to construct than most of the hi-fi and ham kits on the market.

"I cannot make any definite quotes on price or delivery dates at this time, but I am offering you a chance to express your wishes before it is too late to consider them in the initial model.

"The big question is this -- what are you willing to do without, in order to get a useful machine at a minimum price??? If you can wait until sometime next year for a small, slow digital computer at a price in the vicinity of one kilobuck, let me know what you think of the enclosed tentative specifications, and tell me which of the optional features you must have, and which ones you don't want to pay extra for. In particular, how much memory do you need, and what instructions are most vital?? I/O is also a major concern, of course. Any additional suggestions you might have are equally of interest. I have already received a suggestion that circuits be explained in an educational manner, which I certainly hope to use, and there seems to be considerable interest in the Teletype angle, which I would like to explore further.

"MEMORY -- This will probably always remain the most costly item in any small-scale processor. The least expensive seems to be of the wire delay line variety. A single such line can store up to perhaps 20,000 bits, although the lowest cost-per-bit may occur at less than the maximum value. Larger storage capacity calls for more than one line. This introduces more complexity into the addressing structure, as well as the additional recirculation electronics for each separate delay line. This adds up to more than a minimal-sized computer, but is not otherwise incompatible with the proposed logic design.

"SPEED -- We are talking about a memory circulation time on the order of ten milliseconds. In the simplest version, most memory accesses would use up a whole 10-msec cycle. Since both instruction and data require access, this gives a typical speed of about fifty instructions per second. The addition of an extra address counter, plus a judicious allocation of memory between program and data, could

The Amateur Computer Society is open to all who are interested in building and operating a digital computer that can at least perform automatic multiplication and division, or is or a comparable complexity.

For membership in the ACS, and a subscription of at least eight issues of the Newsletter, send $3 (or a check) to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Avenue
Darien, Conn. 06820

The Newsletter will appear about every two months.

just about double this -- 100 instructions per second -- by permitting an instruction and its addressed data both to be referenced during the same cycle. In either version, special programming techniques could be used to make important routines run several times as fast as this, but such programs can be very tedious to write.

"Glass delay lines have shorter cycles -- on the order of a few hundred microseconds -- so are naturally that much faster -- several thousand instructions per second. But the bit rate is faster, too, and more expensive logic elements may be required. Each line stores fewer bits, also, so that more than one may be required, even for a "minimal" machine.

"Any delay line constitutes "volatile" memory, meaning that all stored information is destroyed when the power is shut off. This is most annoying in a small computer, since the power may very well be shut off frequently, and since input devices fast enough to reload memory conveniently are somewhat expensive. In many cases, however, one may wish to reload memory frequently anyway, due to its small size. In this case, a volatile memory may not be unduly inconvenient.

"If a non-volatile memory is required, this would most likely be a rotating store -- disk or drum. The cost would be somewhat higher than wire delay lines, and slower operating speeds would be probable. However, no high-stability oscillator is required, since the "clock" is usually derived from a recorded track on the device.

"Rotating memories can have cycle times as short as 10 msec, but the cheaper ones run to two or three times as long as that. Speeds as low as 15 to 30 instructions per second could easily result.

"INSTRUCTIONS -- There are successful computers on the market with extremely limited instruction sets. I am planning a somewhat more extensive repertoire, wherever this will substantially improve the utility of our small memory and slow speeds. Some otherwise borderline instructions and other features will be provided because they are also needed for internal functions.

"Probably the most controversial category is that of multiply and divide. Do you insist on having one or both of these at a decided increase in cost? A full-word-length operation definitely requires more registers than are needed by the basic machine. On the other hand, to program or simulate these instructions using memory for storage is very much slower than a wired-in instruction using active-element registers. Let's consider three preliminary choices in order of cost -- No multiply or divide; half-word instructions; or full-length, full-speed multiply and divide. We might package this as a separate option to be added to the basic kit."

(TO BE CONCLUDED IN NEXT ISSUE)

ACS NEWSLETTER

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COMPUTER KIT

The previous issue contained most of a letter from Dave Digby in Texas, which contained a letter he'd sent to those who inquired about his computer-kit notice in CQ magazine. The letter ends:

"Index registers are fairly easy to include, if they occupy memory locations, rather than active registers. I favor at least one, possibly three. They can greatly facilitate loops and iterated algorithms.

"WORD LENGTH -- On the order of 20 bits. This would mean about 1000 words using a 20,000-bit delay line. The general idea is a word long enough to contain one complete instruction, including a full memory address. This is not too large in terms of data, representing about six digits in decimal, but will handle many useful problems. And double precision is not completely out of the question.

"INPUT/OUTPUT -- I have mentioned only Teletype, so far, but other devices are not impossible. In particular, a small photoelectric tape reader would facilitate reloading the memory. Thus larger programs or data tables can be contemplated. These come as low as a few hundred dollars, I am told. The general limits on other devices might be described as: only character-by-character devices, no faster than 100 characters per second. The number and complexity of control and synchronizing signals is also a factor."

Dave says he's still working on the computer kit, and is trying to build a small prototype. He's got a couple of delay lines, which he says are a little short, as they hold only 100 words (he's considering words of 16 to 20 bits length). Dave hopes to cut the number of registers to a minimum, and says two might be used, one to address the memory location, the other to contain data. He's using Motorola RTL ICs. With the right backing, Dave would consider producing the computer kit commercially, but that kind of money is scarce.

RC DECOUPLING FILTERS

Our newest member is Louis Frenzel of Maryland, who has a working computer with minimum I/O, and who also gives some very helpful information on RC decoupling. He writes:

"I have build a complete working digital computer. It is in operation now, and as you might expect, is gradually undergoing various modifications and improvements as time, money and ideas permit. The machine uses an 8-bit word, and serial 2's complement arithmetic. It has 8 basic instructions, with multiply and divide being performed by subroutine. The computer is implemented with a mixture of DTL and TTL ICs, including some of the MSI units. The basic add time is 3 milliseconds. So far I use only binary switches and lights for I/O.

"I'd like to comment on ... Problem 5-1. I don't really think that there is a set procedure for calculating RC decoupling (low-pass) filters for use in digital circuits. Every system I've seen has been different. Some use series resistors; some don't. I recently saw a small RF choke used as the series element on one system.

That's going almost too far, but for this system it may have been needed. As for capacitor values, I've seen values from .01 mfd to several thousand mfd. Almost anything works, but there are a few simple rules to follow.

"First, if possible, do decouple each PC board of circuitry. You won't go wrong if you use a fairly large tantalum or electrolytic, say 100 mfd, shunted by a .01 to .1 mfd disc. The 100-mfd unit takes care of most noise problems and is large enough so that no series element is needed. However, the inductive reactance of this large capacitor is pretty high at switching frequencies, so it does not get rid of all the high-frequency stuff. The parallel disc takes care of this. I've used this successfully for years.

"In some systems the larger capacitor just isn't needed. The only way to find out is to experiment. Take a scope and look across your ground buss between the power supply terminal (scope ground) and a ground point in the system. You will probably see a lot of high-frequency junk here. Experiment by connecting capacitors at the point under observation and notice any change. Use the smallest capacitor that best minimizes the noise. A .1-mfd disc fixed my problem in a recent design.

"Decouplers are a necessary evil in digital systems, but their need can be minimized or even eliminated in some cases, if the reason for the noise problem can be found. In other words, treat the cause, not the symptoms. Noise on the ground and power busses generally means poor busses. These busses must have a very low impedance at high switching frequencies. This doesn't mean just low resistance; it means low inductance too. Thin solid or stranded wire just doesn't make it. Try using some fat braid. The multiple strands keep both resistance and X_L low. I recommend at least a ¼" braid, and even bigger if you have a high power consumption system with lots of circuits. Use it for both power and ground. This approach will often reduce the noise to a point where filters are unnecessary. If any noise is left, a .1-mfd disc on each board will get it.

"Good noise suppression is a must if you are using low noise immunity circuits. You can get away with murder if you use DTL or TTL, since their noise immunity is relatively high. But if you use RTL, like a lot of guys do for low cost, you can literally be "eaten up" with noise problems. False triggering, erratic operation, and unusual logic problems will result.

"As a general word on wiring, don't bundle, cable or lace wires in parallel. Scramble-wire all circuits point-to-point. Use the biggest stranded wire you can stand and keep it short."

MOUNTING ICs

A recent look at the various ways of mounting ICs shows that prices are still high, no matter who makes the device, or how they make it.

Augat's Universal IC Packaging Panel, which accepts 14-, 16-, 24- and 36-lead DIPs, and has Wire-Wrap terminals on the back, costs about $1.50 per position to mount 14-pin DIPs. Other Augat packaging panels cost $1.00 per position. Augat DIP sockets are about 25¢ each. Breadboards for flat-pack or TO-5 ICs cost $5 to $6 per position.

Cambion DIP sockets for 14-pin ICs cost 75¢ each in small quantities, or $550 per thousand. The high-

density Wire-Wrap circuit boards cost from $1 to $3 per position. Breadboards are $4 to $5 per position.

Vero PC boards holding up to 20 14-pin DIPs cost $16 in lots of 100, or 80¢ per position.

ELCO DIP sockets cost from 80¢ each (1-19) to 55¢ (200-999).

Vector Micro-Vectorboard is one of the cheapest methods of mounting DIPs (if permanent mounting is desired), by inserting the ICs thru the holes in the board and soldering directly to the leads. Vector also makes sockets, but they are not cheap: a solderless DIP socket for 14-pin ICs costs $4 for 1-19.

DISPLAYS

Alco Electronic Products has some interesting displays:

Incandescent readout indicators, using a stacked set of plastic edge-lit plates with a dot-pattern number engraved on each; about $8 each, for 6, 14 or 24 volts.

Seven-segment incandescent readouts cost $6.45 each; a "matrix-driver module" costs another $25, plus $1 for a connector.

Seven-segment neon readouts cost $5 each; a "decode-display module" is $30, plus $1 for a connector.

BOOKS AND MAGAZINE ARTICLES

What To Do With Your Computer

Anyone wondering what to do with his computer after finishing it is referred to "Problems for Computer Solution," by Fred Gruenberger and George Jaffray (John Wiley & Sons, 1965, 401 pages, paperback $5.95), probably the only book of its kind. The book contains 92 problems, ranging all the way from "The Game of Dice" to "Economic Lot Size," and includes problems in primes, games, random numbers, puzzles, geometry, and many others.

Even if your computer may never be able to handle Dartmough Basic, the paperback by the parents of Basic, John G. Kemeny and Thomas E. Kurtz, contains some interesting sidelights in computer programming: "Basic Programming," John Wiley & Sons, 1967, 121 pages, $4.95.

After a thorough discussion of Basic, the authors present chapters on number theory, simulation (dealing a bridge hand, baseball, the knight's tour), games (NIM, ticktacktoe), business problems (compound interest, tax depreciation, decision trees), statistics, vectors and matrices, calculus, and special topics (teaching machines, codes and cyphers, and music harmony).

Software

Control Engineering has an interesting reprint of a series of 14 articles on programming (which ran from Oct. 1967 to Dec. 1968) and available for $3. Although mainly about programming for process control, there is a lot of meat here, especially the article on "How Hardware Responds to Software" (Dec. 1967), which is recommended reading for those who are not too familiar with the subject.

Multiplexers and Logic Circuits

"Multiplexers double as logic circuits," by James Anderson of Fairchild (Electronics, Oct. 27, 1969, pp 100-105) is about using the dual four-input 9309 and the eight-input 9312 multiplexers in place of interconnected gates.

The technique requires a good know-

ledge of Boolean, truth tables and Karnaugh maps, which are required for translating a function into multiplexer inputs. The author says the multiplexer "is so versatile that it takes on the aspect of a universal logic circuit."

"The multiplexers are electronic switches that sequentially connect input-data lines to a single output. On the dual 4-input unit, the two select lines are common to both halves of the multiplexer, so that it behaves like a two-pole, four-position switch. On the 8-input multiplexer, three select lines control the eight input lines, and the device resembles a single-pole, eight-position switch.

"Applied as a universal logic circuit, the 4-input multiplexer can handle as many as three variables; two are applied to the select terminals, and the fourth variable or its complement goes to each of the input lines.

"Any of the possible functions of three variables -- there are 256 -- can be generated with one-half of the dual, 4-input multiplexer. And any of the possible functions of four variables -- which amount to a prodigious 65,536 -- can be handled by just one 8-input unit."

As an example, the function $F = \overline{X}YZ + X\overline{Y}Z + XY\overline{Z} + \overline{X}\overline{Y}\overline{Z}$ can be implemented on half of a dual 4-input unit, whereas, if it were built with discrete NAND gates, this even-parity function would require five 2-input and two 3-input gates.

MOS Memories

"MOS Memories Save Power" is the title of an article by Dale Mrazek of National Semiconductor in The Electronic Engineer (July 1969, pp 49-53). It is about the advantages of MOS shift registers over magnetic cores, for data storage in low-power digital systems, and includes schematics for data input select circuits and for the data alighment section (for aligning the serial output of the parallel registers).

Inexpensive Pulse Source

"Inexpensive pulse source has 'high-priced' features," in The Electronic Engineer for Oct. 1969 (p 78) describes a circuit using only two Fairchild TTμL 9601 one-shots, yet it has adjustments for period/delay and for pulse width, switches for output-pulse polarity, for pre-trigger output-pulse polarity and for internal or external trigger, a button for single pulses, and inputs for gate and for external trigger.

Reduce IC Package Count

"Cut binary-to-BCD conversion costs," by Roland B. Anderson of Bunker-Ramo, in Electronic Design (Oct. 11, pp 104-110), tells how to reduce your IC package count with a nonsequential circuit using full adders and TTL gates, rather than a static converter.

Application Memos

Signetics Corp. (811 East Arques Ave., Sunnyvale, Calif. 94086) recently put out a small book of several hundred pages, "Application Memos," which you may be able to get on a letterhead.

The book covers a lot of ground. The first section includes guidelines for selecting a digital IC family (relative comparisons), and a fine, illustrated glossary of logic terms.

The second section, on digital considerations by family, is the largest section, and includes applications in counters, shift registers, adders, comparators and de-

coders. Section 3 is on decoding and steering; 4 on counters, shift registers and memory ICs; 5, interface and display elements; 6, linear considerations; 7, timing circuits; and 7, parallel data handling.

This book seems well worth obtaining, which may not be so easy, as is usually the case with such publications, except for those that DEC gives out in such quantities.

Understanding Core Memories

Two recent publications by Ferroxcube are about core memories. "Taking the Mystery Out of Memory" is a 5-page brochure that covers the basic facts. Much of this information is contained in "How to Use Ferroxcube Digital Magnetic-Core Memories," a 28-page booklet (Bulletin No. 666) well worth reading. After a brief review of how memories work, it gives some memory control techniques, and then goes into applications: data links, instrumentation, small business-data machines, process control and monitoring, telemetry and digital communications, and data organizers.

A letterhead might be required to get either of these, from Ferroxcube Corp., Systems Division, Englewood, Colo., or from a local office (Annapolis, Burbank, Cleveland, Denver, Minneapolis, Northlake, Orlando, Phoenix, San Francisco, Union (NJ), Waltham, or Toronto).

Logic Display

The "Wireless World Logic Display Aid" is described in a series of construction articles in the British magazine, Wireless World, by assistant editor B.S. Crank (May 1969, pp 196-202; June pp 255-264; July pp 311-316; Aug. pp 372-377; Sept. pp 419-422; Oct. pp 466-470; Nov. pp ??). The logic display aid produces, on a standard oscilloscope, the Venn diagram, Karnaugh map or truth table of any gate or logic circuit that is connected to the display aid. The display is a 16 X 16 dot matrix.

Author Crank priced out the components, and lists half a dozen British sources for the various groups of parts, at low cost. The ICs, for example, are by Ferranti, and cost £33.15.0, or about $80. Total parts cost, including cabinet, is £74.17,6, or about $180.

SEQUENTIAL CIRCUITS -- INQUIRY

Don Fronek writes: "I have just finished some research in the area of sequential circuits and wonder if anyone in the ACS uses sequential programming. It's not a bad way to go for these smaller machines. Gives a cheap method of calling subroutines with only the basic commands (add, subtract, etc.).

I'm about ready to tear down my machine and re-do it in a parallel fashion (was series addition for process control).

Am interested in obtaining a cheap printer -- any suggestions?"

Later, Don writes: "Have obtained some core planes for the heart of a small 17-bit-word memory. Would like to know if anybody has a simple read-write circuit (including elementary circuits for transistor line drivers). I would like very much to obtain this information. These core planes are 16 X 16, and I'm planning on stacking them 17 deep." Don Fronek, 520 E. "B" Street, Moscow, Idaho 83843.

QUOTRON MAGNETIC TAPE UNITS

Bill Pfeiffer sent some notes he

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Darien, Conn. 06820

The Newsletter will appear about every two months.

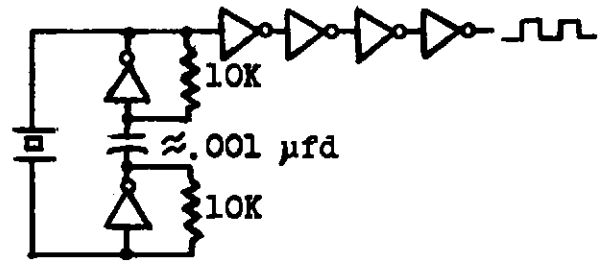
wrote up on the Quotron tape handlers, which are available for about $100 in California. Also, he says, the modules and other parts are available. If anyone is interested, write to Bill for a copy of his notes: William F. Pfeiffer, 932 Via Del Monte, Palos Verdes Estates, Calif. 90274.

WHERE TO BUY IT

B&F Enterprises, P.O. Box 44, Hawthorne, Mass. 01937, has a catalog showing a memory core stack (12 planes with 2048 cores each) for $90; PC logic boards at 10 for $3.50 with connectors; one-μsec delay line for $1.50; and a magnetic drum with 146 heads for $95, if you have 115 VAC 400-cycle.

IDEAS AND INQUIRIES FROM SHOSTAK

Bob Shostak has several ideas and questions: "Modification of a Popular Electronics circuit makes a stable, simple yet reliable clock for any frequency up to around 3 Mc. Use one Motorola MC789P hex inverter IC (about a dollar) and a few components on a PC board. Four series inverters square up the oscillator output. Harmonic suppression may be required, depending on your luck -- a tuned circuit before the four squaring inverters should do the trick.



"Solution to the serial-parallel, vice-versa conversion problem with TTY I/O: software! The computer can wait around and pick off each serial bit as it comes (it might even do some calculation while waiting out the 22 msec between TTY pulses). I doubt many members have plans for interrupt systems, I/O buffers, etc., that would allow the CPU not to be tied up during I/O anyway.

"What is a source of cheap taper-pin terminals to be crimped or soldered to the end of plugwires?

"What is a source of surplus neon drivers or indicators driven from ICs? What cheap transistor would brave the 90 V DC?

"Possible memory idea: a small tape loop on a regular tape recorder used as a delay line. Read, write heads must be spaced very closely for good access time; one could probably get bit densities of about 1000 bpi using just audio tones."

DON'S TRADING POST

Don Tarbell (11200 Hillwood Drive, Huntsville, Ala. 35803) would like to trade, for items of equal value: 2 SN7483N (4-bit adder, cost $13.43 each); 6 MC778P (dual D FF, cost $2.35 each); 2 MC784P (dual half shift register, cost $2.30 each). Don needs: MC717P, MC789P, MC790P.

ACS NEWSLETTER

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February 1970

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THOSE ADDRESS LABELS

If there is a machine-printed address label on the envelope this newsletter came in, the program used to print it was written in Cobol, for an IBM 360/30.

The addresses are keypunched into cards, three cards per address, with a maximum of six lines per label. The program deck consists of 105 cards. The 360/30 puts all the addresses on magnetic tape, then prints as many sets of labels as called for by a control card.

Another control card permits the labels to be printed "three up" (three across), or two up, or one.

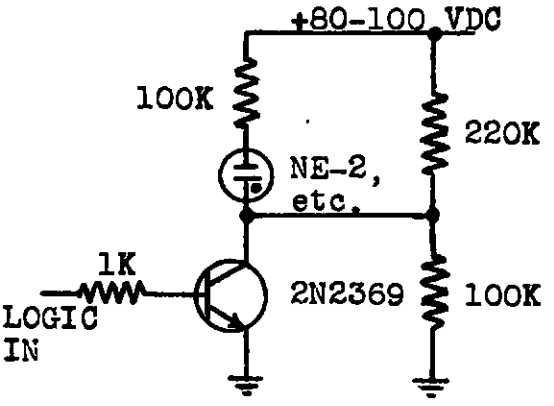
LAMP DRIVERS

Louis Frenzel, the new member who contributed the item on RC decoupling filters to the previous issue, now comments on lamp-driver circuits. He says:

"This is an area usually neglected or taken for granted, as it is one of the less interesting and rather simple circuit requirements. I did dig into this area when I designed my computer, and found some interesting things.

"First, with all the sophisticated indicator lamps available today, you can literally spend a fortune on simple off-on indicators. Most of them look good, of course, but still do nothing more than go off and on. There are several good, cheap ways to make indicators that will serve your purpose and still look good. They are not as fancy as some of the commercial units available, but their low cost permits you to use more of them.

"My initial thought was to use neons because of their low cost and availability. Besides, I had a batch of NE-2's on hand. But I quickly found that I needed some high-voltage transistors to drive them. These I didn't have, and since they are expensive, I didn't get them. However, I did find that high-voltage transistors weren't needed if care was taken to limit the collector voltage on a low-voltage transistor to a value within its ratings. I used this circuit:

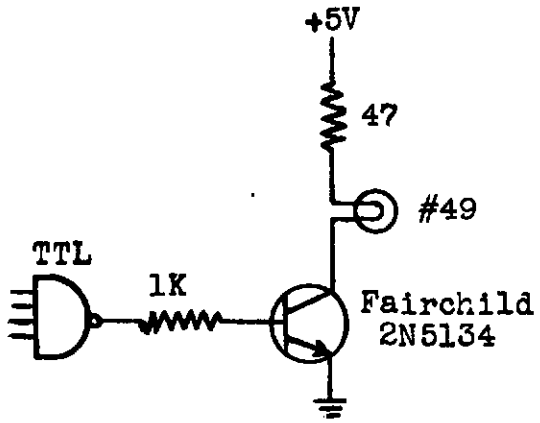


"The voltage divider keeps the voltage on the collector below the breakdown level when the transistor is off. The transistor is a 2N2369, whose breakdown is 40 volts. Almost any switching transistor can be used. Just set the R_1-R_2 divider to a value high enough to prevent the lamp from remaining on when the transistor is off. The lamp sustaining voltage is lower than its ignition voltage, and when the transistor is off, the potential voltage across it is the supply voltage less the divider voltage.

"I mounted the lamps by pushing them through a 3/8" grommet in a panel. It's a snug fit, so no further support is needed.

"While this works fine electrically,

it does leave something to be desired in appearance. Frankly, I hate neons and the high voltage they need. So I went to a standard incandescent. The cheapest is the old bayonet-base type. I used a #49 (cheap), rated at 2 volts and 60 ma. I drive it with a 2N5134 Fairchild npn (19¢) through a 47-ohm dropping resistor. The supply voltage is the existing 5-volt regulated logic supply. The driver transistor base can be fed directly from TTL or RTL gates or flip-flops. Inexpensive bayonet sockets can be used to mount the lamps behind a panel. No jewel or colored filter is needed. Just drill a hole in the panel a hair smaller than the diameter of the bulb. Then let the bulb end poke through the hole slightly. The effect obtained is unusual but pleasing in appearance, and ever so cheap. Try it.



"I highly recommend a book titled, 'Digital Computer Design Fundamentals,' by Yaohan Chu. This is a McGraw-Hill book, and it outlines detailed design procedures and even describes a small hypothetical computer that could be easily modified or added to, and built by an amateur."

NEWS FROM A MEMBER

Richard Dickey of California says:

"I have a nice full decimal one-digit adder/subtractor built and tested. It takes just 69 NAND gates. I found that the inclusion of direct subtraction takes so few extra gates that the nuisance of complementation is unnecessary. It is to go into a serial-by-digit, parallel-by-bit arithmetic unit based on the delay lines I got thru the ACS Newsletter.

"The price of the adder/subtractor, by the way, was 6 boards of 12 NAND circuits per board, at 69¢ per board, for $4.14 plus tax, plus a few hours of design.

"I plan to start out using this, at first, with the four-bit I/O register doubling as the MQ register. As a calculator, each digit of the multiplier, as it enters from the keyboard, can be counted down as the multiplicand is accumulated. On division, as each digit of the quotient is produced, it can operate the Flexowriter, thus printing the quotient as it is produced.

"Later I hope to get my drum memory working, and convert the kludge into a computer.

"I could get more done on my little computer if the big ones would stop breaking down. At the college we may have established some sort of record last week, with all six of our G.P. computers down for one reason or another (one 360, one B205, three G-15's, and an Athena)."

MORE ON ECHO IV

Some new information about Jim Sutherland's computer, ECHO IV, appeared in the February 11 issue of Computer World.

ECHO IV has 17 machine-language instructions, 15-bit words and an 8K core memory, to which is being added 2K words of read-only memory to eliminate bootstrapping. Another

expansion will be two tape drives, adding 1.5 million characters on each drive.

Instead of punching up cards or tape, ECHO IV goes directly from keyboard to core, and then will transfer the programs onto the mag tape after debugging.

Control keyboards can be plugged in at any of 16 receptacles scattered around Jim's house, using an 18-wire data trunk.

Jim plans to hook the TV picture tube to ECHO IV so the machine can communicate with the family thru an unused channel. On school nights, the set will switch to that channel at a certain time and remind the children to go to bed.

* * * * * * * * * *

Incidentally, by what may not be a coincidence, there was a book published in 1965 by Little, Brown & Company, "The Tin Men," by Michael Frayn, a reporter for the London Observer; in this comic novel, a small part is played by a computer named ECHO IV.

HARDWARE

Semiconductor Memories?

The technical magazines and journals are full of articles and news items about semiconductor memories. For instance, Motorola showed a 8192-bit random-access memory at the 1969 Fall Joint Computer Conference in Las Vegas. A hybrid, it contains both MOS and bipolar LSI circuits. The MOS circuits provide the high density and low power dissipation for the storage arrays, and the bipolar circuits provide the high speed for driving, sensing and decoding.

The memory access time is about 120 nsec; the cycle time about 150 nsec. But how about cost? Motorola expects a price of about 10¢ per bit "when the memory goes into mass production." By 1972, the price may be reduced to "about 5¢ a bit." That would be about $800 now, and $400 in a couple of years. Cheap for an 8K memory, if you can wait.

Electronic Typewriter Actuator

Here's an idea that may be worth borrowing from:

Colorado Instruments, Inc. (One Park St., Broomfield, Colo. 80020) has designed an actuator for use with an IBM Selectric typewriter. The ETA-14 is a long, slim box containing 14 solenoids, and which clips on the Selectric to actuate the 0 to 9 keys, plus tab, dash, return and equal signs. A separate coupler provides the power and drive circuits.

Viatron has gone this one better: they will offer (or intended to at one time) a "solenoid robot" with 50 solenoids, for operating a Selectric at 12 characters a second, using an OCR font.

U-Shaped Cores

U-shaped cores are coming into use for read-only memories, with the sense wires strung through or around the cores, depending on whether a 1 or 0 is desired. However, these U-shaped cores do not seem to be available off-the-shelf yet; companies such as Indiana General and Ferroxcube make them only to order.

Cheaper ICs by 1973?

Toshiba will build a $19-million plant to produce 100 million integrated circuits annually by 1973, according to Business Week.

Mitsubishi will also make ICs; by

1973 the two will be producing more than 250 million ICs a year, which is about 20% of U.S. production.

For years, U.S. semiconductor manufacturers have been saying that only strong Japanese competition could thwart their continuing, dramatic growth. If the tariffs are not changed, Japanese ICs may become as prevalent in the U.S. as Japanese transistor radios. (Presumably, nearly all these ICs will be for entertainment products at first, but digital ICs may come along a little later.)

Nixie Readout at $15 per Decade

The February 1970 Popular Electronics (pp 33-47) has a long construction article, "Build Numeric Glow Tube DCU" by Don Lancaster, based on the Burroughs B5750 Nixie.

The counter operates from DC to 8 or 12 Mc, depending on whether RTL or Signetics Utilogic is used. The article describes the 8-Mc RTL model (Motorola MC700P series). Complete information on the Utilogic version is available from a Texas address.

As usual with Lancaster articles, kits are available. A complete kit of all parts for a 2½-digit counter costs $43.50; for 3½ digits, $59.50; 4½ digits, $75.00. Etched and drilled PC boards are available alone, at $4, $5.75, and $7.50. That half-digit is a neon lamp that indicates a one, permitting counts up to 199 with the 2½ digits. At the 200th count, an over-range neon indicates that the counter has gone beyond its limit. A power-supply kit is available at $6.50.

Expensive Breadboard

The breadboard mentioned in Vol. II, No. 1 (page 6), now has a big brother, Elite 2, which has three power supplies instead of one; a waveform generator that outputs sine, triangle and square waves, and positive and negative pulses. The cost is twice that of Elite 1: $1300.

The "universal matrix" that is the heart of both Elite models can be bought from AP Inc., 72 Corwin Dr., Painesville, Ohio 44077. The AP breadboard consists of 8 groupings of 64 terminals each, with 4 tiepoints per terminal, making 2048 tiepoints, plus two groups of 27 four-tiepoint terminals, for a total of 2264 tiepoints. Any DIP from 10 to 128 pins plugs in, also 8- and 10-pin TO-5 cans, and standard discrete components. Interconnection is by any piece of wire, from size 10 to 30. Cost: $85 each. Seems expensive for five acetal copolymer terminal strips on a glass epoxy base, even with a "gold-plated copper ground plane" on the back, and "spring-loaded beryllium copper, gold-plated" tie-point contacts.

Lower-Cost Fairchild 7400 ICs

During the last week in January, Fairchild Semiconductor started offering 7400-series ICs at what they say are the lowest prices in the industry. And their ad compares prices (the first column gives the basic IC number):

	TI	Signetics	Motorola	Fairchild
7400	1.26	1.20	1.10	.85
7404	1.58	--	1.36	1.07
7450	1.26	1.20	1.10	.85
7474	2.52	2.40	--	1.88
7472	1.77	1.69	1.50	1.31

These are the 0° to 70° C types, in quantities of 100; only several of the 24 types are shown.

Fairchild is aiming at producing 2 million circuits a month. There are 17 gates, 6 flip-flops, and a BCD-to-decimal decoder/driver. Fairchild also aims to produce at

least two 7400 MSI elements every month.

Core Memory Drivers and Amplifiers

Texas Instruments published, last October, two applications reports of interest. "The Operation and Use of Series 7520N Sense Amplifiers," CA-101, has 25 pages of not-too-technical information on the 7520N, a 16-pin plastic DIP family of three threshold-and-strobe circuits.

The SN7520/21N sense amplifier has dual sense-input preamplifiers with independent strobing of each sense channel. The outputs of the two sense channels are combined in a common-output circuit composed of two cascaded TTL gates. It is compatible with standard TTL.

The SN7522/23N also has dual sense-input preamplifiers with independent strobing of each sense channel. The outputs of the two sense channels are combined in a double-inverting open-collector output gate. It can be connected with logic gates with the wired-OR capability, such as most DTL gates and the SN7401 TTL gate.

The SN7524/25N is two separate single-preamplifier sense amplifiers. Each sense-input channel can be independently strobed. The output circuit of each channel features a simple TTL gate with a high fan-out capability. This is designed primarily for small memory applications where performance and cost are important considerations.

TI Bulletin CA-107, on the SN75 324 monolithic memory driver, is a 5-page item adapted from the 1968 Spring Joint Computer Conference proceedings. The SN75 324 was designed specifically to replace the traditional discrete transistor-transformer circuits. However, it can also be used as a lamp driver, relay driver, or high-fan-out logic gate. It consists of four fast, high-current switches controlled by seven logic inputs that are compatible with 54/74 TTL and other standard logic systems.

TI Bulletin CA-122, "Monolithic interfacing in computers," briefly describes (in 10 pages) the 75 109 line-driver circuit, 75 107 line receiver, 75 308 transistor array, 75 324 memory driver, and core memory sense circuits.

Printed Circuits Without Photography

The "negative drafting system" of Bishop Graphics, Inc. (7300 Radford Ave., North Hollywood, Calif. 91605) permits making printed-wiring boards without photography.

The secret is PC-component patterns on black matte acetate film, called "B Neg," with which one can make up the equivalent of a photographic negative. This eliminates two steps: making a photo positive, and photographing it.

A PC board is made by spraying a clean copper-clad laminate with Bishop Resist, placing the B Neg on the sprayed board and exposing it to ultraviolet, developing the pattern, and etching it.

Bishop sells a complete kit, containing 5" by 7" trays, photo resist, developer, stripper, etchant, contact pressure frame, and three 4" by 6" boards, for $28.70. For $36.80 you get an 8" by 10" kit. All items are available separately. B Neg artwork patterns (1:1 scale) cost $7.55 a roll of 100 patterns, and include DIP, flat-pack and TO-can types.

Cheapest Commercial Computer?

For $1800, Unicom Inc sells the CP-8A, with a 1.5-μsec-cycle pro-

The Amateur Computer Society is open to all who are interested in building and operating a digital computer that can at least perform automatic multiplication and division, or is of a comparable complexity.

For membership in the ACS, and a subscription of at least eight issues of the Newsletter, send $3 (or a check) to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Avenue
Darien, Conn. 06820

The Newsletter will appear about every two months.

cessor, 512 bytes of read-only memory, 4 scratchpad registers, and 40 byte-oriented instructions. Core is extra. The D model, with a million bytes of tape-cassette storage and 1K of core, is "under $5,000."

Unicom is at 1275 Bloomfield Ave., Fairfield, New Jersey

BOOKS AND ARTICLES

Computers for Amateurs?

"Computers for the Amateur Constructor," by R.H. Warring, was published in England in 1966, and is available from Sportshelf, P.O. Box 634, New Rochelle, N.Y. 10802 (102 pages, $6.75).

Although the title is misleading, the book is of some interest, mainly because it is about the only one of its type. It tells how to build a counter, adder/subtractor, decade scaler, NAND, AND, NOR, OR, and lamp driver. These seem to have been designed by Mullard, and use transistors such as the OC71 and OC78 (there are substitution manuals that give the American equivalents).

However, the book tells nothing about how to connect the basic modules together, except for a couple of simple logic circuits.

Semiconductor Memories

The November 1969 EEE contains an interesting section, on pages 52-67. After a brief introduction and a list of 40 manufacturers, there is an article, "MOS Memories," by Leonard of TI, mainly about content-addressable memories and read-only memories. "Bipolar Memories," by Snyder of Raytheon, mainly describes the operation of a memory array, and has almost a page on LSI memory subsystems.

An Electronic Digital Slide Rule

A fascinating article with this title, by Schmid and Busch of GE Avionic Controls, appeared in The Electronic Engineer for July 1968 (pp 54-64). This hand-size calculator, weighing less than two pounds, measuring 5x7x1½ inches, contains 40 standard digital ICs, 8 rotary input switches, and four Nixie tubes.

The EDSR is based on integration, and has three basic sections: a pulse rate generator, output integrator/timing circuit, and function selector switch. The switch provides the proper interconnections for add, subtract, multiply, divide, square, square root, exponential, logarithm, and sine-cosine functions.

The EDSR has not gone into commercial production, according to one of the authors, but has been offered for licensing to outside manufacturers. If nobody picks up this item, the authors may be able to release the detailed schematics. However, it looks possible to figure out the construction of the EDSR from the schematics in the article.

ACS NEWSLETTER

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THOSE UNDEFINED DEC COMPONENTS

As the ACS Newsletter of July 1969 noted (page 1), one of the big problems in copying a PDP-8/L is that many of the components bear DEC numbers only.

One of the DEC District Managers very kindly provided some help.

For the transistors and diodes with no commercial equivalent, a DEC part number is given.

Transistors

DEC 2	(15-05369)
DEC 1008	(15-02155)
DEC 2904	2N2904 or 2N2905
DEC 3009B	(15-03100)
DEC 3568	2N3568
DEC 3790	(15-03399)
DEC 6534B	(15-034090-1)
DEC 6534D	(15-03409)

Diodes

D662	1N645
D664	1N3604,1N914,1N3606
D671	1N3653
D672	1N3653
MR2064	1N4001

No information was received on the two delay lines (DEC 16-05530 and 500), rectifier (11-05397) and transformer (T2037).

A NEW MEMBER'S COMMENTS

Our latest member is Steve Wiebking in Nebraska, with the USAF. Among his interesting comments are these:

"I have bought so-called tested ICs from Polypaks in the past. Their linear devices seem to be generally OK, but I have no confidence in the quality of their digital devices. At any rate, tested surplus is usually only marginally cheaper than brand-new devices, and is not really worth it from the viewpoint of difference in quality.

"Polypaks also asks ridiculous prices for their unsorted devices. Mike Quinn and Electronic Components Co. (also known as General Sales Co.) are the only companies I know of that sell unsorted ICs in the 5¢ each range. I cannot deny that getting these into usable condition involves a lot of work, but as one of your correspondents pointed out, "insanity and wiring is what computer building is all about."

"So far I have built a tester for series 53 (TI) DTL, and also a device which allows me to easily identify unmarked ICs. At present, I am working on a more general tester, which will be able to handle TTL as well as a number of other lines of ICs.

"I also have a couple thousand ICs in a narrow-gage TI DIP that I would like to sell once I get them tested. Prices would be 30¢ for a 5360, 60¢ for a 5302 (dual FF), and I also have some series 74 in this package, as well as many other series 53 types.

"Gadgeteers Surplus sells a number of panels of lights at about 10¢ per lamp assembly. These are generally low-current incandescent lamps; the ones I have are 10 v, 20 ma.

"On the subject of making your own PC boards, I presently use a technique given to me by Bill MacBeth of Austin. I draw my layout on graph paper, tape the paper to the PC board, and use a scratch awl to center-tap the hole positions, which I drill with a number 70 drill for ICs. This makes a fairly

tight fit on IC leads, but it makes soldering easier. After drilling the holes, I dip a draftsman's bow pen in airplane dope and use this to draw resist lines on the board. I etch the boards by gripping the board with pliers and stirring the etch solution, using the board as a paddle. This gives me a better etch factor than merely laying the board in the tray and rocking it. The improvement is especially great with double-sided boards.

"The book, 'Circuit Design of Digital Computers,' by Hawkins (John Wiley & Sons), contains a discussion of the transmission-line aspects of a core memory, and also takes a practical approach to many other aspects of discrete component design. As for the logical end of computers, my introduction to the subject was 'Understanding Digital Computers' by Siegel (Wiley), about 1961 or 1963.

"Fairchild has a nice application note on using the uA711 as a sense amplifier. However, things are getting to the point where 711s have only a marginal price advantage over straight sense-amplifier ICs. In the latest Electronics, National Semiconductor advertises dual sense amps for $4.80 each in 100-up.

"In answer to question 4-2 (Feb. 1967, p 6), 'The Logic of Computer Arithmetic' by Ivan Flores (Prentice-Hall 1963) contains the most information on floating-point hardware I have seen.

"You may already be aware that the Selectric typewriter can be converted for automatic operation using only about 10 low-power solenoids to operate the control rods under the keyboard. These rods can also provide coding of the keyboard for input to a computer. There is a company which does this commercially and has advertised in Computerworld.

"On breadboarding ICs: I haven't tried this yet except in a single-IC version, but I think I have a good arrangement. Mount three IC sockets side-by-side. Solder the leads of the two outside ones to the adjacent leads of the center socket. You now put your IC in the center socket and plug #24 solid tinned wire into the two contacts that are connected to each pin of the IC. This is a little cheaper than commercial breadboards, almost as dense, and requires no special plugs.

"A possibility for an I/O device that no one seems to have mentioned yet is a FAX transmitter/receiver set changed to provide a digital output instead of an analog one. Through the use of software, the transmitter could be used to input ordinary typewritten material, or carefully lettered handwriting. The I/O of graphs and curves would be possible. I remember reading several years ago of an Australian university that converted a standard FAX machine for use on their computer. Also, the Visicon company is now making a device of this type for computer input.

"I have bought a great quantity of surplus ICs for 5¢ each, from Mike Quinn Electronics. In December I spent $750 on 15000 ICs and expect the following yield of perfect devices, based on small samples: 7400 - 1500; 7410 - 500; 7420/7440 - 1100; 7441 - 90; 7473 - 300; 7474 - 150; 7475 - 650; 7442 - 50; and a handful of other types."

If you're interested in buying some of those narrow-gage TI DIPs, write: Stephen A. Wiebking, 5802 South 14, Apt. 6, Omaha, Nebraska 68107.

Inexpensive T/S Terminal

Within a year, one of the electronics hobby magazines may publish a

construction article on a time-sharing terminal to cost less than $200. It will use a CRT (for off-line editing), a 21-inch tape loop with a cheap Japanese tape recorder, and one of the new Flex Key "integrated" keyboards.

A read-only memory will be used for ASCII conversion. Future options may include a color adapter, cassette storage, and a solenoid matrix for typewriter hard copy.

Two reasons for the long lead time are the metalworking problems, and the fact that no two Japanese tape-recorder heads (of the cheap variety) are alike.

Flex Key Integrated Keyboards

Those Flex Key keyboards got a lot of attention at the March IEEE show in New York, because they are so simple, and the button travels only about 0.02 inch.

In the thin version, the keyboard is only 1/8 inch thick; the exterior is all plastic. It uses a "proprietary structure of conductive elastomeric membrane, deformed under pressure through a thin aperture film on a printed circuit board, to accomplish effectively bounceless switching." This seems to mean that pushing the surface will force a conductive plastic up against a rigid PC board, after which the plastic returns to its original position.

The thick keyboard, with raised numbers (0 to 9 and decimal point), is ½ inch thick. Both measure 2½ by 3 inches. The thin model is $9.95; thick, $12.95 each, from: Flex Key Corp., 1277 Main St., Waltham, Mass. 02154.

An Even Cheaper PDP-8

Another version of the PDP-8 is slated to come out this summer. The PDP-8E, a 12-bit computer slimmed down to compete with the small 8-bit computers, will sell for about $4000 in quantities, with 4K core and no Teletype.

Arithmetic Unit in a 24-Pin DIP

In March, Texas Instruments introduced the SN54/74181 arithmetic logic unit, claimed to be "equivalent to 75 TTL gates ... it is the closest thing yet to a 4-bit CPU in a package."

The SN54/74181 performs 16 arithmetic binary manipulations on two 4-bit words, including add, subtract, compare, decrement, direct transfer and shift right. It will also perform all possible 16 logic functions of two Boolean variables, including AND, NAND, exclusive-OR, OR and NOR.

Four of the SN54/74181 can be hooked up with a SN54/74182 carry look-ahead generator (also new) to add/subtract two 16-bit words in 36 nsec, more or less.

The SN74181 is $16.50 in quantities of 100-999; the SN74182, $3.63. The 1-24 price is about 50% more than those prices.

IC Plugboards from Vector

New at Vector this year are the 3677 series DIP plugboards, which provide universal mounting for DIPs, flat packs, transistors and discrete components. The longest board in the series (3677) will hold up to 24 of the 14-pin DIPs, and costs $9.89 for 1-19, $8.90 for 20-99. There are 22 tabs per side at the plug-in end. The 3677 is 9.6" X 4.5" with two sides; 3677-1 has only one side; 3677-2 is a 6.5" X 4.5" version of the 3677.

The 3682 DIP plugboard holds up to 54 14-pin DIPs. The size is the same as the three boards in the

3677 series, but the layout is different, and the prices are slightly less.

Within the last year, Vector has brought out two breadboard kits for IC experimenters. The 29K, costing $59.75, includes a 4.5" X 13.9" perforated Vectorboard with side and end rails, five 14-pin DIP sockets, two 16-pin DIP sockets, four 4-lead TO-5 sockets, two 10-lead TO-5 sockets, four flatpack adapter plates, ten 12-hole mounting pads, and contacts, wire, terminals, lugs, bus strips, tools.

Another kit, for $17.95, comes in two versions: 30X and 31X. The main difference is that these two kits contain no sockets. The 30X has two 4.5" X 8.5" Vectorboards with side and end rails; the 31X has one 4.5" X 17" Vectorboard with rails.

These are not the only Vector DIP plugboards; for full information, write to Vector Electronics, Inc., 12460 Gladstone Ave., Sylmar, Calif. 91342.

Cross-Reference Guide for TTL ICs

National Semiconductor has put out a handy one-page cross-reference guide to the series 74N TTL ICs, giving the pin-for-pin replacements (or nearest equivalents) for the 74N ICs made by National, TI, AEG (Germany), Amperex, Fairchild, Ferranti (England), ITT, Motorola, Sescosem (France), Siemens (Germany), Signetics, Sprague, Sylvania, and Transitron.

For a copy, write to National Semiconductor Corp., 2900 Semiconductor Drive, Santa Clara, Calif. 95051. They will also send a chart of "helpful general rules-of-thumb regarding practical uses of standard TTL Series 54/74," plus a list of their own TTL ICs: 16 gates, four flip-flops, six counters, etc.

Heath and Digital Kits

One reason Heath hasn't gone into the digital-logic kit business is due to their designers' insistance on using, for esthetic reasons, decimal readouts such as Nixies, rather than a row of binary lamps. This raises the price to the point beyond "customer acceptance."

In talking with Heathkit men at the March IEEE, it seems that Heath had worked up a prototype kit several years ago for a combination Eput meter, frequency meter and interval timer, which would have been the TB-18 kit. The project was abandoned because the kit price would have been too high, due to such factors as Nixies being specified.

Incidentally, it would seem, at first glance, that Heath has lowered the price of its digital system from $435 to $365, on looking at the Spring 1970 catalog. However, the $435 price, as noted in the August 1968 Newsletter (p 4) was for the 801-A Analog Digital Designer, with 13 plug-in cards. For the $365, you get the 801C Computer Logic Teaching System. This seems to be just like the 801-A, but minus four of its cards: one-shots, relays, comparator, and operational amplifier. These four cards cost a total of $132 (1969 catalog). Yet the 801C is only $70 cheaper.... That's quite a bit of inflation in only one year.

Computer Designer's Conference

Called the "first national conference encompassing all areas of computer design," a Computer Designer's Conference & Exhibition is scheduled for Jan 19-21, 1971, at the Anaheim Convention Center in Anaheim. Calif. Although most of the papers to be presented will be too far out for amateur applications, there may be one or two of interest. "Proceedings will be published and will in-

clude all papers."

The conference is being put on by Industrial & Scientific Conference Management, Inc., 222 West Adams St., Room 1098, Chicago, Ill. 60606, from which address is available a "free exhibit entrance badge," along with conference details.

"Low Cost Output Device"

Unicom, Inc., which has offered the lowest-cost computer so far ($1800 -- but without core), offers a "low cost output device for minicomputers," which turns out to be an Olivetti Praxis typewriter with a solenoid box over the keyboard, at $790. The PR-2000A types at 10 characters/second; for another $300, an 8-bit custom code-converter is attached to the back.

The Haynes Cookbook

Jim Haynes, an ACS member in California, recently became the editor of a new department on the Computer Group News (IEEE), called "The Cookbook." This new column "is an attempt to be of service to the practitioner of computer design," and will contain notes, suggestions, comments, "who-is-doing-what-and-where-to-write-for-more-information," "questions, problems, gripes and goofs." Jim is at the University of California in Santa Cruz.

CURRENT ARTICLES

Binary-to-BCD Conversion

"Comparing Binary-to-BCD Conversion Techniques" by MacDonald and Sklar in the Dec. 1, 1969, EDN (pp 33-39) discusses parallel techniques (logic matrices, summation of BCD components, read-only memory), counter techniques, Couleur's technique (BIDEC, integers only), divide by 10 (binary integers only), and multiply by 10 (binary fractions only).

Microprogramming

An interesting semi-tutorial, "System Design of a Dynamic Microprocessor," by Cook and Flynn, was in the March 1970 IEEE Trans. on Computers (pp 213-222).

Nearly all the microprogramming done to date is of the static type, in which a machine instruction repertoire is implemented by a fixed program in a read-only memory. A dynamic microprocessor uses a read/write memory for microinstructions, and permits a computer to be restructured to represent any computer instruction vocabulary that exists (or can be conceived of), by simply writing and loading its microprogram.

The article discusses a hypothetical computer, describes its basic operation, and gives several coding examples. In logical-type operations, the speed is about 10 times as fast for directly microprogrammed logical programs as for the machine-language equivalent, because the actual operation called for by a logical machine instruction is such a small percentage of the overhead operations of instruction-fetching, decoding, and address generation. However, for programs involving arithmetic operations, the time savings is much less (only 20% in the sample square-root program), since the arithmetic instruction's loop will dominate the total execution time.

IC Flip-Flop Control Problem

If you've been applying (or removing) the preset and clear signals simultaneously to an IC flip-flop, you've probably been having troubles. According to a Customer Engineering Clinic item in the Jan. 1, 1970 EDN (pp 74, 74), if the two signals are applied together, both outputs of a JK master-slave flip-flop such as TI's SN7495 will go high; simultaneous removal of both "will permit

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For membership in the ACS, and a subscription of at least eight issues of the Newsletter, send $3 (or a check) to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.
Darien, Conn. 06820

The Newsletter will appear about every two months.

random patterns to set up."

Trouble also arises when applying preset or clear signals while clock pulses are being received, even though IC makers may say "preset and clear are independent of the state-of-the-clock."

The solution is to avoid simultaneously applying or removing opposing control functions. Also, phase-lock all inputs, to prevent nonsynchronized inputs from drifting in their phase relationship.

Poor Packaging of LSI Chips

LSI packages are being delivered with missing leads, broken or warped ceramic, loose caps, and bent pins, according to a March 30 article in Electronics, "The broken promise of LSI: packaging" (pp 123-125).

According to the article, "the problems of packaging LSI devices seem to be growing faster than the market." "Reliability, assembly yield, and delivery problems plague users of large ceramic packages." "With chip makers throwing away two packages for every three deliveries, and using 2.5 packages for every delivered LSI device, price becomes an important issue."

Character Generator

A character generator using MOS read-only memories and shift registers is described in "There's a better way to design a character generator," by Carter and Mrazek of National Semiconductor, in the April 1970 Electronics (pp 107-112). The memories shape the characters for CRT readout; the registers handle refreshment.

A pair of ROM chips, either MM 5240 or MM 5241 (available in June, and designed for generating CRT display characters) generate the raster scan and vertical scan. A 5-by-7 dot matrix is used. The article shows a logic diagram for generating multiple-character lines.

Computer Music

Not recent, but interesting, is a letter from Himelhoch of Martin Marietta in the Jan. 1969 Data Processing Magazine (p 14):

"... I have taken orchestration on a computer with no converter or other type of an adapter. This was accomplished by capacitor-coupling the output of some controllable flip-flop such as "sense light switch" direct to an audio amplifier or home-entertainment tape recorder.

"The flip-flop was turned off and on under program control. Pulse width is produced by the length of time the FF is on, and frequency by the number of times per second the pulse is turned on and off. The pulse width controls the quality of the audio, producing a range of quality from that of clarinet to organ....

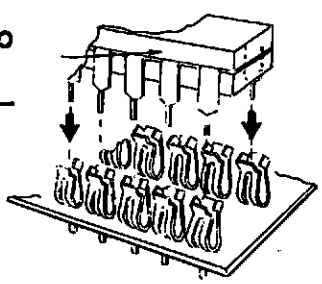
"Audible music can be produce directly from a chain printer such as an IBM 1403. I've heard "Jingle Bells" on a 1403 under program control of a 1401 computer."

president Lowell Wilkes (Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass. 02138), and mention the ACS.

Cambion's usual policy is to "withhold the sale of any products which fail to meet our quality standards," but they would "consider making an exception in the case of any sockets which might be available, so long as we can clearly distinguish such sockets from our first-quality sockets."

DIP IC Connectors

A new line of low-cost IC connectors by Molex has no insulator, just terminals that are inserted individually into a PC board, and into which you plug the IC.



The terminals are supplied loose or in chain form, for inserting into 0.10" holes. Cost is $4.84 per thousand for 50,000 and up; for anything less than that, $6.06/M. Minimum billing charge is $25. At $6.06/M, the cost of terminals for a 14-pin DIP is 8.5¢, about as cheap as you can get for plug-in terminals. For information and/or samples: Molex Products Co., 5224 Katrine Ave., Downers Grove, Ill. 60515.

Imitation PDP-8/L

The DCC-112, recently introduced by Digital Computer Controls (23 Just Road, Fairfield, N.J. 07006), is plug, program and mechanically interchangeable with the PDP-8 family, and looks like an 8/L or 8/I. Sales are limited to OEM's, and the only software currently available is diagnostics. Built with TI 7400N TTL ICs, it is all on five 13 x 16 PC boards; two for the CPU logic and standard-feature logic, two for the basic 4K word core memory, and one for the memory extension control. Each additional 4K words of core adds one board. A diagnostic program determines which board is malfunctioning and should be replaced. The ICs, however, are soldered in, not plugged in, for economic reasons.

The DCC-112 has a 1.2-μsec cycle (the 8/I has 1.5 and the 8/L, 1.6 usec). Basic price is $5900, said to be lower due to: large volumes of the few types of PC boards; the number of connector points is reduced; and back-panel wiring is simplified.

Computer on a Chip

RCA has built a computer for NASA on a chip 1/7" square, according to the Wall Street Journal (June 22). "The tiny chip, which may accompany astronauts to Mars someday, can perform all the arithmetic functions of a medium-size, medium-speed computer."

Logic Indicators

Now that half a dozen logic probes are on the market, along come a couple of in-circuit logic indicators, which clamp onto the DIP and display the states of all logic pins, simultaneously. One or the other could probably be copied cheaply for amateur use.

Hewlett-Packard's Logic Clip 10528A, which costs $95 each and weighs only 1.5 ounces, clips over the IC like a large clothespin. The state of each pin is shown by individual LEDs, of which there are 16.

Caltron has a different approach that is more complex and more expensive. The Circuit-Vu 100 has the same type of spring-loaded clothespin clip, but it's connected by cable to a small box which has lamps

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on the front panel. Overlays for the specific IC types are held in place over the lamps with small magnets. Price: $229.

LATE WORD FROM WIEBKING

A postcard from Steve Wiebking adds:

"More good news. Just got a call from Intel, and the ACS is definitely in the semiconductor memory business. Like the other companies, they had no specific details to offer, but Intel said that the types of devices that they feel would be most useful to us are the "cosmetic" and "hermetic" dropouts. The cosmetic dropouts have been tested in the package and would have a high yield. Intel, of course, is pretty exclusively in the memory and shift-register business, and could be counted on for a good supply of a variety of products; note their recently announced 256-bit bipolar 120-nsec scratchpad."

SAL'S COMPUTER — AND AN OFFER

Sal Zuccaro says his computer now has about 450 neon lights, to be driven with neon drivers he got at 10¢ each; two 36-bit 4K word stacks have been built; the first language will be 7090 Fortran IV, for which he already has an in-core compiler on punched paper tape.

Sal says "I still have a lot of PDP-8 information, prints, training tapes, etc., on the IC version, for anyone who wants them. Write 939 Breton Ave., Simi, Calif. 93065

HIGHLY ACCURATE DIGITAL CLOCK

The National Bureau of Standards has been experimenting with providing an extremely accurate time standard via TV sets. The NBS transmits a digital code in the vertical retrace, or blanking interval, in four cities: Denver (Ch. 7), Los Angeles (11), Washington, D.C. (5), and Cheyenne, Wyo. (5). NBS uses an atomic-standard clock, which is accurate to one part in a billion, or within one second in 300 years (my figures say 30 years).

The digital code signal is on the 20th line, and can be picked off the video amplifier (or detector or sync separator) and with various digital techniques can be used to drive an IC clock. One of the hobby magazines is working on an article on such a clock, for less than $50.

A clock based on the digital code signal alone would not be as accurate as the original NBS standard, due to propagation delays. Therefore, the blanking interval contains a second signal, for correcting this error; proper use of it requires knowing, for one thing, the time difference between the TV transmitter and the NBS source.

Further information is contained in NBS publication TRG-6592W, a two-pager called "New Role for TV: Atomic Clock."

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type coded for either parity or non-parity ASCII code.

COMPUTERS ON AUCTION

The first computer auction ever held took place in New York last July 30; 93 lots were disposed of in 80 minutes by a fast-talking auctioneer.

The first item was a Univac Solid State 80 system, with six Uniservo tape units, read/punch, and printer; it went for $325, FOB NYC. A Univac I control panel, for display purposes only, 80 pounds of lamps and switches, went at $110. Five identical LGP-30 computers sold at $300 to $550 each (FOB Michigan), mainly for the accompanying Flexowriters. An IBM 1401 CPU, 4K, went at $1750; a second one, for $1500. One 360/20 went at $52,500, another for $29,000.

Two minicomputers went high: a Varian 620i with ASR-33 and options, original cost $21,800, went at $7000; an Interdata 15-103 with 7 datasets, for $9000. There were no bidders on an IBM 7072 that was opened at $2000, nor for a 7094 that was started at $20,000, and dropped to $15,000; a 7070 went for $2250.

The biggest item was a Univac 1107, with 7 tapedrives, card reader, punch, printer, and communications subsystem — no bidders at $100,000 or at $50,000. One of the last items was a Univac Solid State 90, with 6 tapedrives, printer, punch and reader, which went at $425; the 90-column card equipment to go with it (3 keypunches, verifier, interpreter, collator and sorter) went for $75; an optical scanning punch for $75, and an alphabetic tabulator for another $75.

Before the auction, one publication had described it as a good place for a hobbyist to pick up some useful computer items; perhaps he could "start with a processor and add to it later." There were several high-school and college students at the auction, but after a few half-hearted bids on items that went too high after a few rounds, they gave up and just watched.

More than two-thirds of the $269,000 worth of used computer equipment was bought back by the people who had consigned it to the Parke-Bernet gallery for sale, because the bidding "failed to reach the upset price," according to the man who bought back both 360/20 systems, as well as about 60% of his 23 consignments, for which he will have to pay a 15% commission.

HARDWARE

PDP-8/E to Replace 8/I and 8/L

Digital Equipment Corp. announced in July its first under-$5,000 member of the PDP-8 family, the 8/E. Cost is $4990 for 4K core and no Teletype. Fully compatible with the rest of the PDP-8 series, the 8/E will eventually replace both the 8/I and 8/L, which are the current models.

Speeds are faster than previous models: I/O transfers are executed in one usec (4.25 μsec for 8/I or 8/L). One reason for the lower cost is the use of busing rather than wire-wrapped backpanels; all options are pre-wired for later plug-in, and logic modules are bus-independent.

A byte-swapping command has been added to the instruction set; it operates on the right and left halves of the accumulator.

Fred Sias says that used 8/S models are having trouble finding buyers, as they are slower and serial. DEC gets several calls a day from 8/S

owners wanting to trade for later models, but DEC doesn't want to stock up on the 8/S. In contrast, a used PDP-8 sells for at least $7-8,000.

Another Look at Wire-Wrap Tools

Gardner-Denver Wire-Wrap tools "for solderless wrapped connections" are expensive. The electric-powered tools run about $180 or more, the air-powered ones about $130, and even the battery-run tool costs $95. Wrapping bits and sleeves are extra.

There are manually operated tools: the squeeze type, for 22, 24 and 26-gage wire, is now $60, plus bit and sleeve. The rod types run from $18 to $23, depending on gage, and terminal-hole diameter and depth. Unwrapping tools cost $75 (squeeze type) or, for the rod type, $4-5.

It would be much cheaper to make a wrapping tool from a short piece of tubing. Might be easier to use with an offset handle, something like the old Victrola windup handles, or an automobile crank.

Has anybody had any experience with home-made Wire-Wrap tools?

Price War Cuts IC Prices

A price fight between Texas Instruments and National Semiconductor has driven the cost of some 7400 TTL gates by National from 63¢ (in 1000 quantities) down to 30¢. Motorola and Fairchild hope to remain competetive. From the others, no comment yet.

The 7400 gates have been sold below cost for several months now; some projections see gates sold for less than 20¢ in 1971.

Paste-Up PC Boards

"Instant circuit boards" can be made with the "sub-elements" marketed by Circuit-Stik, Inc., 1518 W. 132 St., Gardena, Calif. 90249. Made of very thin metal, and backed with an adhesive that "withstands soldering temperatures," these IC pads come in two basic groups: one pre-drilled to match the .001" grid of pre-punched mounting boards; the other is not pre-drilled and is not "on grid," and is for maximum compactness.

Patterns available are for TO-5 and TO-18 cans (3 and 4 leads), DIP strips in various lengths (with and without power and ground connections), individual DIP pad sets (24 and 14-lead), flat-packs, connectors (15 and 22 pins), SCRs, TO-3 power transistors, distribution strips, and discrete components. Also in the catalog are pre- and un-punched boards, jumpers, and conductive and insulative tapes. These pads are not cheap; a package of ten sets of 14-lead DIP pads costs $3, or 30¢ per IC. The strips, which mount six ICs each, cost from 22¢ to 30¢ per IC. Minimum order: ten dollars.

Cheaper GaAs Displays

Monsanto has been marketing segmented and dot-matrix displays. MAN 1 is a 7-segment GaAs readout; MAN 2 is a 5x7 LED matrix (plus a 36th LED for decimal point); and MAN 3 is a planar monolithic 7-segment GaAs display, cheaper than MAN 1.

The news is that Monsanto will sell the fallouts from MAN 1 on the hobby market, calling it something like H4.

IC-Socket Fallouts

Cambion has some "manufacturer's seconds" of 14-pin sockets for DIP ICs, with Wire-Wrap terminals, style 703-3897-01-03-16, at 25¢ each for 100 to 499, 20¢ each for 500-999. If interested, write to vice-

ACS NEWSLETTER

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LOW-COST ICS

Steve Wiebking, who letter was printed in the previous issue, has been negotiating with IC makers for their reject-but-usable ICs:

"I have written to six IC manufacturers so far and have received replies from Philco and Advanced Micro Devices. They both seem interested in selling reject ICs to us (I would consolidate orders to avoid bothering them with small orders), but I have no specific details yet since this is not a standard line of business with most companies. In general, however, it should be possible to get the devices for less than the 5¢ per IC I've been paying Mike Quinn for mine.

"It is likely that some complex devices may run a little higher; Advanced Micro Devices makes only MSI TTL and linears, and Philco makes some 256-bit random-access memories (RAMs). Philco makes a limited but growing amount of series 74 TTL, including a wide variety of types, and some MSI. They indicated that the majority of their present output consists of series 930 DTL and RTL, but the proportion of TTL could be expected to rise in the future. So far, it looks like we would be able to buy only the series we actually wanted. Advanced Micro Devices makes a few series 9300 TTL MSI (9300 shift register, 9301 decoder, 9304 dual adder, 9309 dual 4-input multiplexer, 9310 decade counter, 9312 8-input multiplexer, 9316 hexadecimal counter, and two devices from the Signetics line) and a slightly larger variety of Fairchild and National series linears. I do not yet know if it will be possible to buy mixes containing digital ICs only, but I presume that something of this variety could be worked out.

"All devices are untested, of course, and I presume some percentage of them will be unmarked — it was about 75% for the National ICs I bought from Mike Quinn. I am not particularly interested in trying to do sorting and testing for others, since my previous experience with this indicates that it takes up more time than I have, to do it for anyone but myself. It is possible that I might be able to do sorting only (by this I mean identifying the unmarked devices), since I have this part of the operation semi-automated, but I would prefer to simply resell the ICs at cost and let everybody do their own sorting and testing.

"Naturally, I would publish in the Newsletter everything I have learned about sorting and testing from my past experience with many thousand ICs. The work required to sort and test enough ICs for a small computer should not keep a member busy for more than a few months of average spare time (not working continuously!!), and this is not really too much, considering how much time most members will wind up putting in on a discrete-parts machine. In addition, the ICs for a small computer should not cost much more than $100 in a deal like this, and this will represent a savings of well over $1000 even for the most modest machines a little larger than a PDP-8/L (compared to new IC cost). Further, the resulting benefits in the areas of decreased size, power, and design work

from using ICs should be plain enough, especially if compared to discrete parts, which the majority of members seem to be using. Consider, in particular, the advantages of semiconductor RAMs over using old core frames, if we are able to get the former.

"Of the four remaining companies that have not yet answered me — Intel, Sprague, Advanced Memory Systems, and Computer Microtechnology — all but Sprague make large RAMs.

"In case anyone is worried about the reliability of ICs obtained in this manner, I used over 50 such rejects in a sorting aid I built last year, and I would estimate that it has been in operation 300 hours without any signs of failure. This, of course, is not very long for determining a useful reliability figure, but it is certainly a step in the right direction.

"Philco has mentioned the possibility of selling us "mechanical rejects," which are devices rejected simply because the sections of the case are misaligned, or the lead spacing is a little off, etc. These have been tested electrically and would therefore contain more than the usual number of electrically perfect devices. My past experience indicates that the yield of good devices from rejects is generally 30-60%, but Advanced Micro Devices feels their should be somewhat better, since they test all their devices to military standards.

"For the time being, I would like to hear from all members who think they might be interested in purchasing any of the types of ICs mentioned above. I am not asking anyone to commit himself, but I would like to be able to estimate the total amount of ICs that we would eventually want to purchase from the various manufacturers. I would expect that nearly everyone would be interested in RAMs, so please write soon and give me some estimate of how much you want of what. Remember that the distribution of types will be somewhat random, but we will most likely be able to control the series we are buying. I will send more information as it becomes available."

Steve's new address is: Stephen A. Weibking, Apt. 119, 251 W. Dayton-Yellow Springs Rd., Fairborn, Ohio 45324.

Steve also notes that anyone working on a delay-line machine would do well to consider the 1024-bit 5-Mc shift registers Intel now sells for $38.50 (1-24), $31 (25-99), $24.10 (100-999).

IS THERE AN AUTHOR IN THE HOUSE?

Fred Sias sent the first chapter, on general design principles, of a book he started on amateur computer construction. But now that he's finished his PhD work, and been promoted to Assistant Professor, he feels any writing he does now should be in his field, which is in applying computers to biophysics. (I think).

If any qualified ACS member would like to carry on with what Fred has started, please write to Dr. Fred R. Sias, Jr., School of Medicine, Dept. of Physiology and Biophysics, University of Mississippi Medical Center, 2500 N. State St., Jackson, Miss. 39216.

Fred is looking for an 8-level paper-tape punch operating at at least 50 cps, in working condition and reasonably priced. Or he will trade a new-condition 350-cps photoelectric paper-tape reader (CDC model 350) for the right punch. He would also like to locate a repairable ASR-33 or KSR-33 Tele-

ACS NEWSLETTER

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HARDWARE

Low-Cost ICs Again

Steve Wiebking, who has been negotiating with IC makers for their usable fallouts, writes:

"Intel is the only firm to give us a firm offer so far. Their offer is to sell us cosmetic rejects at half price. Taking half of their current price list, this comes to:

	1-24	25-99	100-999
1101 - 256x1 RAM, 1.5 µsec.....	$20.00	$16.25	$12.80
11011- same, 1 µsec	24.00	19.50	15.38
1103 - 1024x1 dynamic RAM, 600 nsec	30.00	24.38	19.20
3101 - 16x4 RAM, 60 nsec	20.00	16.25	12.80
1402 - 256x4 dynamic shift reg, 5Mc	20.00	14.00	9.00
1403 - 512x2 " " " "	15.00	10.00	6.00
1404 - 1024x1 " " " "	15.00	10.00	6.00

"Any of Intel's other devices are also available on the same half-price deal. The only thing here that interests me is the 1404 (or 1403), and I'm thinking about placing an order for some of these if nothing else turns up by next spring. If anybody else is interested in the registers, I'll be trying to build up an order of 100. (Write Steve at Apt. 119, 251 West Dayton-Yellow Springs Rd., Fairborn, Ohio 45324.)

"I wrote a reminder to Advanced Micro Devices about the middle of October, and still have no useful information from them. Sprague and Philco have also both said they are interested, but have not yet made any kind of offer.

"Core Drivers: As long as semiconductor memories are not turning out to be as easily obtained as I had imagined, perhaps some of the members would like to consider a faster, cheaper and lower-powered way of driving core stacks, which is described in "Submicrosecond Core Memories Using Multiple Coincidence," in the June 1960 issue of IRE Transactions of Electronic Computers, pp 192-198. Using standard 4-wire planes with the system described here gives a 2-µsec cycle for 80-mil cores, and a 1-µsec cycle for 50-mil cores. The low-cost driver system used with the 80-mil system built by the author is described in "A New Core Switch for Magnetic Matrix Stores and Other Purposes," on pp 176-191 of the same issue.

"If any members would like a copy of these articles and cannot obtain them locally, I can make copies at 5¢ a page. Allow something for postage if you decide to take me up on this.

"Cassette Decks: A solenoid-operated cassette drive is available from V-M Corp., P.O. Box 659, Benton Harbor, Mich. Model 1602 is read/write in one direction only, and costs $40-$25, depending on quantity. The 1622 can read or write in either direction, and costs $76-38. Rewind time is 75 sec for 323 ft. The ad, which appeared in Computerworld (Sept. 16, 1970, p 35), was not explicit, but apparently this is the mechanical portion only, with a half-track head and no

read/write electronics. It was mentioned that multi-track heads can be ordered as an option.

"Have just purchased a model 533 IBM card-reader/punch from a local surplus dealer for $200. Main reason it's so cheap (I guess) is that this is the reader for the IBM 650 and isn't any good with anything else. If anybody wants the IBM 650, the dealer still has the rest of it. I didn't ask what the price was, since it is about 3x7x12 ft., and it would not blend in too well with the furniture. I hope to rebuild the reader into a somewhat smaller cabinet, so this will divert me from my other projects for some time."

Earlier, Steve wrote: "I figure I can get my core stacks operating at around a 2-μsec cycle time for .06-.1¢/bit ($360-$600 for $6x10^5$ bits)."

Low-Cost TTL, DTL, and Surplus

Norman Sanders sent word about low-priced TTL, and shift-register and ferrite-core surplus.

The TTL (and DTL) is sold by Gerber Electronics, 852 Providence Highway, U.S. Rte. 1, Dedham, Mass. 02026. Their price sheet shows 7400 TTL and 930 DTL ICs; the 7402 quad 2-input NOR at 60¢ each, 7472 master-slave J-K flip-flop at $1.11 each; 949 quad gate at 70¢, 9093 dual clocked J-K FF at $1.30, etc. Minimum order, 25 assorted circuits.

Norman says: "These are the lowest prices I've seen for new material. What I've gotten was Sylvania, and all have worked well on insertion.

"The surplus is from my intruder alarm, a piece of new equipment developed in the course of my work. This is for manufacture and sale by the security people. I overbought for my engineering work. The shift registers are the National MM5016 512 or 500-bit dynamic shift registers. In general, beware of dynamic registers, because they require odd voltages, excessive clock drive, and won't run slowly enough. These are the best I've found so far. I purchased in quantity because the single-unit factory price of $15 was too much. I'll sell my surplus at $10 each, the 25-up factory price. The factory driver is far too expensive, so I suggest discrete components for that.

"The ferrite cores are General Ceramics CF123 in O-5 material. They are suitable for 100-watt direct from the line to low-voltage loads with ultrasonic switching. The factory price is $5.70, and I'll let my surplus go at $5.00. In the alarm, one is used to generate -12V, -21V, and -30V from the +5V supply. Thus only the +5V supply needs to be taken from the mains and regulated, since the conversion introduces very little regulation at its outputs. The total load is one watt. A core with the semiconductors, capacitors, resistors, wire, and schematic and instructions for a one-watt supply with input from a 5 to 12V source and outputs up to three, each from 5 to 30 volts, can be had for $10 while the supply lasts.

"A preliminary check shows that it takes me about an hour to wire in each IC of the DIP type. I'm wondering what the experience of others is."

Write: Norman B. Saunders, 15 Ellis Road, Weston, Mass. 02193.

No Catalog From Mike Quinn

Steve Wiebking mentioned (on page 1 of the May and August 1970 issues) that he'd bought many unsorted ICs from Mike Quinn Electronics. At that time, Quinn intended to put out a catalog. He has since decided

not to, says the stock changes too fast, even for another ad in Electronics World (his last was back in November 1969).

Mike no longer sells unsorted DIPs, but he does have unsorted flat-packs at $13 to $19 per 100, depending on whether they're RTL or TTL. His DIPs are tested; a 7490 costs $2.95, with 10% off for 10 (the 10 can be mixed). Mike supplies Poly-pak with 70% of their material, and also sells to a kit outfit in Indiana called Environmental Products. He also has core memories, mainly from IBM 1400 and Ramac, also some Ampex and GE types.

If you're in the area, you may want to drop in on Mike Quinn Electronics, 727 Langley St., Oakland Airport, Calif. 94614, (415) 569-1539.

One ACS member doesn't recommend Quinn. He sent a money order after seeing the magazine ad, never got a reply, and when he applied for a refund from the post office, found Quinn had cashed his money order two weeks after it had been sent.

LSI For a Calculator

Electronic Arrays (501 Ellis St., Mountain View, Calif. 94040, (415) 964-4321) has developed the EA5100, a set of six MOS LSI circuits for a 16-digit calculator with 8-digit display capability. The six circuits are 24-pin DIP types, and provide the complete electronic portion of the calculator, except for the display.

The set includes a control array which uses a 1920-bit ROM to generate the basic control sequences that operate the calculator. The other five arrays are for: input, control logic, register, arithmetic, and output.

In addition to the normal arithmetic operations, the logic permits chained operations, negative sign and overflow indication, and electronic interlock. Price for 1-10, $158.46 a set; for 11-49, $144.06. Applications material is available.

IC Dropout

The first victim of the TTL price war is Sylvania, which will end its IC operation in Woburn, Mass., by the end of 1970, thus ending the SUHL line by the originator.

Immediately after Sylvania's announcement, other IC makers ran ads for their SUHL lines; Philco-Ford, Motorola, TI, Transitron, Raytheon; all are hoping for a piece of Sylvania's $8-$10-million market in this ultra-high-level logic family.

In late September, Fairchild cut the prices of its 9300 line-up to 54%. Advanced Micro-Devices has cut its 9300 prices to the point where gate functions in arrays are down to 8¢, in quantity; these compete with discrete TTL gates that are priced at 18¢ in quantity.

Alterable Read-Only Core Memories

At least two companies have U-core ROMs that can easily be altered. To change a word in the Mempac memory from Datapac Inc. (Santa Ana, Calif.), clip a drive line at its terminals, and weave a new drive line through or around the cores according to the new bit configuration. Datapac provides a "simple little wire dispenser."

Varian Data Machines uses a different approach for their VROM (variable ROM), a 20Kb memory that costs about $500. The braid is in a package that plugs onto the ROM board, and is quickly changed for another braid. Small changes can be made (at another part of the VROM) by removing or inserting

I-bars into the plastic holders around which the sense winding is wrapped. The entire configuration could be altered by changing the I-bars, but it's faster and easier to snap in a new braid board.

Arithmetic Logic Unit

Fairchild has an MSI 4-bit arithmetic logic unit, the 9340, which can perform in parallel the add or subtract operations, or any of six logic functions on two four-bit binary words. The high-speed IC TTL ALU incorporates full carry-lookahead internally, and provides either a ripply carry output or carry lookahead outputs. Further information is provided in a data sheet and in a 16-page brochure on application notes, which covers, among others, interconnections for 8-bit, 12-bit, 16-bit and 28-bit ALUs; single-address and three-address arithmetic registers; 4x4 multiplication; and detection of overflow, all one's, and all zero's. Price for 1-24, $20.90; for 25-99, $16.70 each.

Full Multiplier on a Chip

"Parallel multiplier gets boost from IC iterative logic," in the Oct. 12 Electronics (pp 89-93), discusses what is claimed to be the only TTL IC full multiplier on the market, the Fairchild 9344.

The H-P "Logic Clip" Again

Hewlett-Packard's $95 Logic Clip, described on page 5 of the August 1970 issue, turns out to have quite a bit of circuitry in its two customized ICs. The clip can be clamped to an IC any way you like, including upside down and off to one side. The clip contains 16 Decision Gate Networks of proprietary design, which determine if the input at each pin is V_{cc}, ground, or logic signal (high or low), and automatically connect the clip's V_{cc} and ground connections to the proper pins, according to a March 1 article in EDN (pp 74-75).

Clock and Control with TTL

This is the title of an article in Electronic Design (May 10, 1970, pp 82-88) on a digital clock, by Dennison of National Semiconductor.

For as little as $180, a clock that will display time in the form 11:43:56 with six Nixie tubes can be built with 14 TTL ICs of the SN7400 type, plus 7 transistors, 16 diodes and a transformer. The clock uses line frequency as the input time base, which is accurate enough for most applications. If very precise timing signals are required, a crystal-controlled oscillator may be substituted. For actuating an external device at a specific time, a comparator circuit is described.

$70 Data Modem

"Design pruning trims costs of data modem" (Electronics, July 20, 1970, pp 99-101) by Stifle and Johnson of the University of Illinois, gives the full schematics for a 1200-bps transmit-receive modem with a total parts cost of less than $70, about 25% of the cost of commercial modems.

The modem can be built on two 3x4½-inch PC boards, and consists of six ICs in the SN7400N series, three op amps, seven 2N2369 transistors, eight 1N995 diodes and six 1N4154 diodes.

The low cost was achieved by using digital techniques rather than analog, eliminating all "unnecessary" circuits such as data-set-ready and clear-to-send, direct interfacing with TTL to eliminate voltage-level shifting circuits, and use of only one oscillator.

Digital Tape Sensor

"Digital-tape sensor requires no

adjustments," in Electronic Design (May 10, 1970, pp 112-114), describes a simple five-transistor detector for beginning-of-tape and end-of-tape, using 1N2175 photodiodes in a differential amplifier circuit. The design operates "without adjustment, over wide ranges of: illumination, detector sensitivity, wrinkled tape, dull reflective tabs, power-supply output, and temperature."

PUBLICATIONS

Don't forget that if you don't have one of the referenced magazines in your company library or handily available elsewhere, you can get tearsheets from nearly all of them by writing to their Readers Service Department, at the address given in the June 1967 issue of the ACS Newsletter. All of those listed are still being published, except for Electro-Technology, which died this last March, and Industrial Electronics, dead as of January 1969.

New DEC Book

Digital Equipment Corp. has recently published their second programming handbook in the PDP-8 series, "Programming Languages," as a companion to "Introduction to Programming," which appeared previously.

The new volume covers FOCAL, BASIC, 4K and 8K assemblers, FORTRAN, the floating-point package, and math routines. The first copy is free; additional copies are $2.

Hypothetical Automatic Computer

CREI (Capitol Radio Engineering Institute) offers home-study "Major Elective" courses in Computers (#253) and Automatic Control Engineering (#255); both contain a lesson on the "Design of Hypothetical Automatic Computer (HAC)." As the forward phrases it: "In this assignment, we have called our proposed product a 'hypothetical' automatic computer only because its performance will not match ordinary commercial demands; but for educational purposes, HAC is ideal -- and its paper design can be converted into real hardware. We know it can be made real because our advisors and authors at the U.S. National Bureau of Standards who conceived HAC for this study have produced the hardware and have made it work. You who study this design can also build HAC."

HAC has 64 ten-bit words of magnetic-drum memory, eight instructions, and a serial adder. The drawing of the operator's control panel shows 42 lamps, 16 push-buttons, a 3-position switch, and HALT and RUN buttons.

The logic diagrams are very much like those in NBS Technical Notes 68 and 168, as described in the Dec. 1966 ACS Newsletter.

There are various block and logic diagrams, including a complete logic diagram of the arithmetic circuitry. There are no specs for any hardware; it would take a good man to build HAC from these lessons, particularly the memory-unit part. Input/output is theoretically by keyboard and printer; in the lesson, the I/O buffer pushbuttons and lamps on the console are used to enter and read out information.

Another lesson in both courses, on "Digital Computer Components," seems to have also been written by NBS men. After a description of various components, there are 18 pages on operating the HAC. This lesson notes that HAC was never built, but that "a much larger computer has been simulated to operate as HAC." A program to add five numbers (and check for overflow) is shown; it takes 50 instructions.

Incidentally, neither course is

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Stephen B. Gray
Amateur Computer Society
260 Noroton Avenue
Darien, Conn. 06820

The Newsletter will appear about every two months.

available separately; the prerequisite for either is one of four "programs," in electronics, or electronics and mathematics.

MOS IC Course

A six-part course in MOS integrated circuits appeared in The Electronic Engineer between February and October of 1970.

Part 1 (Feb., pp 55-64): history and background. Part 2 (Mar. 55-73): MOS circuits (p-MOS, MNOS, and Si gates). Part 3 (Apr. 61-73): application of MOS circuits (interfacing MOS and bipolar logic; MOS arrays in a data terminal; MOS shift registers in arithmetic operations). Part 4 (May 51-57): complementary MOS logic and applications. Part 5 (June 63-81): random-access memories, static and dynamic, performance and cost tradeoffs. Part 5B (July 63-69): MOS RAMs, performance and convenience tradeoffs. Part 5C (Aug. 53-56): MOS associative memories. Part 5D (Sept. 49-54): memory costs. Part 6 (Oct. 41-46): testing MOS. The Nov. issue (pp 83-86) contains an examination, "What's your MOS IQ?" Fill it out, send it in with $1; if you pass, a certificate is sent.

Counter Survey

"A Survey of Counter Design Techniques," by Langdon of IBM Endicott, appears in the October Computer Design (pp 85-93). The article covers a number of binary and non-binary trigger counters, shifting counters, and three other counters, and includes block diagrams for 27 counters.

IC Digital Logic Families

A three-part article comparing the major IC logic families opened in the IEEE Spectrum with part one in the Oct. 1970 issue (pp 46-58), on "requirements and features of a logic family: RTL, DTL, and HTL devices." by Garrett of Motorola Semiconductor. The advantages and disadvantages of the three families are discussed, along with input, transfer and output characteristics, plus a few basic gate designs.

Part II is on TTL devices (Nov. 1970, pp 63-72); Part III is on ECL and MOS devices.

Low-Cost Digital Record & Playback

"Low-cost stereo recorders can adapt to digital data" (Electronics, July 6, 1970, pp 90-93), by Newton and Buczek of Fort Monmouth, includes block diagrams of the record and playback circuits. Combining data and clock on a single track beats the problems of intertrack phase-shift and head-gap spacing that audio machines have.

A tape speed of 15/16 ips was used for maximum recording time; the higher speeds of 1-7/8, 3-3/4 and 7½ ips were used for data compression when playing back data.

The military version cost $650 for the electronics, using TTL and an a-c power supply. A $750 Uher recorder was used; a less expensive one with fewer speeds would cut the cost quite a bit.

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BUYING AN OLD COMPUTER

HARDWARE

Latest on Reject ICs

Steve Wiebking writes: "The possibility of getting reject ICs direct from the manufacturers seems to be dying a quiet death. I just read that Philco has gone out of the IC business, joining Sylvania.

"At any rate, the Gerber ad below makes it unlikely that anyone would be interested in rejects, unless we could get some MSI dirt cheap (very unlikely).

"In Electronic News, Feb. 8, Gerber Electronics advertised these unit prices for TTL: 7400 - 22¢ ... 7472 - 48¢ ... 7491 - $1.38 ... 9300 - $2.73, 9306 - $5.95 ... 9328 - $4.62. Linears: 709 - 53¢. And a number of other types.

[In a previous Gerber price list, quoted on page 2 of the Nov. 1970 Newsletter, the 7472 was $1.11.]

"On that Gerber price list you quoted from, there is an interesting item you missed. The 2N2222's at $31 per hundred should make pretty good core drivers, if you can believe the specs in the Motorola data book.

"If I had suspected that tested prices would ever be as low as this, I would never have bought the 15,000 ICs from Mike Quinn. I guess the best advice would be: don't buy any ICs until you absolutely need them."

Buying an Old Computer

Bill Pfeiffer writes: "Up until about a month ago I was building my version of a PDP-8/S and having trouble shifting information between registers. The memory plan hadn't been nailed down but I had accumulated a lot of options to choose between. Naturally, each had disadvantages in terms of additional effort needed, and risks in regard to potential performance.

"For instance, I have 2000 26-bit words of twistor (from Bell system military gear), 2 X 8-bit 1000 words of core with electronics and power, five 10,000-usec delay lines with electronics and power, several other cores, some thin-film whisker planes (NCR), tape, several hundred bits of MOS, etc. I also have parts of several computers. One of these might be the major portion of an IC breadboard job, including core memory, all on four large boards. Another may be the major part of a small aircraft computer using core logic; it has power, memory, etc. No prints, though, and I gave up trying to figure it out.

"About a month ago I bought an RPC-4000 at a graveyard-type disposal sale. A company that had been in the business of reconditioning LGP-30's, G-15's and RPC-4000's had decided to quit that end of the business, and hence sold out. I got most of the RPC remains. Now I have to make it operate and then learn how to run it.

"As the result, I would be happy to dispose of my collections of computers, discrete-component cards including core drivers, etc., integrated circuits identified and unidentified, MSI, LSI, RTL, DTL, TTL, switches, power supplies, a display for an LGP-21, and a lot of other stuff that gets forgotten and rediscovered from time to time. For someone who can come and get it,

I could part with an RPC-4000 mainframe for, say, $25. (This computer is still on maintenance contract with Control Data.) No memory for this one.

[Bill Pfeiffer is at 932 Via Del Monte, Palos Verdes Estates, California 90274.]

"The RPC is a very fascinating machine. I have learned about adjusting the heads on its magnetic drum, adjusting the electric typewriter, about free programs from the users' society, etc. It seems like it would be difficult to program without the regular assembler, which I have, and the compiler tapes, which I expect to get. The instructions have all sorts of masking, shifting, indexing variables, repeat and transfer modes, plus using hexadecimal 4-bit bytes or 6-bit symbols. My work is really cut out for me. What I learned about the PDP-8 doesn't seem to help much. I was getting to like octal. Now I have to get used to the idea that DFFOB-F84D7F03F80* is equivalent to
27 12702 12702
26 12700 12700."

In a later letter, Bill encloses a table of data on "Small Computers Produced Before 1964," listing the word-length, number of instructions, mode, memory type and size, number of tubes or transistors, I/O, power and weight, for 13 computers: CDC G-15, 160A, LGP-30, LGP-21, RPC-4000; Librascope L-2010; NCR 310; Packard-Bell 250; Recomp III, SDS 910 and 920; TRW 230 and RW 300. The letter says:

"Enclosed are the results of an analysis of computers made before 1964. The sources were Department of Commerce publications describing about 300 computers. The criteria for selection was a consideration for the practicality for amateur usage. The main factors were weight, power, number of active circuit elements, input/output device, memory and such. Some omissions were made on the basis that my information suggested that perhaps only one machine had been manufactured. This may be of interest to some of the fellows who, like me, may be thinking that the purchase of an old computer may be the shortest route to getting a machine working that has some usable capabilities. Quite a few of these old machines are turning up on surplus sales. Most of these are too big to be useful to amateurs.

"The machine that is of particular interest is the LGP-30. Look at the number of active circuit elements, only 113 vacuum tubes. The clock rate is 120 KHz. The word length will handle 9 decimal digits. Manuals are available from Control Data. Also, there is quite a library of programs available to those who belong to the Users Society. The weak point of the machine is the drum or the sensitivity to pilot error. I understand that if you run the machine long enough to warm up the drum and then shut it down, you can't restart it until everything cools back down to ambient room temperature. Otherwise, the heads will scrape the magnetic coating off the drum. There were 40 or 50 of these machines offered at $25 each without their drums. A few drums could be had for $200 each. The main input/output device is a Flexowriter, but there is also a separate punch and a faster optical paper tape reader. The reader handles characters at about 250 per second.

"The G-15 is still available, or at least was before Christmas, and is in the same price range. It is a bit too heavy (1000 lb.) and the power requirements (110V, 50A) present some problems. If my information is correct, the unit contains the tape equipment and uses a typewriter instead of a Flexowriter.

There are a lot of programs for the G-15 from the same Users' Society that is available to LGP users.

"The LGP-21 will catch one's attention too. It is a solid-state version of the LGP-30. It has the same instruction format, but is not as good as the LGP-30 from the standpoint of speed. The clock frequency is 80 KHz instead of 120 KHz. The book "Computer Structures" by Bell and Newell puts the LGP-21 performance below the LGP-30 by a factor of 3. The RPC-4000 design is apparently the result of an effort to recoup. It has twice as much memory, twice as many basic instructions with micro-variations that extend the capability considerably further. A next-instruction address is used in the instruction word, the clock rate is brought back up to 125 KHz, and options include a high-speed paper tape reader controlled by the computer to supplement the memory with external routines. The reader handles a 1200-foot reel of paper tape backwards and forwards at 500 characters per second in an on-line mode.

"The machine that really catches my eye is the CDC 160A. The chances are that we will never see it available at the right price for a non-commercial application. Another factor is the 1700 transistors. I look at this number as an indication of the problem I would have in keeping it running or even getting it going. You can see from my selection list that this is where I topped out. The SDS computers, I suspect, are in the same category."

Diode Matrices for Sale

John Green writes that he has some new diode-matrix circuit boards, MIL spec, for sale: seven 4x25 arrays, $2.75 each postpaid; nine 10x24 arrays, $5 each ppd. They measure 5.6" x 6". Details on request. Write John K. Green, Box 1038, Boulder, Colorado 80302.

Minuteman I Computer Club?

A member asks if anybody knows of a club formed by those who have bought surplus Minuteman I computers. He adds:

"Just bought an old Univac Synchro-Tape typewriter (for $25), which I understand, besides autoletter typewriting, was used in the early days to feed computer programs to the computer for medical purposes as well as for airport control purposes. Does anybody have any references and/or application data for this? It punches a 7-level tape while typing. I'd like to know if possible and how to convert this type of equipment for general-purpose data-processing purposes, as well as info on conversion to receive teletype from a shortwave receiver, a line, etc., and to possibly use this paper-tape equipment for feeding standard computer-timeshared equipment via telephone lines."

If you have any of the answers, please write Johan Svanholm, 6019 Baltimore Blvd., Riverdale, Maryland 20840.

A Simple Computer Kit

Many of the electronics hobby magazines have recently been running an ad for the National Radio Institute on a new course in computer electronics. Part of the course includes building a simple desk-top computer, which measures 19" x 7" x 14", and weighs 22 pounds.

The Model 832 NRI Digital Computer contains 52 TTL ICs, 7400 type. The specs include: 17 storage locations for 8-bit words, expandable to 32 words; over 15 basic instructions; I/O is switches and lights. A close look at the photo in the ad shows that the memory is made up of slide

switches.

The NRI course, in Computer Electronics, with 58 lessons, costs $578 cash. The advanced course, "For men with electronics experience -- first 19 lessons omitted," costs $503 cash. Monthly-payment plans are available.

The 832 was designed by Louis E. Frenzel, NRI Assistant Director of Education, and Project Leader for the Computer Electronics course; he is also an ACS member. When asked for details on the circuitry of the 832, Lou said he plans to write an article on it for one of the electronics magazines. The 832 kit is not available apart from the course yet, but plans are underway to sell it separately, either in kit or wired form.

DEC Unified Bus

"Unified bus maximizes minicomputer flexibility" (Electronics, Dec. 21, 1970, pp 47-52), by Chertkow and Cady of DEC, describes the interconnection system used in two computers. The PDP-11 Unibus has 56 lines; the PDP-8/E Omnibus has 96 signal lines connected to each module slot.

The article notes that solid-state memories "are not now available on DEC computers, but will probably be announced in the not too distant future."

How Cheap Can a Mini Get?

Coming this Fall is a $1700 computer (in quantities of 200), a Computer Automation 8-bit model 208, with 4K of core, but no power supply, console or chassis. The same company will offer the 16-bit 216 on the same kind of stripped deal, for $2400. A chassis-mounted 216 will cost $5600 for one.... And what kind of modular processor does DEC have up its sleeve??

Passive DIPs

Now that so many integrated circuits are DIP types, a number of companies have adopted the DIL package for other components -- resistor networks, relays, capacitors, etc.

Beckman's Helipot Division has standard resistor networks in DIP form, such as digital pull-up networks ($1.45, 1-99), analog scaling networks ($2.75, 1-99), and digital line-terminator arrays ($1.25, 1-99). Others making DIP resistor networks are Sprague, Mepco, XTS, IRC, Dale, and Centralab.

Daven has a "Dipswitch," with up to six contact arms, for a maximum 6pst or sp6t. The unit has a piggyback option, allowing any 14-pin DIP to be plugged into its back; contacts of the mounting DIP are commoned to the Dipswitch terminals. A special coupling and rear-shaft extension permit tandem operation of another Dipswitch. Cost is $2 to $3 in 100-up quantities.

Corning Glass plans to put combinations of as many as 20 components into 16-pin "Cordips."

8K Bits for $240 or $80

A planar array of thick-film elements, called the Flux Ring memory, is being marketed by Signal Galaxies, Inc., 6955 Hayvenhurst Ave., Van Nuys, California 91406.

The manufacturer says the Flux Ring memory is about twice as fast as plated-wire types, requires less complex electronics and about half the drive current. They call it the Flux Ring because "the magnetic flux from the film elements is provided with a low-reluctance path in the form of a ring surrounding the element."

Two adjacent memory elements per bit provide a 100% redundancy. If

power fails, the elements remain locked in their magnetized states due to a proprietary technique called "magnetic closure"; thus the memory is non-volatile.

The 8Kb array costs $240, or $80 each in lots of 100. A 64Kb stack costs $1415, or $393.20 in 100's. The exorbitantly high prices of the single "evaluation samples" seem intended to keep out all but OEM's, which is all that interests Signal Galexies, Inc.

In-Circuit IC Tester

The Aug. 1970 Newsletter described the Hewlett-Packard Logic Clip for $95 (p 5), which clips over an IC like a large clothespin and indicates the state of each pin on individual LEDs.

A less compact, but similar and cheaper tester, the Digi-Viewer, is described in the March 1971 issue of Popular Electronics (pp 41-46). This is based on the IC test clip made by AP Inc., from which 16 wires run to a box containing 16 lamps driven by Darlington-pair amplifiers. A transparent overlay of the particular circuit arrangement is slipped between the two rows of lamps to show the IC logic.

A complete kit of parts (including a "basic set of the most-used circuit slides) is available at $19.85 plus postage and insurance for 4 lb., from Southwest Technical Products, Box 16297, San Antonio, Texas 78216. The IC test clip is available at $5.95.

Low-Cost Logic & Minicomputers

"The Effect of Low Cost Logic on Minicomputer Organization," by House and Henzel of Honeywell (Computer Design, Jan. 1971, pp 97-101) has several facts of interest.

While the cost of minicomputer memory decreased by a factor of 6 between 1965 and 1971 (from 3¢ a bit to 0.5¢ a bit), the cost of logic dropped by a factor of 27 (from $2.70 for a discrete-component DTL gate, to 10¢ for a DIP TTL IC gate).

The factory cost factors for the DEC PDP-8/E are 15% for logic, 47% for memory, 15% for power supply, and 23% for miscellaneous. The PDP-8/E is constructed of MSI and SSI TTL DIP packages mounted on double-sided boards.

The factory cost factors for the Honeywell H-112 are 24% for logic, 44% for memory, 10% for power supply, and 22% for miscellaneous. The H-112 is made of SSI DTL logic of the 930 series, mounted on circuit boards 2-3/4" square. The memory is a 1.6-μsec, 4-wire, 3D design.

Magnetic Drums

Herbach and Rademan, Inc. (401 East Erie Ave., Phila., Pa. 19134) lists two magnetic drums in their Winter 1971 catalog. One is a Ferranti-Packard 371-4A, 10-inch diameter, 12½ inches high, 38 data tracks, 2 timing tracks, 180 pounds, $195. Vertically mounted in aluminum housing, protected by dust cover.

The Ferranti 371-12A is also a 10-inch drum, but is 31 inches high, has 480 tracks (384 data, 3 timing, 58 spares and spacers), over 3 million bits (65K words, 48 bits plus 6 parity bits), 500 lb., $395.

H&R also has an IBM core stack for $24.50 (five planes, each with 14 rows of 16 cores) and a no-name stack for $89.50 (7 planes, 15-usec cycle).

This is an expensive company, even more now than previously, many more high-priced items than a few years ago. (They also have a computer tape transport, without read/write heads or electronics or vacuum

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pump, for $99.50.)

More Paste-Up PC Boards

The Aug. 1970 Newsletter described (p 4) the Circuit-Stik system of thin-metal IC pads with adhesive backing, for pasting up a PC board on laminate or perf board.

Bishop Graphics (7300 Radford Ave., N. Hollywood, Calif. 91605) has come up with a similar product, Circuit Zaps. Standard patterns are for DIP mounting, with 8, 10, 14, 16, 24 or 36 leads; for TO cans with 3 to 16 leads; for flat packs with 10 to 36 leads; connector strips, etc. Also in the catalog are terminal pins, zap guns for staking, jumper cords, and laminate board. These pads aren't cheap either; a package of 12 sets of 14-lead DIP pads costs $7.55, or 63¢ each, twice the cost of the Circuit-Stik equivalent.

Component Insulators

Robison Electronics (2134 West Rosecrans Ave., Gardena, Calif. 90249) makes tiny insulators for mounting axial-lead components, for increasing packaging density of DO-7 diodes and ¼-watt resistors. These Verti-Mounts resemble the gunracks found in some barracks, with the components racked up vertically. One lead goes up over the top of the mount and down the other side. The Verti-Mounts, for 1, 2, 3 or 4 components, cost 6 to 7¢ in 100's and 3½ to 5¢ in 1000's.

No-Solder IC Breadboard

The "universal matrix" that is the basis for the Elite breadboards (Feb. 1970 Newsletter, p 4) is expensive: $85 each. EL Instruments (61 First St., Derby, Conn. 06418) has now come up with a smaller and cheaper matrix, the SK-10 "universal component EL socket," for $18.

It consists of a 6.5" x 2.2" plastic board with 64 rows, each with two sets of five electrically-connected terminals, so that DIPs when plugged in have a fanout of four at each pin. Two rows of contacts along both the long sides provide power and ground connections. As many as eight 14-pin DIPs can be mounted at one time, along with any components with leads .015 to .032" thick. Interconnections are made with any solid #22 to #26-gage wire.

Book on Computer Organization

Prof. Ivan Flores' latest book, "Computer Organization" (Prentice-Hall, 1969, 371 pages, $12.95) is an excellent description of computer systems "in terms of functional block organization and relates that organization to software components in their operating systems. Coverage of the IBM 360 is most extensive; several other popular systems are considered in detail: RCA Spectra 70, Honeywell 200, PDP-8, IBM 1401 and IBM 1130, among others."

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MINUTEMAN

FROM $5000 TO $690 IN TEN YEARS?

A recent Auerbach study on minicomputers says the potential domestic market is well over half a million, but competition will be tough and prices will decline 18% a year. Hmmm -- at that rate, a $5000 mini would be down to $690 in ten years. A PDP-8/W?

A MEMBER'S PROGRESS REPORT

Sal Zuccaro writes from California:

"My computer is coming along fine. The various tasks are as follows:

1. Build R&W circuitry for the FR400 tape transports.
2. Finish assembly of memory, 32K, 36 bits (still testing stacks).
3. Build 2 NDRO memories for microprogramming.
4. Finish wiring up lights on front panel (over 300).
5. Build R&W circuitry for drum.
6. Close the loop on the paper-tape-reader/punch/flexowriter setup.

"I've installed a CRT on the front panel for direct readout.

"Also, I've taken over the master bedroom for the installation and I find it helps a lot. There is a lock on the door to keep out little fingers and all of my test equipment is in two 6-foot racks on wheels at the end of the workbench. The scope is on a raised platform over the bench.

"This weekend I'll shift one of the tape transports into the room. I will install R&W circuits and marry it to a buffer memory. This way I can flexowrite into the buffer incrementally and dump blocks onto the tape. Also vice versa.

"Add to this the fact that every so often I have to design and build some special piece of test equipment to take data on some of my special circuits."

SENSE AMPS & FOR-SALE

Steve Wiebking writes from Ohio:

"Gerber Electronics sent me another price list with a few additional ICs on it. They now have 711's for 70¢ each. On the back of the price list was this information: The digital circuits are almost all Sylvania or Philco; the linears are Philco, ITT, and Silicon General. There are no rejects or fallouts; all brand-new circuits, guaranteed to meet all specifications. No minimum -- you can buy one circuit for 22¢ plus shipping....

"I went down to the local DEC office a few months ago to see about buying a set of PDP-8 schematics. For some reason, the field engineer there decided to give me Vol. II for the 8/L for free (this is the volume with the schematics; Vol. I is descriptive). Since then, I've decided that the PDP-8 is not really what I want. So I will pass the schematics along to the first person who sends 50¢ to cover postage.

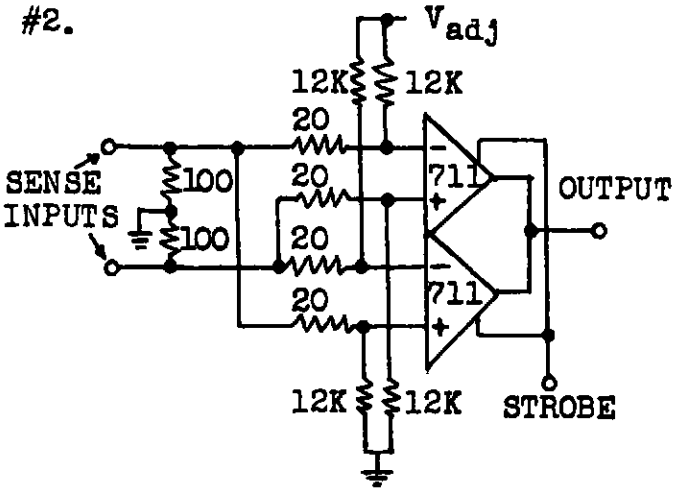
"I've been experimenting with using some of the small epoxy rectifiers that many places sell for 5¢ as selection diodes for a core stack. I haven't run all the tests I should yet (translated: I haven't gotten around to building a complete pair of line drivers), but it looks like they may be OK at least for slower stacks in the 10-μsec area. Also

hopeful is the use of 2N5451's as drivers; they are 15¢ each in the 1000's. They are listed as audio transistors, but are billed as having a fairly high cut-off frequency, so they might work.

"Here is a schematic for using the 711's as sense amplifiers. The Fairchild data sheet from which I am taking the application is a reprint of an article by R.J. Widlar in EDN for Jan. & Feb. 1966. There are two basic circuits; #2 has a slightly improved insensitivity to common-mode noise. No indication is given of what the threshold voltage was supposed to be on these, but they are probably set up for 30-mil or smaller cores. Threshold voltage should be variable by changing the biasing resistors.

#1. [Same as #2, but without the pair of 12K resistors to ground, and without the 20-ohm resistors in the lines from the sense inputs to the plus inputs of the 711's.]

#2.



The V_{adj} is not specified, but presumably is also 12v, as it was in #1.

"I have a Kepro Silk-Screen PC Board Printer that has been sitting around for a couple of years. It cost $35 and can be seen in the Allied catalog. It is all there, untouched, except for a little of the printing ink I tried to use for resist. I will sell it for $10 plus postage. -- Stephen Wiebking, Apt. 119, 251 W. Dayton-Yellow Springs Rd., Fairborn, Ohio 45324."

USED COMPUTERS AND MINUTEMAN

Bill Pfeiffer writes from Calif.:

"The Minuteman club mentioned in the Newsletter must be the Minuteman Users Society formed by Dr. Charles H. Beck at Tulane University, New Orleans. I would like to know where they are selling the computers. My understanding of the Users Society is that it is for the D-17 computer, which is part of the Minuteman system. The 400-cycle 3-phase power requirements are an interesting problem that I would like a solution for. The best idea I have requires 6 SCR's and 3 transformers.

"I found the TRW engineers who bought the LGP-30's. They obtained 70 in total, with 20 memory drums and a similar shortage of Flexowriters. The G-15's are all gone. Another group of engineers bought them all."

In a later letter, Bill writes:

"My RPC is working but I can't get an assembly program more than 2/3 loaded. This produces lots of messages telling me my programs are bad; NO, ILLEGAL ORDER, NO LOAD CODE, etc., are the result. I suspect some memory aberrations, but the memory print routine won't load either. So I have been trying to write a simpler routine of my own in machine language. That is a drag. It is amazing how many ways you can make mistakes with 32-bit instructions.

"Attached are some notes I put together on the Minuteman computer:

Minuteman Computers

Over 1,000 Minuteman D17B computers are being made available to qualifying applicants as a result of modernizing the Minuteman ICBM's. These units were designed and produced by Autonetics, vintage 1962, and are used in the missile as part of the inertial guidance system. It is a small, versatile, multi-purpose, serial computer, designed to meet the highest standards of ruggedness and reliability.

Structurally, the unit is doughnut-shaped, with the computer occupying one half of the package and the power supply filling the other half. The computer weighs 65 pounds and is 20 inches high, 29 inches in diameter. A 28v, 20-amp source should meet the primary power requirements. Secondary voltages are furnished by the power supply and include various voltages between +36 and -36 volts, as well as 28 volts, 3-phase, 400 Hz. It is unclear as to whether power supplies will come with the computers.

The computer components are located on 75 plug-in circuit boards. There are over 1500 transistors, largely silicon or mesa-germanium, and 6000 diodes. The memory is a small, light disk system about 6 inches wide and 3 inches high. The disk turns at 6000 rpm and has a capacity of 2727 27-bit words of which only 24 bits are used; three are spacer bits. The disk also has a number of circulating registers and loops. The clocking is at 345 kHz.

The number system is binary, fixed point, 2's complement. The machine operates serially and synchronous. There are 39 instructions decoded, an external direct interrupt, and numerous I/O lines which include digital, discrete levels, analog, and pulse. Three, four, or eight bit-parallel I/O lines can be selected.

In normal operation the D17 was programmed via an umbilical cord from a test stand on the ground. Typewriter, tape reader, printer, and a control unit were, therefore, separate. The control unit has switches, a keyboard, and a Nixie display. The ground equipment is not always available but has been seen on surplus. An interface unit and I/O devices are thus usually needed to put the D17 into use."

WORD FROM DR. BECK ON MINUTEMAN

A telephone call to Dr. Beck brought out this information:

The Minuteman computer is not available to individuals. The schedule of availability priority is first to the Defense Dept. (the Army uses them for automated data acquisition in laboratories); second, to DOD contractors; third, to universities with DOD grants or contracts; fourth, to civil agencies of the Federal government; then, much further down the list, the Dept. of Health, Education and Welfare, for colleges and universities.

As of mid-April 1971, DHEW had a waiting list of 125 universities for the computers as they become available at that level. (Some may want more than one computer.)

The MCUG has 63 paid members.

Only 100 of the D17B models were made. Then about 1000 of the D27 (Minuteman II), and about 1000 of the D37 (Minuteman III); this III is still in production.

Only six test stands were made; Dr. Beck has one. This part of the hookup, he says, could be the hardest for anybody who doesn't realize how simple the interface actually can be; the user's group will tell him how. For a typewriter, a Flexowriter or TTY can be used.

The computer, if for use on a government contract, costs the recipient only the shipping charges. If at DHEW level, the recipient pays about one percent of cost. The cost is $234,000; one percent of this is over $2000. However, some states limit the maximum cost, for a single item made available thru DHEW, to $600.

There is a very slim chance of these computers becoming available to individuals.

The D37 is an integrated circuit version, takes up 0.6 cubic feet.

DEC'S PDP-16

What had been rumored as a highly modular computer, with any word length desired, turns out to be a custom-designed hard-wired no-software semi-computer that DEC has decided to call the PDP-16, even though some of the 16's will be no more than logic systems that perform a minimum of computing.

The PDP-16 is designed by a PDP-10, using "Chartware, which interprets your problem and generates the right logic design, hardware requirements, and system price." Word length is 8, 12 or 16 bits; these can be taken in multiples to make, for instance, a 32-bit system. The price of typical PDP-16 systems will be $800 to $3000.

Memory of the PDP-16 is up to 1K of hard-wired read-only memory, 16 or 256 words of scratchpad memory. Up to 150 program steps.

So the PDP-16 is a minimum computer custom-tailored to the application, for some of which it will be no more than a calculator.

The PDP-16 demonstrated at the IEEE show in March (and described in the 4-page brochure) does only this: if the switch-input number is positive, divide by eight and store in location L1; if negative, divide by 8 and store in location L2. Cost is $800, if you order ten or more.

CALCULATOR CIRCUITS

The Nov. 1970 newsletter reported a set of six LSI circuits by Electronic Arrays for a 16-digit calculator with 8-digit display capability, $158.46 for one set.

Varadyne Systems (10060 Bubb Rd., Cupertino, Calif. 95014) has now come up with a $249 MCM-14 Micro-Calculator, a 7" x 9" PC board with 6 MOS/LSI arrays, 4 memory registers, and "the entire logic and controls functions required to perform 14-digit displayable arithmetic functions." Standard keyboard and display units are available as options.

CIRCUIT ZAPS MAY GET ZAPPED

The Bishop "Circuit Zaps" mentioned in the previous issue (p 6) won't be around long if the suit by Circuit-Stik is successful. Circuit-Stik claims patent infringement and theft of trade secrets.

Circuit-Stik pads cost 30 to 50% as much as the Circuit Zaps, are plated to mil spec, the 1000 Series is drilled to a 0.100" grid, and the connector tapes can be overlapped without shortcircuiting.

MOSTLY BREAD, LITTLE MEAT IN BOOK

"Computer Technician's Handbook," by Brice Ward (Tab Books, 1971, 475 pages, $10.95), is almost entirely about such basics as number systems and Boolean algebra; 160 pages on circuits (CDC, TI, Signetics); and 200 pages on the hardware and software of Computer Automation's PDC

808 minicomputer. Most of this material you can find in manufacturer's manuals. Only a page or two actually get down to the work of figuring out what's wrong and how to fix it.

EDP ON STAMPS

Even if you're not a stamp collector, you might be interested in making a specialty of collecting only EDP stamps, more and more of which are beginning to be printed.

For instance, several recent Swiss stamps have non-representational computer-art designs. The Canadian 6¢ "Centennial of National Census Taking," issued June 1 this year, shows a strip of perforated tape and two mag-tape reels, arranged to make "100."

TUTORIAL MANUALS

Tektronix, manufacturers of oscilloscopes and data-display terminals, publishes a series of "new concepts" books that provide much information. Most of these are in the CRT area: scope trigger circuits, spectrum analyzer circuits, storagr CRTs, etc. However, two are of interest to ACS members.

"Information Display Concepts" is one of half a dozen Measurement Concepts books, and discusses, with block diagrams, the basic principles of data display. The chapters on time-sharing, programming, etc. are rudimentary; the chapters on "D-to-A and A-to-D converters and vector and character generators" and on "characteristics and specifications of direct-view bistable storage tubes" are highly informative, and easily understood.

"Digital Concepts" is one of eight books (so far) on Circuit Concepts, giving basic theory on digital logic circuits, as used in Tektronix instruments. The circuits are analyzed in details; families such as RTL, DTL, DCTL, CML and TTL are described, as are specific types used by Tektronix, such as the Fairchild 914 NAND/NOR, 923 clocked JK FF, Motorola MC 357 gage, MC 354 regulator, MC 360 NAND, MC 352 RS FF, and MC 358 JK FF. Some counting and counter-readout circuits are presented.

These books nominally cost a dollar but there seems to be no charge when sent to a company address.

ANALOG COMPUTER SIMULATION

For those with access to a General Electric time-sharing terminal validated for the Mark II system, there is a program in the on-line library, ANALG$, which simulates an analog computer.

ANALG$ is based on the PACTOLUS program, described in the paper by Brennan and Sano, "PACTOLUS -- A Digital Analog Simulator Program for the IBM 1620," published in the AFIPS Conference Proceedings 1964 Fall Joint Computer Conference.

In ANALG$, the conventional patchboard interconnection used to operate a standard computer is simulated by specifying, using the terminal keyboard, the interconnections between the many types of blocks available. Thru using these blocks, the response of any time-dependent linear or non-linear system can be obtained. For instance, the operation of mechanical, electrical, and hydraulic systems can be simulated by using this program.

Program features include: on-line configuration modification, on-line initial condition modification, on-line timing changes, maximum of 250 blocks for defining a system, 31 different types of blocks available,

The Amateur Computer Society is open to all who are interested in building and operating a digital computer that can at least perform automatic multiplication and division, or is of a comparable complexity.

For membership in the ACS, and a subscription of at least eight issues of the Newsletter, please send $3 (or a check) to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.
Darien, Conn. 06820

The Newsletter will appear about every two months.

and numeric output values may be printed or plotted.

MAKING PC BOARDS WITH RISTON

Du Pont has a new product, Riston, a photopolymer film resist, which comes sandwiched between two one-mil films. The polyethylene cover sheet is removed just before laminating the resist to a copper-clad board under heat. A negative (or positive) mask is laid over this, then exposed to an ultra-violet source. The other film, a protective layer of Mylar polyester, is then removed; the board is developed, the unexposed resist washed away, and the board dried.

Since the photoresist is solid, it has uniform thickness and neat sidewalls, and it covers the board's holes without penetrating in them.

Ordinarily, the film is laminated by a machine at 230-250° F. It may be possible, Du Pont says, to do this with an ordinary iron set at the right temperature; try to keep the film wrinkle-free and also free of airpockets. After lamination, allow the board to stand at least 30 minutes; the adhesive strength of the resist increases during this holding period; longer hold times after lamination can be very beneficial.

After removing the Mylar, develop in Du Pont's Methyl Chloroform, Dow's Chlorothane NU, Ethyl's 1,1,1 Trichlorethane Cold Cleaning Grade Inhibited, or PPG's NU Stabilized. A container of the 1,1,1 trichlorethane with a soft brush, or adequate agitation, should work well for development. Rinse with water and dry after development.

Suitable U.V. sources are, in order of preference, mercury vapor lamps, carbon arc lamps, and pulsed xenon lamps. Riston should be handled under gold fluorescent or equivalent safelight.

The film comes in thicknesses of 0.5 to 2.5 mils, depending on the end use; the 0.5 and 1.0-mil thicknesses are for etching. Five-inch-wide rolls cost $112.50 for 150 feet (minimum) of 0.5-mil; $115.50 for 125 feet (minimum) of 1.0-mil. Samples may be obtained (on suitable letterhead) from: E.I. Du Pont de Nemours & Co., Photo Products Dept., Room 2428-A, Wilmington, Del. 19898.

HELP! HELP! HELP!

I'm running very short of material for this Newsletter, otherwise I wouldn't have run the last couple of items.

Please send a longish letter on how you hooked up a surplus core memory and made it work, how you figured out what to use for drivers and amplifiers, etc. Memory is the Number One problem of ACS members.

ACS NEWSLETTER

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AMATEUR COMPUTER SOCIETY

THE ACS STORY

An article about the Amateur Computer Society has been accepted by Computers & Automation magazine, and should appear shortly.

RECOMP II AND III FOR SALE

Autonetics is offering a very limited number of Recomp II and III general-purpose computers for 3% of the original cost: $3.000; used but guaranteed to operate. Joe Tolbert says the II is more desirable, even though it's older, because it has, for one thing, more hardware instructions (71 to the III's 48). It has more available programs (50 subroutines, 80 programs and 185 users' programs) than the III (56 subroutines, but only 63 programs and 16 users' programs).

Both the II and III are fully transistorized and include: computer, control console, photoelectric tape reader, tape punch, typewriter and desk. Both operate from standard 115-volt lines. Also available is a limited number of peripherals such as high-speed tape punch/reader, and Versa tape and keyboard.

For further information, and/or a system description and index of programs, contact H.O. Elkins, (714) 632-3031. Address: Autonetics, North American Rockwell, P.O. Box 4192, 3370 Miraloma Ave., Anaheim, Calif. 92803. There may still be a couple left.

$750 EDUCATIONAL COMPUTER

Information about a new educational computer, the Kenbak-1, was sent by John Ranelletti, a new member in California. Further info was obtained by a call to Kenbak Corp., 8714 Darby Ave., Northridge, Calif. 91324, phone (213) 349-3861.

This $750 machine weighs 12 pounds, measures 19 by 4½ by 12 inches, consumes 40 watts. To keep costs down, it is a minimal computer: I/O is by console switches and lamps; memory consists of 1024-bit Intel MOS shift registers; the Motorola, TI and Fairchild TTL ICs are soldered in.

There are no peripherals just now; a punched-card input device, manual type, will be available this winter for about $100, with factory retrofitting. A more flexible model may be available in a year or two, but no work has been done on it yet, says president John Blankenbaker.

A 24-page programming reference manual costs $2.00, and a manual of 30 laboratory exercises is $6.00. A maintenance and theory-of-operation manual, containing complete schematics, will be published soon, at $10.00.

The 8-bit Kenbak-1 has three programming registers, five addressing modes (constant, memory, indexed, indirect, indirect-indexed), two's complement arithmetic, serial operation. The memory consists of 256 eight-bit bytes. There are 21 basic instructions: Add, Sub, Load, Store, And, Or, Load Complement, 4 Jumps, Skip on 0, Skip on 1, Set 0, Set 1, Shift Left & Right, Rotate Left & Right, No Op, and Halt.

There are 34 register-to-register operations (transfers, additions, subtractions, etc.) produced by a single instruction using the memory-

addressing mode.

There are no plans to offer a kit. "Our answer has always been that we might consider it, but only at a higher price. What we would potentiallly save on labor is lost in headaches and troubles (for us)!" However, it might be possible for some people to come in on several Saturdays and each build one under supervision, but no price has been established for this, says John Blankenbaker, who also says that Kenbak would be happy to receive members of the ACS for a visit to the plant.

MINUTEMAN COMPUTER INFO

Autonetics has prepared a Technical Data Package for the D-17B computer for $100. The publication contains sections on logic fundamentals, a D-17B description, word formats and programming, circuits, functional logic description, and maintenance data. The 15 guidance electronics modules can be removed to reduce power consumption and heat generation. The cutoff date for ordering this package was 9-15-71, although it may still be available.

Autonetics has also developed an Input/Output Interface for the Minuteman I D-17B computer. It comes with or without an ASR-33 Teletype. With, $5200 (all electronics are in the TTY console); without, $3500. Interface schematics are not available separately.

CODE IN, PRINTED TAPE OUT

"Automatic radiotelegraph translator and transcriber, by Gonzales and Vogler (Ham Radio, Nov. 1971, pp 8-23), uses several dozen TTL ICs in digital circuits to decode Morse (at up to 120 wpm) and feed it to a strip printer. The printer described is the Model 4 by Computer Terminal Systems in Plainview, N. Y., and costs $129.99 for an "evaluation sample." On page 99 of the same issue is an ad by the authors, offering detailed construction plans for $14.95.

SIGNS OF THE TIMES

Several ambitious construction projects have been mentioned in these pages as forthcoming in one of the electronics hobby magazines. Well, the magazine has decided to cut out the big build-it-yourself articles and go to the smaller stuff. So don't look for an IC clock run by TV digital code (Aug. 1970 Newsletter, p 6) or the inexpensive time-sharing terminal (May 1970, p 2). (The magazine is Popular Electronics, which, starting next January, will be merged with Electronics World, and will be known as Popular Electronics including Electronics World. After all the converted EW subscriptions run out, the EW name will be dropped.)

DESK CALCULATOR KIT

The last big construction article Popular Electronics will run is "An Electronic Desk Calculator You Can Build," (Nov. 1971, p 27-32). The calculator adds, subtracts, divides and multiplies up to 16 digits, and has an electro-luminescent segmented display of eight digits. A shift key causes the first or last 8 digits of the 16-digit results to be displayed. The six LSI ICs can be bought separately for $75 (this is called item EA-80, which sounds like an Electronic Arrays item), as well as a keyboard for $21, etc.; the complete calculator kit, with case, is $179 plus $5 for postage from MITS, 2016 San Mateo N.E., Albuquerque, New Mexico 87110. The article hasn't enough details to permit building the calculator; you'd have to buy the kit. MITS

has another calculator, with square-root capability, but none of the electronics hobby magazines are running big construction articles any more. The emphasis is now on the easier-to-build items.

NIXIE TUBES AND MOLEX IC TERMINALS

Joe Tolbert mentioned a company with low prices on several items: Black Mountain Engineers, P.O. Box One, Corinth, Vermont 05039.

They have type AZK Nixies, manufacturer's rejects, at $2.90 each, for 1 to 19; socket for 55¢. Molex IC-mounting terminals (see Newsletter for Aug. 1970, p 5) are 67¢ per strip of 56 (for four 14-pin or 3½ 16-pin DIPs); over 500 (9 or more strips), 56¢ a strip; over 5000 terminals, 0.9¢ each.

Black Mountain sends several application notes on numerical indicators. They also sell first-quality 7400-series ICs; a 7400 gate is 35¢ each; the 7483 4-bit full adder is $2.25 each.

XDS MEMORY STACKS

Valley Computer Corp., 17027 Roscoe Blvd., Northridge, Calif. 91324, sells used computers such as the RPC-4000 ($14-21K), LGP-21 ($12-14K), LGP-30 ($5-7K) and XDS 930 and 940 ($50K up). They have ten XDS memory stacks, 16K words of 24 bits, 1.75-µsec cycle time, for $300 each; "some of them have minor problems, but all are generally operational."

WORD FROM WIEBKING

Steve Wiebking writes from Ohio:

"I've located a dealer who will be of interest to many members. He has a 4K x 40-bit, 1-µsec memory unit with drive electronics, for $80. He can't guarantee it, but he expects that more such units will be available from time to time. They are failures from G.E. computers; one or two of the inhibit lines have burned out, leaving 38 or 39 usable bits. Otherwise, they are supposedly OK. Present units are of Ampex manufacture. Future units may be Fabri-Tek or Lockheed. The complete unit is 4 x 10 x 12 in., and weighs 12 pounds.

"The dealer is Mr. Gary Forbes, 3641 E. Van Buren, Phoenix, Ariz. 85008. He mentioned that he gets other "interesting" Honeywell items from time to time: IC boards, Teletype and other interface circuitry, CPU's (GE 200 and 400 series), and miscellaneous peripheral equipment."

Steve's letter of July 8:

"I have finally regained my sanity long enough to settle firmly on building a PDP-8. I am nearing the end of about 4 weeks of leave of which I spent a large part giving closer consideration to the various machines I have collected information on. While I still feel that there are many machines I would prefer to a PDP-8, I am forced to the conclusion that any machine I can build in a reasonable length of time is better than any machine I can't. I can use DEC's plans right down to the last logic board except around the memory controls, and this will save me a lot of work over trying to design my own from scratch.

"So, I won't be giving away that manual as in the previous letter, but I can still supply Xeroxes at the following postpaid prices:

PDP-8/I	Vol. 1	$7
	Vol. 2	$12
PDP-8/L	Vol. 2	$4.50

Volume 2 in either case contains all the logic diagrams. Volume 1 is probably not necessary.

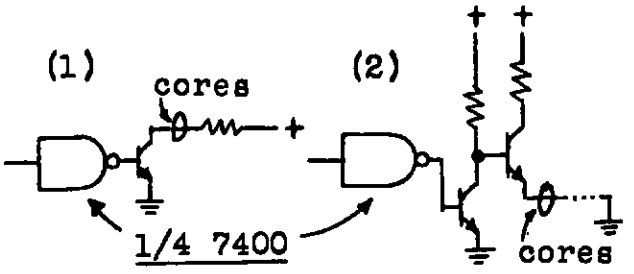
"On memories: I haven't gotten around to testing the rectifiers yet, but it has occured to me that part of the advantage of 3-to-1 selection ratio in a core stack can be had without the need for separate drivers for the X direction on each plane. (Three-to-one selection ratios are usually achieved by using the inhibit line to bias all cores in the plane with $-\frac{1}{2}$ units of current and driving the X and Y lines with +1 full units of current each. This results in +3/2 units of current at the selected core and $+\frac{1}{2}$ or $-\frac{1}{2}$ at all other cores in the plane. Unfortunately, inhibiting will not work with this arrangement even if you had a fifth wire to do it with. Consequently, separate driving of the X lines is required for each plane; this much of the system is similar to a $2\frac{1}{2}$D conventional system.)

"Note that the only problem arises in the write cycle. There is no real difficulty connected with using 3:1 selection in the read cycle when the inhibit wire is not used anyway, and using the 2:1 selection system in the write cycle. There may be a problem if your drivers are transformer-coupled to the drive line, but I will be coupling my drivers direct to the selection lines, and the only change required in the design to have different read and write currents will be to have different load resistors in the drivers at opposite ends of the lines. It would also be necessary to change the inhibit drivers to bi-directional operation.

"Members may be wondering "why bother" if they have not read the two articles I referenced in the Nov. 1970 Newsletter (p 1). The 3:1 selection allows a higher current at the selected core; this results in faster switching, which means a faster read cycle in the case I've described. Because the core switches about twice as fast, the output is higher for a stored "1" (about 250-300 mV in the case of my 80-mil cores). Alternately, the value of the $\frac{1}{2}$-select current can be reduced so that the memory will operate over a wider temperature range without a temperature-compensated power supply. Since you are still using 2:1 selection in the write cycle, you can't reduce it too much, but increased speed in the read cycle over a 2:1 system should more than make up for what you lose by lowering the drive currents."

Steve's postcard of Sept. 11:

"At the rate things are going, I may not get any more work done on my computer until I graduate from AFIT next March. 2N5451's work OK as high-current switches. The switching speed looks like it is OK for memories as fast as 1-2 μsec if used in circuit 1. Note



that there is no base resistor. Use of a base resistor in this circuit with 2N5451's or other cheap transistors causes the turn-off time to become longer than the memory cycle. Circuit 1 has been built and will definitely work. Circuit 2 has not yet been tried, but should be OK as the positive-end-of-the-drive-line switch. (No. 1 is for ground end.) While testing testing #1, I found that a little bypass capacitance on the power supply is worse than none. I originally put .01 μF across the supply, but this converted the .2v spikes into a 3 or 4v sinewave on the 5v supply. A large (~10 μF) electrolytic finally smoothed them out."

Steve's letter of October 19:

"I never have quite given up on the IBM 360/50, although I have off and on considered a number of smaller, more sensible machines. Lately, though, a number of things have happened to make this a much more reasonable project.

"About a year ago I bought a copy of 'Microprogramming: Principles and Practices' by Samir S. Husson (Prentice-Hall, $16.95). Mr. Husson was one of the leading designers of the 360 series, and the book concentrates on the "how it was done" approach to the subject. There are long chapters on the 360/40 and 360/50 as well as two other machines. Reading the chapter is sufficient to put you in a position to write your own microprograms, but the chapters cover a lot of ground; it took me about 10 days to get through the one on the 360/50.

"A very helpful feature of the book is the many references to IBM engineering manuals. I ordered the model 50 manuals referred to by Mr. Husson a few months ago, and I have just ordered the ones referred to in the first set of manuals. The logic diagrams in these manuals are much easier to follow than the DEC PDP-8 manuals, mostly because they are broken up into small functional units and all signals flow from left to right. The manuals generally seem to be directed to field engineers learning how to service the machines, and are loaded with explanations and charts.

"I bought one manual on the 360/25 last year, and it is not nearly as clear as the ones on the 50. Different models of the 360 were developed by independent teams.

"From what I have read in the Newsletter, most members seem to be interested in a machine that will cost only a couple hundred dollars. I can't see any of the 360 models falling into this category. I would guess that a model 40 with a 4K x 18 memory could be put together using surplus core and cheap ICs for a little over $1000 (would you believe $1500, maybe?). The 50 with minimum memory (4K x 36) should cost me about twice as much.

"If there are any members interested in spending this amount on their machine, I would be more than happy to write them a letter on the sorts of problems likely to be encountered in building such a machine. I don't have any information on the 30. I don't recommend the 25. It is interesting from the point of view of havings its microprogram in main core, but unless you think the ability to change your instruction set at will is an advantage, the only thing it has to offer is upward compability. Even though it uses 900-nsec core, a PDP-8 could easily beat it in terms of 'numbers crunched per second.'

"The thing that has kept me from taking the 360 seriously before now was the need to build a large, fast ROM without going broke; in the case of the 50, a 1408-word by 176-bit ROM with about 100-nsec access and 500-nsec cycle is required. Assuming half the bits are 1's, over 100,000 diodes would be needed for a diode ROM, so that approach is out...."

Steve's letter of Oct. 28:

"American Micro-Systems offers a dual 480-bit shift register for $3.50 in quantities over 25. Depending on which part of the country you live in, the distributor is Cramer, Industrial Electronics, Bodelle, or Century Electronics. I didn't have any luck the last time I tried to coordinate an order for registers, but the price is lower and the quantity is smaller this time, so I'm willing to try it again. The registers are guaranteed to 1

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Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.
Darien, Conn. 06820

The Newsletter will appear about every two months or so.

MHz with a "typical" 2½-MHz rate. [Steve's address is Apt. 119, 251 W. Dayton-Yellow Springs Rd., Fairborn, Ohio 45324.]

"Incidentally, members who are willing to put up with a serial memory no longer have any excuse for putting off construction; 1024 words of 15 bits will cost only $56 plus drive circuits.

"The rest of the IBM manuals I ordered arrived. They did not contain all I had expected, but the combined set contains diagrams of all the logic "whose function is not immediately apparent" and has flowcharts of all instructions that will convert to microinstructions rather easily. Actual logic and microinstruction diagrams are apparently buried in manuals referred to as the ALD's and CLD's. These are frequently referred to, but no form number is ever given, so it is probably not possible to order them. From a sour-grapes point of view, what I have might be optimum, since it will require me to get a fairly good understanding of the machine before I start filling in the missing parts.

"Direct substitution of TTL is feasible for all 360 models from 50 on down. The logic used is similar to series 930 DTL. The easiest way to collect a set of hardware manuals for a model is to order a few known ones, then order the ones referred to in these, etc. Starter sets for several of the models are:

360/20 Y26-5909, Y25-3027
360/25 Y24-3527, A24-3510, R25-5402
360/30 A24-3231, 225-3360, 225-3362
360/40 223-2840 thru 223-2844
360/50 Y22-2821, Y22-2822

"Particularly with the newer models 20 and 25, you may occasionally find that some of the manuals are "restricted distribution" and cannot be bought. On the other hand, depending mostly on the time of day, you may be able to buy them after all. In the case of hardware manuals, they apparently all start out with Z prefixes, which means they can't be sold to anybody, including the fellow who wrote them. Only one of the 360/50 manuals I ordered was restricted (the time of day was wrong that particular time) and this was volume one of a pair for which the second one is not restricted."

WANTED: HELP WITH 8/L

Al Kilburn writes that he has a PDP 8/L. He's interested in information on interfacing an audio tape recorder with it, and in cheap peripherals such as printer, card reader; and also used boards compatible with DEC sockets; 6844 S. Oglesby, Chicago, Illinois 60649.

CONNECTORS FOR SALE

I have 62 used Amphenol connectors, female, type 26-190-32, 3 3/4 in. long. These have 32 contacts; two opposed sets of 16, the sets ¼ in. apart. Originally held ¼-inch-thick analog boards. Catalog price (for 50-99), $2.60 each. Sale price for all 62: $30 or best offer.

ACS NEWSLETTER

Volume II, Number 12
(Serial Issue 23)
March 1972

a publication of the
AMATEUR COMPUTER SOCIETY

LAST ISSUE OF
VOLUME II

RENEWAL TIME AGAIN

The Volume II money has run out, so this is the last issue of the second series. For a subscription to Volume III, please send $5.00 ($5.50 foreign).

Sorry about the rise in price, but the cost of printing and mailing the ACS Newsletter has gone up almost 50% since 1966.

THE ACS STORY

"Building Your Own Computer" appeared in Computers & Automation in two parts: Dec. 1971, pp 25-31; Jan. 1972, pp 20-22, 40-42.

Eight photos of five amateur computers were sent to C&A; none was used, because C&A, for reasons of economy, contains a minimum of photos, only 1 or 2 per issue. The manuscript was printed exactly as submitted, except that the references to photos were changed by the editor. Where the original had "The logic for the delay-line version of Bill's computer is shown in Fig. 3," for example, the C&A article says, "The logic for the delay-line version of Bill's computer was not very difficult." Sorry about that, Bill.

Responses to the C&A Article

In the three months after the C&A article appeared, 28 people wrote in to say they'd seen it, and wanted more information. Of the 28, at least four have operating computers, four or more are building their own machines, and 12 joined the ACS, including our first couple, Dr. & Mrs. Jun of Ohio.

Computerworld Letter

A brief letter from Steve Wiebking about the ACS was printed in the Jan. 12 Computerworld. Over 100 people responded; two have operating computers, three are building, one has a complete Univac File 0 computer, and 62 joined the ACS, including the first two women members (in Virginia and Alabama), who both joined on the same day.

Most of the money from these new members went toward reprinting Vol. I, because back in 1966 I didn't believe that more than 100 people would ever join the ACS.

Grand Totals

As of 3-26-72, 310 people have inquired about the ACS, 195 have received Volume I, and 113 have subscribed to Volume II.

KENBAK SWITCHING TO CASSETTE INPUT

Development of the card-input device for the Kenbak-1 training computer (see Nov. 1971 issue, p 1) has been shelved in favor of using cassette-tape input.

The audio cassette will be recorded in FM, with several cycles per bit. The user will be able to record on the tape directly from the previously loaded memory of the Kenbak-1, and Kenbak will sell pre-recorded cassettes for games, etc.

Newer models of the Kenbak-1 will contain the necessary interface circuits. Kenbak will recommend and market a cassette recorder, for about $100. A user can try his own cassette recorder, but Kenbak won't

guarantee success with any but the recommended model.

Kenbak-1 Schematics

The Kenbak-1 maintenance and theory of operation manual, for $10.00, contains complete schematics. The input and output lines to and from each group of ICs are identified only by a signal name, such as HT or $\overline{13}$, so you'd have to make up your own wiring lists if you want to copy this ingenious computer.

The Kenbak-1 uses 131 ICs, of which 129 are 14 different types in the 7400 series, and two are Intel 1404 1024-bit dynamic shift registers ($16.30 each from Intel). The 129 ICs, if bought from Solid State Systems, Inc. (P.O. Box 773, Columbia, Mo. 65201), would come to $62.15; add $32.60 for two 1404's, for a total of $94.75. If the 129 ICs are bought from B&F Enterprises (P.O. Box 44, Hawthorne, Mass. 01937), the total, including the 1404's, would be $100.83.

No values are given for the Kenbak-1's couple of dozen resistors and capacitors; most of the resistors are 1K. The power supply, clock multivibrator and clock driver are all shown without component values. There is no parts list in the manual, although one could be obtained from Kenbak.

Kenbak-1 Logic Alone?

John Blankenbaker, president of Kenbak, says they're been thinking of offering the Kenbak-1 logic board alone, as a tested item (taken from a tested computer). This would be the full set of ICs, on the one board, without front panel, switches, lamps, power supply or case, for about $450. If you're interested, write John at Kenbak Corp., 12167 Leven Lane, Los Angeles, Calif. 90049, or call him at (213) 472-8347.

IS A SCOPE NEEDED?

Several members have asked if an oscilloscope is needed for building an amateur computer.

John Blankenbaker, who developed the Kenbak-1 computer, says that one of the big problems many people have with using a scope, no matter how good it is, is inadequate grounding, so there are noise problems that can be tracked down only with a high-frequency scope. John says he feels he could now troubleshoot the Kenbak-1 with a logic probe. And if he were to use a scope, he could get by with a 1-MHz model. For design, though, he'd want to use at least a 15-MHz type, and 30 to 50 MHz if possible. He bought a used 50-MHz H-P scope for $700.

Dual-trace and dual-beam scopes are helpful at times, but John says he can get along without them, as well as delayed sweep.

The biggest problems are grounding, power distribution, and clocking. Amateurs often try asynchronous logic, says John, and this is a mistake, because it causes race conditions, unusual delays, etc. He recommends the fully-clocked system.

According to Tektronix, an electronic switch is OK only up to about 100 KHz. Beyond that you need a dual-beam or a dual-trace scope for synchronized alternate sweeping. The latter is part of a number of Tektronix plug-ins. Tektronics markets the British-made Telequipment scopes: the dual-trace transistor D54 has a bandwidth of DC to 10 MHz, costs $595. The dual-beam vacuum-tube D51 has a DC-to-6-MHz bandwidth in channel 1, DC-to-3-MHz in channel 2, costs $375.---Any comment on scopes?

COMPUTER PARTS IN KINGSTON, N.Y.

Various computer peripherals and

components are available at P&D Surplus, 198 Abeel Street, Kingston, N.Y. 12401, 100 miles northwest of New York City, off exit 10 on the Thruway; (914) 338-6191.

They have mostly components in the retail store: ICs, capacitors, PC boards, etc. They do get peripherals; Wayne Ely got a complete IBM 728 tape handler there. IBM equipment, though, is available only if it comes through government surplus, as IBM shreds and recycles their own used equipment. P&D does get equipment from other makers, such as Univac card readers. They have no catalog or flyer, so you have to go take a look.

A NEW MEMBER WRITES

Bob Carpenter writes from Maryland:

"Over the past four years, I have been in the process of building a computer. The actual hardware work got underway about three years ago. The machine really started working only a year ago. My machine uses the PDP-8 command set and runs at about the speed of a PDP-8/S (24-μsec cycle time). My memory is from an IBM 1620, obtained from Herbach & Rademan. I have implemented only 4K at present, though I have designed the boards to allow easy expansion to 8K (which still leaves part of the core stack free). My only references have been the DEC Small Computer Handbook give-aways, plus a few library books. The NBS reports are pretty useless since they are so old and slow. I use Signetics Utilogic (it was cheap when I started the design) and some 7400 series where it's best. I bought an ASR-33 after I was sure my machine would run!

"I have copies of the DEC software, which all seem to run: Focal, Editor, PAL III, etc. While I use the DEC software, I have made a point of never looking at their PDP-8 hardware diagrams, etc. I'm sure I learned more this way. After all, I'm supposed to be an EE.

"I haven't made much use of my machine; it is less reliable than I would like. It seems to pick up extra bits now and then. At present I am writing a program to reduce the data that the Radio Amateur Satellite Corp. (AMSAT) expects to receive from the telemetering on their "bird" which may be launched in the summer.

"With the recent drastic reduction in semiconductor memory prices, it looks like a fast amateur computer will soon be within the price range of many. My machine must have cost $1200 plus the ASR-33. With cheap 7400-series and semi memories, it should be possible to make a good machine for not much more, nowadays. After all, TI will sell you a complete machine for under $3000."

In his next letter, Bob answered a few questions:

"1) <u>How to get the IBM 1620 memory to work</u>: The 1620 core stack is 100x100 (a total of 10 000 words). Since it was the only source of memory I could come across at a reasonable price at the time (Fall 1968), it seemed to lead the way to a 12-bit machine. Hence the PDP-8.

"As for getting the memory going, I initially used trapezoidal waves in the four switch-core drive lines. I experimentally decided what the bias current should be for the switch-cores. To elaborate: the 1620 had switch-core matrices for each axis. Each switch-core corresponded to one X or Y line in the main core stack. A bias-current wire runs through all the switch cores. There are also two input windings (4 turns) on each core.

"These switch cores are arranged

in a 10x10 matrix (100 cores) for X and a similar set for Y. For one side of a 10x10 matrix, the 10 lines may be called the "units" lines and each goes to 10 cores. The other side of the 10x10 matrix may be called the "tens" side and each line also goes to 10 cores. If there is a one-ampere bias current, and a 250-mA current is put through a "units" line, all the cores it feeds will have zero field. If now 250 mA is put on one of the "tens" lines, the core that has both 1's and 10's current in it will flip and produce a Read pulse in the main core X line driven by it. When the 1's and 10's currents have both been removed, the switch-core will be flipped back by the bias-current field and the Write pulse will occur on the line in the main core stack. Thus we have a way to drive the X and Y select lines of the main stack from uni-directional current drivers, and without any selection diodes.

"Since I felt I could get by with only 4K of the stack, I use only 8 of the 10 lines to each side of each switch-core matrix, giving 64 driven wires on each axis of the main core stack. The fact that my stack came with the switch matrices was a major stroke of luck, at least as far as money was concerned. Of course, the cycle time is pretty slow, around 20 μsec.

"In the summer of 1970 I was at the NBS location in Boulder, Colo., where tapes were being added to an old 1620 and I was able to get a look at its diagram, etc. They drive the core with non-time-coincident rectangular pulses (to ease the voltage compliance requirements of the bias current regulator). Since then I have changed to a similar setup. I used the Motorola MC 1440 or 1540 for the sense amplifiers. At less than $2 each they are a real buy. There is none of the foolishness you have to go through with things like the 710 or 711 to get the desired characteristics, and they include strobe, etc..

"2) How to accomplish the PDP-8 command set: In the first place a large part of my motive for building the machine was to learn something about minicomputers. Therefore it seemed to be defeating the purpose to blindly copy a commercial design. Reason prevailed to the extent that I wanted something that would run with readily available software, since my interest lies in hardware development, primarily. I went through a period of looking at other command sets, but the fact seems to be that the PDP-8 is logically the simplest machine in common use. I have carefully avoided using any DEC drawings, etc., in my design. In fact, my whole source was their "Small Computer Handbook" of the late 60's. This is the reference manual on the 8's, but gives no detailed hardware info.

"I designed both serial (PDP-8/S) and parallel versions, and the extra price for parallel seemed to be worth it. I have mainly used the Signetics Utilogic II series since it was the cheapest 5-volt logic series at the time I got to building. Nowadays one would use the 7400 series most places. I note that DEC uses Utilogic II for buss receivers in both the PDP-11 and PDP-8/E. Construction had many fits and starts. Finally I felt confident enough to invest in a Teletype ASR-33. This represents about 40% of the total cost of the project. I was able to obtain the hardware diagnostic tapes for the 8 which identified a couple of instructions that aren't fully described in the older Small Computer Handbook. Simple wiring changes fixed these up.

"As you see, all I can say about how to duplicate the PDP-8 instruction set is to figure it out. It

really is pretty simple. I fear that no one will be able to get a machine running if they can't design the control logic for this set. The secret seems to be to draw a time chart to plan what happens at what time in each memory cycle (if you want to build a memory-synchronous machine). DEC is good enough to tell you in what order things are done in the "microinstructions."

"If I were starting over today, I might choose the Nova instead, if a 16-bit memory could be found. The PDP-11 looks very powerful, but is doubtless very much more complex.

"What do I have for my $2000? The main thing is a reasonably good insight into the workings of the simpler minicomputers. I also have a small, though unreliable, machine which has enough software available to be of some practical use. Homegrown instruction sets are fine, but who has the time to write a Fortran or Basic, or even an assembler? If your main interest is software, buy a machine."

A 320-NOR COMPUTER

For $1.25, you can get a "Computer Lab Workbook" from Indiana Instruments, 15054 Gulf Blvd., Madeira Beach, Fla. 33738. The workbook is used with a logic laboratory (cost: $425) based on NOR gates. On four PC boards are 80 NORs, each consisting of an npn transistor, four resistors and a capacitor on the input lines, and a collector resistor, in a square 9-pin pattern. Various "logic symbol plates" are laid over one or more of the NORs and then leads are clipped on according to the lines on the plate, to create flip-flops, gates, one-shots, exclusive-ORs, clocks, etc.

The student progresses from gates up through interconnected groups of circuits, such as adders, decoders, counters, and memory. The last construction is of the "Baros computer," using four logic labs, two 256-bit MOS memory ICs, and four mounting frames (total cost: $1804) to build a single-address, 8-bit sequential machine with 8 instructions. Not bad for only 320 transistors and two ICs.

The new version of the workbook, coming out in April, will also contain a logic-lab schematic for an interface required to connect an ASR-33 Teletype to the Baros mini.

SPEAKING OF SCOPES....

For $595, there is also a Heath/Schlumberger EU-70A assembled scope, with dual trace, triggered sweep, and 15-MHz bandwidth.

COMPUTER ART

Computra (Box 608, Upland, Indiana 46989), has a booklet of computer-generated art, all originals, from $5 to $16 for standard items, and $5 to $20 for a "unique revision of the catalog version."

FOR SALE

Keith Stoicheff (P.O. Box 74, Burnham, Pa. 17009) has a Milgo 1735-1A analog/digital plotter for $295 (originally $20K), a model FL Flexowriter (some repairs needed) for $95, and the main frame of a Logistics Research CRC-105 decimal digital differential analyzer for $150.

Herbach & Rademan (401 East Erie Ave., Philadelphia, Pa. 19134), has a Feb/Mar catalog with: Friden Flexowriters (7-level Daspan code), $395; Hewlett-Packard 565A digital printers, $280; Univac 1103 single-plane memory (4K bits), $14; 11K-

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bit core stack, $60; Ferranti 371-12A magnetic drum (480 tracks, 3 million bits), $295; Ferranti 371-4A drum (38 tracks, 3K bits per track), $95.

IN PRINT

Display Terminal Under $200

"Convert your scope to a display terminal," by Armstrong and Hern of Marquette University (Electronic Design, Nov. 11, 1971, pp C20-C24), describes a display generator that uses any general-purpose oscilloscope. It's based on a 22-stroke starburst pattern, portions of which are blanked to form the various characters. Flip-flops and gates generate the four required bit-patterns, which are summed and integrated by op amps to give the X and Y deflection voltages. Up to 250 characters can be displayed with a software package (interrupt program, table look-up subroutine and output character table) using no more than 410 core locations.

Schematics for PDC 808 Computer

A member writes that Brice Ward's "Computer Technician's Handbook" (mentioned in the June 1971 Newsletter, p 4; TAB Books, $10.95) gives schematics of Computer Automation's PDC 808 computer, which was designed for communications, control, and monitoring applications. The eleven schematics are: processor (4), processor timing circuits, processor control (2), memory regulator, driver switches, memory data, and Teletype control. The ICs are SN7400 and MC800 types. Values are given for all discrete components except the transformers in the core-driver circuits. This looks like most of the schematics; it may be all needed for the 808.

1103 Handbook

Get the 32-page booklet on the 1103, a 1024-bit dynamic MOS RAM chip, from Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051.

Magnetic Heads

Nortronics' "Design Digest for Mini-Digital Magnetic Recording" is a 32-page booklet on magnetic heads designed for minicomputers, desk-top calculators, I/O systems and other peripherals. The first 9 pages discuss technical considerations, 5 are on test procedures; the rest is product data. Nortronics Co., Inc., 8101 Tench Ave. North, Minneapolis, Minn. 55427.

Logic Systems Design Handbook

In mid-May, DEC will publish a "Logic Systems Design Handbook," which will be a user's manual of typical applications.

STARTED A PDP-8?

If you've built, or started to make, a copy of one of the PDP-8 family, please send info on your work, success, problems, etc., especially about getting a core memory to work.

FIRST ISSUE OF VOLUME THREE

ACS NEWSLETTER

a publication of the AMATEUR COMPUTER SOCIETY

Volume III, Number 1 (Serial Issue 24) June 1972

VOLUME III IS UNDERWAY

Thanks to all who mailed in checks so promptly, enough were received within only 40 days after mailing the last issue of Volume II to pay for printing and mailing eight issues of Volume III. Of course, the rise from $3 to $5 for a subscription meant that only half as many checks were needed.

A WORKING COMPUTER

Don Tarbell wrote from Alabama:

"My machine is now in working order! I have done quite a bit of programming with it in the past several months. My first piece of software was an editor, which enables me to type programs on the Teletype, into memory, and to modify them from the keyboard. The editor receives letters for commands: N for new entry, L for list the buffer, A for append, D for delete, I for insert, and P for print. The D, I and P are followed by the appropriate line number.

"The second piece of software I designed is the CALCULATOR. With it, I can add, subtract, multiply, and divide integers up to 256 digits long. It does not yet accept decimal points, but it will in the near future.

"I am still working on the third piece of software, the ASSEMBLER. It will convert symbolic programs into machine language, and will at first be a stripped-down version, later to be expanded, by using itself to create more subroutines.

"The machine is an 8-bit byte-oriented machine, all integrated circuits, with 16 8-bit file registers, and 4K bytes of core at present (soon to be expanded to 65K!). The 16 8-bit file registers are used for 5 16-bit index registers, 1 16-bit accumulator, 1 16-bit program counter, 1 8-bit terminator register, and 1 8-bit temporary register. The cycle time is at present 7 usec, but will be speeded up to 2.4 usec shortly. The 8-bit byte organization does not really slow things down, since six 8-bit transfers between registers can take place during one cycle. The byte orientation also speeds up list-processing-type subroutines, which will be used considerably in my work in artificial intelligence. Even with the 7-usec cycle time, I can multiply a 140-digit number (all nines) times itself in about 40 seconds.

"There are eight address modes: direct relative, indirect relative, direct indexed, indirect indexed, extended, literal, direct to X3, direct to X4. The last two modes use only one byte; the extended uses 3 bytes (instruction and mode, 16-bit address); and the rest use 2 bytes. There are 8 conditional jump instructions, all of which are relative addressing. There are arithmetic instructions which handle both single and double bytes: ADD, SUBTRACT, LOAD, STORE, and AND. One of the conditional jump instructions decrements an index register, then jumps if it is not equal to one. This is very effective for loop control. There is also a jump which may be in any address mode, and also a jump to subroutine.

"My present organization allows for 16 I/O devices, but this will shortly be increased to 256. The I/O devices I have working are: keyboard,

Teletype, cartridge tape write and read. The 8-track cartridge tape is useful as a paper-tape replacement. I run it about 100 characters per second. It is not yet as reliable as I would like it, but as I have error-checking write and read subroutines, it is no problem to read or write again if it is not correct. I use one track for clock and one for data, which automatically compensates for speed variations. I have a 6.5-million-bit disk, and am presently building its interface. I also have an IBM 727 tape drive, but it will have to wait for the disk. A friend and I also have a joint project: a CRT display. It is about half done.

"So I should have a big enough system in the near future to do some really meaningful work in the field of artificial intelligence. Right now, my machine has 45 active instructions, and I'll be adding about 20 more.

"One problem which set me back some was the fact that I had a 20-volt power line (for lamps) running next to an ALU control line. Well, a scope probe slipped, and zorked two of the TI SN74181N ALU chips. If anybody needs a couple of these with the 53 line non-functional, let me know. I learned one great lesson about using MSI: when using high-cost chips, be very careful to protect them against accidents such as this. Another thing I found is that interboard wiring on connectors using solder-lug-type terminals can turn out to be a mess. It's too late for me, but I advise anyone who is starting out to use wire-wrap if possible, or at least connectors with widely-spaced terminals.

"Another thing. I am using the 36-place DIP breadboards with 44-pin edge connectors. If possible, use boards with more connections, at least 56. Several times I have had to use another board only because of insufficient pin count. If you use TTL, always use plenty of .01-.1-uf capacitors on the board to bypass noise. Keep the main computer clock duty-cycle to a bare minimum. In other words, it should be a spike-type clock of, say, 100-nsec spikes. This is because many flip-flops are sensitive to what happens on their J and K inputs while the clock input is high. So if you have a control signal running to these inputs, then a spike for the clock allows the maximum time for your control signal to propagate through the logic. This was a major source of problems for me as long as I had a 50% duty-cycle clock.

"While designing your major-state generator (the counter that changes state once per memory cycle), keep in mind that it will need to be stalled in one position for halt, for I/O interrupts, and for direct-memory access. In control-unit design (about half my machine), I found it a good concept to make control lines wire-ORed or tri-state. In other words, when the machine is halted, the required position for the control lines in this state should be defined as normally high. Instructions are then implemented by "pulling down" the proper control lines in the proper sequence, with open-collector or tri-state gates (e.g., SN7401N is good). This organization allows you to build a minimum instruction set on one card which can be used to check out the memory and other parts of the system. Then instructions can be added on in logical sets. I also wire-ORed my 8 data-bus lines to allow attaching more registers."

INTEL MICRO COMPUTER SETS

Intel Corp. (3065 Bowers Avenue, Santa Clara, Calif. 95051) has two

"Micro Computer Sets," the MCS-4 and MCS-8, which are sets of LSI chips for microprogrammable general-purpose computers. The MCS-4 has a 4-bit parallel CPU with 45 instructions; the MCS-8 is 8-bit with 48 commands. The MCS-4 consists of the 4001 programmable ROM control memory (256 x 8-bit), 4002 RAM data storage (320-bit), 4003 I/O expansion (10-bit shift register), and 4004 CPU.

The last three are fairly cheap: $50, $10, and $100, respectively, for 1 to 24. The catch is the 4001; you have to order at least 25, at $25.50 each, plus mask charges of $600. If you don't know exactly how you want the 4001 ROM custom-programmed by Intel, you can do it on a cut-and-try basis with electrically programmable ROMs such as the 1601, 1602, 1701 or 1702, which are $91 to $109 each, for 1 to 24. You can have these ROMs programmed by Intel for $10 if you provide the tape, or $90 additional if Intel prepares the tape.

To program one of these ROMs yourself, you need the SIM4-01 microcomputer ($500, or you can build one from the schematics in the MCS-4 user's manual), MP7-02 programmer board ($400; schematics also available), three control-program ROMs at $101 each ($91 plus $10 for programming), and one ASR-33 Teletype.

The MCS-8 is not just an 8-bit MCS-4; for details see the 45-page brochure. An MCS-8 is made up of an 8008 CPU chip that contains circuits quite different from the 4004, and which costs $200 for 1 to 24; RAMs (such as the 1101); ROMs (such as the 1701) and TTL interface circuitry. To program a 1701 (or 1601) yourself, use the same setup as for the MCS-4, except that you use a SIM8-01 microcomputer at $900, along with the MP7-02, three control ROMs, and an ASR-33. All in all, if you want only one MCS-4 or -8, it's cheaper to buy a SIM4-01 or SIM8-01 and add ROMs and RAMs.

THE TRADING POST

RPC-4000 Parts?

Lyle Bickley (2351 Ridley Creek Rd., Media, Pa. 19063) writes:

"I recently purchased an entire RPC-4000 system which was in working order for $1000, less shipping. It consists of an RPC-4010 CPU with 8K of 32-bit drum memory and a RPC-4437 I/O control unit, Tally paper tape reader (120 cps), Tally paper tape punch (60 cps), and an 180XE console typewriter. Thrown in "free" was a Flexowriter in good working order. The entire system required a good deal of cleaning up and the I/O gear needed adjustments and preventive maintenance. I have completed all this, having easily obtained the service manuals from CDC and Tally. There is a complete set of diagnostic, assembler, compiler and problem-oriented program packages available from the CDC user organization, FOCUS (Forum of Control Data Users).

"One can purchase RPC-4000's (also LGP-30's and LGP-21's) directly from organizations upgrading to more powerful equipment. The names of these organizations are available from CDC salesmen or from ads in the FOCUS newsletter.

"I am interested in finding some parts of RPC-4000 equipment, especially a 300-cps Ferranti reader, and spare heads for the drum."

A Store in Dallas

KA Sales (1312 Slocum St., Dallas, Texas 75207) sent a flyer showing some EDP hardware, such as a "World Computer Unit" containing 58 Signet-

ics Unilogic ICs, power supply, etc.; and also used Nixie tubes, computer-grade capacitors, etc.

TTY Parts for Sale

Per Biorn writes from N.J.: "A friend of mine sells TTY equipment and ham stuff. Although a rather sharp businessman, he is a helpful fellow and has quite a few goodies in his shop. It is also possible to get TTY parts from him at reasonable prices. His address is: Van, W2DLT, 302 Passaic Ave., Stirling, N.J. 07980. He has a catalog he will be glad to send. Or call him at (201) 647-3639, at night only. Say Per sent you; it may (or may not) help."

Computer Parts for Sale

Gary Forbes (2028 W. Indian School Rd., Box 100, Phoenix, Ariz. 85015) writes:

"Your members may be interested in some computer parts I have for sale, some of which are: (1) computer-to-EIA interface boards (all ICs), (2) discrete logic which is compatible with TTL (this is a complete logic line), (3) a nice 32K x 20-bit ½-usec memory, complete except for power and computer interface, (4) a real nice core controller; this is a small IC sequencer and address and parity checker for an 18-bit word, (5) a lot of nice ICs mounted on boards, mostly TTL Sylvania SUHL II, (6) good technical assistance in getting these things operating. I have copies of many of the manuals."

Later Gary wrote to say he also has several boards out of a GE DN500 Datanet, an IC version of the DN30; "these cards would make into a nice minicomputer, I have some of the CR10 table-top card readers at $75 and an I/O interface board at $25. I have several core memories. The most complete ones are 2-usec Ampex 36-bit plus parity, 16K words. Some of the other core stacks I have are (1) 16K, 2 usec, 37 bits (2) 16K, 2 usec, 24 bits (3) 5.6 usec, 1K, 8 bits (4) 10 usec, 8K, 20 bits. Most of the memories are available with drawings and technical info to get them running. Another item is a 300-lpm 120-colum line printer. This stuff comes out of General Electric large computers. A friend and I are rebuilding a GE computer and hope to have it running soon."

A N.J. Member Has...

Wayne Ely (209 Lees Ave., Teaneck, N.J. 07666), who writes that he got a PDP-8 without core for about $1000 from Maynard, Mass., wants to sell a 728 tape drive, complete with maintenance manuals; this is the old tube model; $125, you haul. Also a switch panel, $50. And some core array from an IBM computer, 3 feet square, 16 planes with 4x4 arrays. Wayne needs PDP-8 core and an ASR-33 and PDP-8 cards for extended memory and extended arithmetic, etc.

Integrated Circuits

Steve Wiebking saw in Electronic News an ad for Intel-compatible 1101's, at $5.50; 1402, 1403, 1404 at $6.50; 2150 256-bit TTL RAMs, $28.50; for 1 to 100, $10 minimum order, from: Roni Discount Electronic Supply Co., 61 First St., Derby, Conn. 06418, (203) 735-9333.

Used DEC Computers and Modules

American Used Computer Corp. (15 School St., Boston, Mass. 02108) sells a 4K PDP-8/L or 8/I for $3000, an 8K 8/I for $6500, and a 12K 8/L for $8000. They have various DEC peripherals, from $1K to $3K, such as a TU-55 DECtape for $1200. And DEC modules (series B, G, K, M, R, S, W) and hardware such as 8/L racks, power supplies, etc., at 35% off DEC prices.

MORE ABOUT INTEL'S MCS

The MCS-4 directly drives up to 16 of the 4001's and 16 of the 4002's. Without a 4003, there are 128 I/O lines; with 4003's, I/O is unlimited. Minimum MCS-4 is one 4004 CPU and one 4001 ROM.

The MCS-8's 8008 CPU can directly address 16K x 8 bits of memory (any mix of RAM (including the 1103), ROM or shift register), and 32 different I/O ports.

HARDWARE

Dynamic Digital IC Tester

The May 1972 Radio-Electronics has a construction article, "Build R-E's Digital IC Tester," (pp 33-36, 85). Heart of the Digi-Dyna-Check is a 20x10 matrix switch that connects various inputs to any of the DIP pins; these inputs include 0, 1, a stepping pulse from a push-button, and an internal 50-kHz clock. Sixteen lamps monitor the logic levels. External input to and output from the IC is connected through binding posts. An adapter cable permits in-circuit testing of ICs.

The June R-E (pp 55-59) tells how to use the Digi-Dyna-Check, and is mainly concerned with how to set the matrix switch for the various ICs (SN7400 series, mostly) and then how to test them.

The July R-E (pp 59-61, 94) shows how to use the Digi-Dyna-Check in breadboarding circuits. A complete kit for building the DDC is $79.95 from MITS; a manual listing the pin connections for over 500 ICs is $2.75.

DEC PDP-8/F

The new PDP-8/F is exactly the same as the 8/E, except that it isn't as deep — it has room for only 20 card slots for expansion, instead of 40. So the 8/F is for the user who knows he'll stay within those 20 slots. The 8/F is $3990; the 8/E is $4990. If the 8/F user needs more than 20 slots, he can buy an expander box for — guess — $1000.

LED Edge Card Lights

Monsanto has introduced low-power edge card lights, for diagnostics and for indicating malfunctions. Typical operation is 15 mW at 5 volts, 3 mA. An internal resistor permits operation at 2.2 volts, with maximum set at 6 v DC. The lamps can be stacked 10 to the inch, and they fit in standard DIP sockets. Price for 1 to 9 is $2 each, from Monsanto — Electronic Special Products, 10131 Bubb Rd., Cupertino, Calif. 95014.

LSI for a Calculator

The Nov. 1970 Newsletter (p 3) mentioned the Electronic Arrays set of 6 MOS LSI circuits for a 16-digit calculator with 8-digit display capability; price, 1-10, $158.46, for 11-49, $144.06.

Now there are two cheaper sets from Electronic Arrays, the S-101 and S-114, for 8- and 16-digit entries. Each set consists of four chips: input, control & memory, arithmetic & register, and output. Both sets provide add, subtract, multiply, divide, stored-constant operation, keyboard setting of decimal-point location, and BCD outputs for display control. For 100 to 249, $40.

An Expensive Kit

Lockheed has developed a modular line of minis called SUE (System User Engineered), which involves a kit of parts from which you select the various ones you want: basic chassis, CPU, core, I/O controllers. One minimum configuration, with 4K

The Amateur Computer Society is open to all who are interested in building and operating a digital computer that can at least perform automatic multiplication and division, or is of a comparable complexity.

For membership in the ACS, and a subscription of at least eight issues of Vol. III of the Newsletter, send $5 (or a check) to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Avenue
Darien, Conn. 06820

The Newsletter will appear every two months or so.

of core, costs $3425 each.

Minuteman Computers

Computerworld notes that "only about five of the 100 installations actually have their D17's running." These 100 are the members of the Minuteman Computer Users Group.

Computer-Generated Grey Shades

According to Computerworld, Computax Corp. uses computerized graphics in their office interior design. Variable density was achieved by using ten shades. The #0 shade is blank; #8 is superimposed O, A and X; #9 is superimposed O, A, X and V. Different fonts may require other combinations. The 10 shades:

```
 0  1  2  3  4  5  6  7  8  9
    ...'''===+++XXXOOOOOO
    ...'''===+++XXXOOOOOO
```

More on Scopes

That Heath/Schlumberger EU-70A dual-trace 15-MHz scope, mentioned in the previous newsletter as available assembled for $595, is also available as a kit, model IO-105, for $430 from a Heath store.

And as for electronic switches, the 10:1 rule does say that the highest frequency to input to an electronic switch should be no more than a tenth of the switch's switching frequency. However, in practice it has been found that ratios as low as 2:1 are often suitable, so that if the electronic switch's top rate is 100 KHz, you can input up to 50 KHz without missing too much in the chopping of the signal. Beyond these limits, you either have to examine one signal st a time, or use a dual-gun scope.

TI's Low-Priced Minicomputer

Texas Instrument's 16-bit 960A, with a 750-nsec cycle time and 4K words of semiconductor memory, is $2850, for 1 to 100. The 960A is built with standard 7400 TTL MSI. The CPU is on one 10-layer board, with a front panel also formed from a circuit board. LEDs are used in the panel display. Added MOS memory is $1500 per 4K words. Software includes Fortran, monitors, loaders, microprocessors. For OEMs.

Heathkit Peripheral Interface

A do-it-yourself peripheral interface kit for the PDP-8 family of minis (L, E, M or I), the Heath/Schlumberger "EU-801E Computer Interface ADD" costs $1250, consists of the three-module Analog-Digital Designer (see the Aug. 1968 Newsletter, p 4), an interface-buffer assembly, and a workbook.

A GENEROUS OFFER OF HELP

E. Douglas Jensen (M.S. A3340, Honeywell, Inc., 2345 Walnut St., St. Paul, Minn. 55113) writes: "Since I design computers for a living, and also have a lot of contacts in the surplus and excess inventory business, perhaps I can be of help to other members. Anyone is free to write to me on either topic."

HAL-4096

ACS NEWSLETTER

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HAL CHAMBERLIN'S COMPUTER

According to Hal (Howard) Chamberlin's Survey Form, his operating "HAL-4096" computer has 6 registers and is 3/4 made of IBM cards, 1/4 home-built cards. Core memory: IBM 1620 stack, 16-usec, 4096 16-bit words. I/O is Selectric typewriter, paper tape reader/punch, dataphone. The clock speed is 1 MHz; there are 16 instructions. Add speed: 3 µsec carry propagation, 16 µsec total.

Special features: "16 index registers in upper core, 6-level nested priority interrupt system, programmed I/O to slow devices in 2 groups and 2 independent data channels for fast devices. Trace interrupt permits control program to trace untried program on console typewriter. 4-level priority memory-access scheme." The CPU cost $500, total time was 2½ years to build, with wire-wrapped construction.

Other information: "Paper-tape reader is entirely homemade, with step-motor drive, 125 char/sec; photocell read; total cost with new step motor, $45. I/O devices available but not connected: 384K-word drum, two 7330 tape drives, two 100-cpm card readers, 180-column/sec card punch, alphanumeric keyboard, facsimile machine. A home-built line printer is 1/3 complete; 52-character chain, about 200 lpm. Current use is object machine for computer science class projects. Current programming project is a 4 remote user (by home-built dataphones) Basic-language time-sharing system."

Hal has written 20 pages of notes and schematics, "Using Complete 1620 Memory Units for Binary Addressing." Here are some of the notes:

"This set of drawings and plans represents the original work I did in adapting a complete 1620 memory unit for operation in a 16-bit homemade computer. The method used for converting to binary addressing was optimized for minimum alteration of the unit itself and simplified driving circuitry at the expense of speed. The unit that will be described has been built and operating for about 6 months. Reliability has been perfect. The complete 1620 memory stacks may be purchased from Mike Quinn Electronics, 727 Langley St., Oakland Airport, Calif. 94614, for $175. They include a stack of 12 planes of 10,000 bits each, divided into two sense-inhibit groups each, and X and Y-axis switch core matrices. No electronics are included.

"Statistics on the unit built are as follows: Cycle time, 16 microseconds full cycle read, write, read-modify-write, 6 microseconds access. Size: 4086 words of 16 bits each, 12-bit binary addressed. Special features: split-cycle operation; a cycle may be suspended halfway through it, the data in the memory data register may be manipulated, and the cycle restarted. The data in the memory data register will be written back into the same location. The memory data register is also an up-down counter so that the contents of a memory location may be incremented or decremented in only one cycle. Writing in a location can be all bits, the upper 8, the lower 8, or the lower 12. Where only a portion of a word is written, the rest of the word is unaltered.

"The only modifications made on the memory stack were the cutting of 4 jumper wires on the switch core matrices and bringing the free end of

the jumpers out to the wire-wrap terminal boards. Conversion from the decimal addressing to binary addressing was accomplished with 12 3-input NOR gates, 12 2-input NOR gates, 4 4-input NORs, and 12 inverters. The current drivers are simple saturating switches capable of carrying 350 ma; 40 are used. The drivers have 5-input NOR inputs; all inputs must be logical zero to have drive current. The other logic gates should be capable of dot-ORing. In this design, 4 planes in the stack were wasted. If one wants a 24-bit word, all that would be required is 8 additional sense amplifiers and inhibit drivers. No modifications to the drivers should be necessary. A slight change in address decoding logic would allow 8192 locations of 12 or fewer bits.

"The logic gates, sense amplifiers, flip-flops, and inhibit drivers are all of IBM origin. The current drivers are an original design. Circuits of all plug-in cards are given so that the entire unit could be duplicated, given a good supply of IBM parts boards."

The remainder of the 20 pages contain a page on address decoding and driving, another on the procedure for aligning the drivers and sense amplifiers, and schematics for a timing signal generator, X and Y switch core matrix decoders and drivers, memory data register, and the various NORs, inverters, amplifiers, drivers, etc. The last three pages concern memory driving with ICs, with four schematics.

Ferranti 371-12A Memory Drum

Hal next sent 13 pages of text and schematics on a Ferranti drum. Part of the text is as follows:

"This memory drum is currently being sold for $295 by Herbach & Rademan [401 E. Erie Ave., Phila, Pa. 19134] and is ideal for the advanced amateur computer builder. Although there is space for 480 tracks on the drum surface, only 384 data heads are mounted. As a result, if part of the surface is damaged (H&R do not guarantee a perfect surface, but I haven't found any bad tracks yet), the affected heads can be moved. Along with the data heads there are 6 clock tracks with heads. A read clock, write clock, and index clock along with a spare for each is provided. Actually, I use only the read and index clocks, since the write clock is simply a delayed version of the read clock. The index clock, in conjunction with the read clock, will generate a pulse each revolution at the beginning of the data tracks."

There are schematics for bit and track timing circuits, drum matrix driver, drum amplifier, peak detector, drum write driver, etc.

Plans Available

Later, Hal wrote, "I would be happy to provide copies of the 1620 memory plans to interested people for $2.00. I can reproduce and mail the Ferranti drum information for $1.50. [Hal Chamberlin, 516-B West Cabarrus St., Raleigh, N.C. 27603].

"I would emphasize that the 1620 stack is very flexible in that 8192 locations of 12 or fewer bits are possible for short-word fans, and 4096 words of 13 to 24 bits can be done also simply by rearranging circuits slightly. The cycle time of 16 µsec is unaffected by the word length chosen.

"For people who prefer faster cycle times with more costly drive circuits, I am completing a similar set of plans for a diode-matrix drive which will cycle in 4.5 µsec. The drive circuits can drive any memory of 30, 50 or 80-mil cores with half-select currents of 350 ma

or less. The 4 basic circuits (source-sink drivers, inhibit drivers, sense amp-data register, and load resistors) are laid out on 22-pin edge-connected single-sided circuit boards. I can soon offer a complete package for $5.00, on these universal memory-driver cards, including theory of operation, schematics, timing diagrams, instructions on how to adapt to nearly any kind of surplus memory stack, and a set of layout negatives along with assembly diagrams. All components are readily available on the surplus market from a number of suppliers, and all circuits generate 7400 TTL outputs and accept TTL inputs.

"Any interested person can have a copy of the principles of operation manual on my computer, and a sample program, for 50¢."

Other Surplus Available

"For the moderate-size-memory maker, two items have shown up in surplus catalogs lately. First, Star-Tronics (Box 17127, Kenton Station, Portland, Oregon 97217) is offering a 1024-word by 8-bit, 50-mil core memory stack for $20. The selection diode matrix is included and all connections terminate in a connector with mate supplied.

"A perfect complement is a PC board sold by Delta Electronics Co. (P.O. Box 1, Lynn, Mass. 01903) for $12. This board has all of the source-sink drivers, inhibit drivers, and sense amplifiers for two of the Star-Tronics memory stacks, which would provide 1024 words of 16 bits each with about 6-usec cycle time. The only items needed for a working memory are a timing generator, a handful of 3-input gates for address decoding, and 8 dual D flip-flops for a data register. Inputs and outputs are TTL compatible. Delta also has another board for $20 which appears to be the same thing except for a 4096-word by 16-bit memory."

Hal's Uses of HAL

"As to what kind of programs I run on my computer, the story goes something like this: The computer was built to control an electronic music synthesizer (analog) which I built up during high school for science fairs. In the course of building the computer it became clear that the synthesizer could be greatly improved if the analog circuits were replaced by digital circuits. So here I am with a computer and without a satisfactory music synthesizer to connect it to.

"I have two friends who are regular users and who are helping write a firm software base. So far we have written a full-function debug program which doubles as an operating system, a complete in-core assembler, and are about 75% finished with a 4-user timesharing Basic system. When the hardware catches up, access to the Basic system will be on a dial-up basis from any standard Teletype terminal. Since the compiler, interpreter, telecommunications routines, and math routines take up nearly 3K words, a 20K-word memory expansion is being put on to give a reasonable-sized user partition. My Herbach & Rademan drum should be up in 2 or 3 months, which will give users the ability to save programs and data."

Home-Grown Instruction Sets

"At this point I wish to take issue with Bob Carpenter's remark March 1972 Newsletter about "home-grown instruction sets." The HAL-4096 has a homebrew instruction set which seems to be optimized simultaneously for simplicity and effectiveness. The simplicity is borne out by the fact that the softwear mentioned above has all been written and debugged since last December [6 or 7

months ago]. The effectiveness shows when a full-function assembler fits in 1200 words, or a stripped assembler (such as PAL-III for the PDP-8) fits into about 750 words. The floating-point package is 30% smaller than the one supplied for the IBM 1130, which uses the same data format, and the 1130 has automatic multiply/divide!

"In short, I think that a big part of amateur computing is programming and discovering programming tricks that can be done with one's own instruction set. To me, copying a production machine's instruction set is like building a kit, in that you can't honestly say that the final result is all yours. Anyway, commercial machines with decent I/O provisions are way too expensive. If you exclude the 453 oscilloscope, then the computer, I/O gear, 40K words of add-on memory, and drum have all cost less than $1500.

"At any rate, I still plan to connect the machine to a digital music synthesizer (the design of the synthesizer is my Master's thesis topic), an organ keyboard, and a graphics display so I can experiment with computer-aided composition and performance of music. When the hardware is ready, I would also like to set up an amateur modem network with other members' computers which have data modems."

Hal sent a photo that shows the console keyboard set into one end of an L-shaped desk, with the CPU and its lamps and switches directly behind, in a cabinet about 6' high, 3' wide, and maybe 6' deep. At the other end of the desk is a Selectric typewriter; in between is the 453 scope for alphanumeric display. To one side is steel shelving with the tape reader and punch, facsimile machine, etc., and next to that the magnetic-tape drives. Most of it is in quiet, pastel shades of green and yellow, and blue.

WHAT OTHER MEMBERS PLAN TO DO

The latest version of the Survey Form asks "What kind of programs do you intend to run on your computer when operational?" Here are most of the responses so far:

Engineering calculations, statistical data reduction, data storage and retrieval, entertainment graphics, perhaps automatic machine-tool control (Durk Pearson, Calif.). Computer-generated music (J. Hemenway, Calif.). Games, personal income tax, bookkeeping, etc. (Steve Marum, Ind.). Data storage, number crunching with "programmable calculator," computerized music (G. Chamberlain, Fla.). Mostly educational programs (Dale Schutte, Ariz.). Interpreter, compiler, assembler, editor; real-time applications; i.e., monitoring, timing (Bob Diffely, Ore.). Accounting programs (tax, general ledger, financial, etc.)(Jim Law, Tex.). Usual games and desk-calculator-type programs, and simulation and learning programs. Would like to try multiprogramming when core and drum permit (Pete Bayly, Ontario, Canada). Number experiments, linguistics, CAD for a bigger machine, high-school student math projects, home economics (Jerry Bryson, Va.).

Fortran CAD programs (Rickey Caldwell, Okla.). Desk calculator, computer demonstrator and trainer, music synthesizer, and processor for a programmable terminal (Elmer Beachley, Pa.). The first task will be to write utility routines and an assembler. After that, I am primarily interested in exploring the development of new languages designed to allow non-programmers to utilize computers. One example might be something to permit young children to interact with a computer. Another might be a language to facilitate programming of games. Of course, I also intend to write household ac-

counting programs and things like that (Gene Witherup, Pa.). Intend to use machine as proving grounds for software systems experiments, and eventually to build a time-sharing machine (Ira Baxter, Cal.). General purpose; e.g., home "MIS," possibly service-type operation. Hope to develop commercially (Jim Melton, N.J.). Mainly for educational purposes (Michel Dreyfus, France). The machine will be used for dedicated real-time control of a robot (Chris Dewhurst, B.C., Canada). Artificial intelligence (after assembly language and operating system are written)(Ron Carlson, Calif.). Statistical analysis, computer-aided education, and language translation (George Dinsmore, Calif.).

THE TRADING POST

A Garage Full

Ron Carlson (6717 #44 La Cienega, Inglewood, Calif. 90301) has "an entire garage full of stuff that needs cleaning out," and will sell (1) a Douglas experimental digital computer in two 6-foot relay racks, without backpanel wiring; all schematics; will deliver within 75 miles, $60. (2) Two Goodyear analog computers, 24 amplifiers each, two patchboards each, one set manuals; 600 lb. each, so bring a trailer; $400 each, $600 both. (3) Teletype model 18, 4 char/sec, $100. More information on request.

IC Mounting Boards

Gary Forbes (2028 W. Indian School Rd., Box 100, Phoenix, Ariz. 85015) has "some real nice boards for mounting 14-pin ICs. They are mounted dead (pins up) and soldered to wire-wrap pins. This board will mount 200 ICs. One side of board is $+V_C$, other is ground. The mating connector will handle 6 of these boards. Boards, $3 each; connector rack, $6. I think this would solve the IC-socket problem if you're willing to solder the ICs."

PC-Board Layouts

Peter Stark (196 Forest Drive, Mt. Kisco, N.Y. 10549) has several PC-board layouts he'll send you for a self-addressed stamped envelope: (1) frequency counter (to 20 MHz), uses Fairchild ECL and 7400 TTL, Numitron or LED readout (costs $90 with all new parts), ECL scaler (about $25) extends range to 300 MHz (see 73 magazine, May, June, Sept. 1972); (2) touchtone decoder.

HELP WANTED

Bendix G-15 Computer

Charles Kiessling (P.). Box 539, Endicott, N.Y. 13760) is rebuilding an old Bendix G-15 computer, and is "interested in contacting others with G-15's either as hobby or business."

AWCIS MA-1 Computer

Alvin Marshall (412 Oakwood St., Angola, Ind. 46703) is "thinking of using the drum unit from an AWCIS MA-1 computer -- some sort of USAV Nav-Attack system -- as a file unit. Has anyone used one? What is the drum speed, what data rate - bpi - did you use, what did you use to drive the heads? Any problems with the drum coating, heads, etc.? If anyone has a drum and no data, I have prints for head-to-socket-pin data. Send a SASE and I'll send you a copy. Would be glad to hear from anyone using disk/drum for fast mass memory."

Associative Memory

Darrell Foster (8220 Research Blvd., Apt. 173C, Austin, Texas 78758) would like to know if anyone is working on a "general purpose" associative memory or processor.

The Amateur Computer Society is open to all who are interested in building and operating a digital computer that can at least perform automatic multiplication and division, or is of a comparable complexity.

For membership in the ACS, and a subscription of at least eight issues of Vol. III of the Newsletter, send $5 (or a check) to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.
Darien, Conn. 06820

The Newsletter will appear every two months or so.

His computer "is not going to be designed around the CPU, but around the memory (e.g., to give the memory a data-processing capability). As is indicated by various computer projects (e.g., CDC's STAR, TI ASC), the wave of the future is in high memory utilization (not high CPU utilization alone.)"

Ampex Memory Unit

Louis Taber (3520 N. Prescott Pl., Tucson, Ariz. 85715) asks for information on an Ampex memory unit, model MA6, Assy. No. 3227339-10 M, Issue No. 088.

HARDWARE

More on the NRI Computer Kit

The 16-pound desk-top 832 computer is built as part of a $500 National Radio Institute course (March 1971 Newsletter, p 3).

ACS member Louis Frenzel, who designed the 832 for NRI, and is their Director of Instruction and Product Research, has very kindly arranged to make the 832 Reference Manual 10KX available for $10, if there is enough demand. The manual contains block diagrams and full schematics, with all component values except the power-supply transformer and rectifiers.

The 832 computer will soon be offered separately from the course, in wired form, for $600-$700. There are 16 8-bit words in a read-only memory consisting of slide switches. For another $35, the student gets another 16 words of semiconductor RAM memory, plus the 11K manual on how to install the RAMs, along with 10 programming experiments including square root, floating point, and some games.

The ten PC boards will be available for about $10, without ICs or IC sockets or terminals. If you're interested in either the manuals or boards, write Louis E. Frenzel, Jr., National Radio Institute, 3939 Wisconsin Ave., Washington, D.C. 20016.

The full 832, with bipolar RAM memory, consists of 74 ICs, 7400 types. The 832 has 15 instructions.

The 10K manual contains ten programming experiments for the 832, and the assembly manual has a set of diagnostic programs for checkout.

Digital Kits

Environmental Products (Box 1014, Glenwood Springs, Colo. 81601) has a 52-page catalog that includes quite a variety of counter/display modules, with both LED and Numitron (vacuum-tube) segmented displays, and several types of counters, plus several assembled instruments, 7400-series ICs and other components. No surplus, all new from the factory. Quarterly, they publish application notes, mostly digital, for $5 a year, and they pay authors for new notes. EP invites ACS members to submit circuits.

ACS NEWSLETTER

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BOB BENJAMIN'S COMPUTER

From Texas, Bob Benjamin first sent the following:

"I read your article on building your own computer. I have built one and thought you might be interested. I'm an electronic engineer with LTV Electrosystems. Never had digital experience. Built the computer to learn. Now doing digital work as a result. Started October 1968, was operating stored programs by Feb. 1969. Have added instructions and I/O features since....

"Started with model 19 Teletype and worked I/O first. Memory: 62 words, 25 bits, dynamic shift register.

"Registers: ACC, MQ, 1 Index, I/O status, program count save for subroutine save. Arithmetic: 2's complement; add, subtract, logical And, mult, divide 2's comp, increment ACC, clear + add, clear ACC, etc. Branches: jump if minus, not zero, unconditional; decrement Index and branch if not zero.

"Five-bit byte symbol string oriented. "FIGS" used as op code prefix for digit keys causes automatic decimal to binary conversion into ACC. If op code (5 bits) needs address, next byte is address. FIGS prefix on address op codes causes displacement by index register value.

"Op codes semi-mnemonic: AX means Add contents of location X to ACC. D = divide, M = subtract, L = load ACC ⇆ Index register, X = multiply, S = store, O = output one byte off ACC to TTY and shift 5 bits, C = clear ACC, H = halt, etc.

"Word organization for programs is 5 consecutive symbols - address not in particular bit positions - reads symbols in sequence - ops that don't need address just 5 bits then next op examined.

"Binary to decimal conversion and print on TTY is software but takes only 8 words (less for positive numbers). E = external execute, takes instructions from paper tape if actuated or from keyboard if tape not actuated, such as for loading bootstrap program. Some op codes required an extra byte, use next 5 bits as modifier, such as for shifts: long, short, left, right, circular, non-circular, etc.

"Some software: wife's adding machine, desk calculator for me, random flash-card exercises for children with messages typed to user, line by line text edit.

"FIG F in program prints following message until FIG H, then proceeds to compute "F" by itself, prints next symbol such as for decimal point. Each key on Teletype is a potential address (31), "LF" changes pages of memory. Machine serial and very slow; 100-kHz clock, 400 symbols/sec execution. Following is a program example for binary-to-decimal conversion and printing result:

Program	Loc. Letter	Loc. Bin.
(#1,000,000)	E	01
F - N G SP	LF	02
J LF F + SP	A	03
L C FG 7 L	SPACE	04
D E Z Q Ø	S	05
I S F CR F	I	06
LF R SP SP SP	J	07

"Main program would say RGA, meaning Return Go to location A (03). R remembers program count by swapping with 5-bit register. J LF (02) means jump if ACC neg to location LF (02). F - means print a minus sign. N = negate ACC. G SP, go to location SPACE (04). L = swap ACC and index to save ACC. C FG 7 = clear ACC, loads binary 7 to ACC. L = swap index and ACC. D E = divide ACC by E, 1,000,000. Z = print digit of 4 LSB's of ACC (quotient ends up in ACC, remainder in MQ). Q = swap ACC with MQ to get remainder. Ø = mult ACC by 10. I S = decrement index, if not zero go to location S (05), otherwise continue. F CR F LF = print carriage return and line feed. R = return to main program. (Spaces are no op.)

"Branch points must be beginning of 5-symbol block. Numbers are 24 bits and sign. This machine has been functioning for 2½ years. Made for $400 with samples and surplus. Have a 4K core memory now that this computer can read and write with -- planning PDP-8 with old computer primarily as ASR33 simulator and executive control."

Bob's second letter said, in part:

"Scientific Controls Corp. in Dallas went bankrupt and had an auction. Couldn't make the auction but friend bought me a 4K x 12-bit complete Fabri-Tek memory system (new) for $25. I've added a general I/O instruction to old computer to talk to it. Can load data and retrieve data with 12-bit address and 12-bit data from ACC of old computer. Have loaded TTY pictures and played back. Also have run worst-case test patterns.

"Plan is to build PDP-8/I. Got all ICs for 1½¢ apiece, including such items as 1-out-of-16 decoders at SCC auction.

"Design of computer was at random, no previous conceptions or books, except Richards' "Arithmetic Operations in Digital Computers." Machine is serial. The 25-bit word was shortest National Semiconductor dynamic shift register. Also, machine was originally wanted for stock market, and 25 bits is approximately correct for personal finances and hopes 300,000 dollars (wishful thinking). The PDP-8 software can be bought for a nominal fee including FOCAL which would make a nice home scientific machine.

"Incidentally, I find my easy-to-program computer more useful for doing some work problems than the IBM 360, H-P 9100B, or Raytheon 703, particularly in simulating digital algorithms related to hardware."

In his third letter, Bob notes:

"I've been amazed at how useful only 62 words (two 31-word pages) of memory can be when symbol byte oriented. Memory size has not yet limited what I have wanted to do with the machine. If the problem is much larger it is done at work on the 360/50."

HISTORICAL PERSPECTIVE

Doug Jensen, who kindly offered to help ACS members with design problems (June 1972 Newsletter), writes:

"I cannot imagine better advice to an ACS newcomer than for him to read straight through from issue 1 to (the current) issue 24. The historical perspective of computer technology that can be obtained could well be one of the most important benefits he receives from his amateur computer activities. Semiconductor cost/complexity curves have changed

by orders of magnitude over the design cycle of a typical ACS computer. This will continue to be true: SSI circuits will be 10¢ and microprocessors such as the Intel 8008 will be $25 in the near future. ACS members should carefully consider their motives and goals in the light of rapidly changing technology. Even if a builder's principal objective is to acquire engineering experience, it is still frustrating to see hundreds (even thousands) of hours and dollars be replaced by a $10 IC. A member who is more concerned with having and using a computer would be wise to concentrate on the systems and software aspects of the machine rather than the detailed design of its processor. Even if it were free, the 8008 is not much of a processor — how could you build a more capable machine from several of them? Learn to program the PDP-11 and/or the Nova — the next generation of IC processors will have instruction sets which are compatible with these popular minicomputers."

In an earlier letter, Doug wrote:

"Much more sophisticated 16-bit and larger processors are now imminent from several major IC manufacturers. Some of these will be directly program and I/O compatible with today's popular PDP-11 and Nova minicomputers. Many other valuable units (such as complete 103-type modems) will also be introduced soon as LSI chips. This indicates that perhaps amateur computer builders should stop worrying about a level of design which for the most part they are ill-equipped to cope with. Vol. 1, No. 8 noted that successful members have been professional EE's. The availability of low-cost TTL ICs may have altered that situation slightly, but the emergence of LSI subsystems should allow serious hobbyists to construct their own machines. This goal will still require substantial technical knowledge, and in some cases the traditional EE will be no better prepared than the amateur. For example, LSI microprocessors like the 8008 may be inexpensive, but they are also very low performance, which raises the question of how to effectively interconnect more than one of them to increase throughput. This is a very broad and complex problem that is the subject of study at many corporations and universities.

"In the area of excess inventory, I list below several sources that I have found to be productive. Few, if any, of these advertise in national media; most do not have catalogs or mailing lists — write and tell them what you need.

Vide Corp.
1918 Ottawa
Houston, TX 77043

Teco
P.O. Box 1050
Garland, TX 75050

AC Equipment
10616 Hempstead Hwy.
Houston, Texas

KA Sales
1312 Slocum St.
Dallas, TX 75207

Acme Electronics
224 washington Ave. N.
Minneapolis, Minn. 55401

Gordon Elliott White
1502 Stonewall Ave.
Alexandria, Va. 22303

"It should also be noted that large companies everywhere frequently operate surplus stores; these almost always require personal visits. Another extremely good way to find components, subsystems, and even complete systems, is to attend electronics company bankruptcy auctions. These are usually advertised in the local papers; some auctioneers maintain mailing lists. You must attend personally and bring cash, but even travelling a consid-

erable distance can sometimes be worth the time and cost. However, not everything sold at an auction is a bargain — particularly beware of test equipment, which often goes for near new prices.

"I am afraid that I am unable to assist your readers in the design or selection of core sense amps and drivers.

"I have for sale some new, factory-sealed Lambda 5V/48A power supplies. These are 3½" rack-mounted units. The manufacturer's current price is $475 each; my price is $150 each. [Doug also has Augat 8136-PG1 high-density DIL packaging panels, new, unused, list price over $350, for $100. Also for sale: a variety of IC's, mainly SN7000N types, at "10% less than any advertised prices."]

"I do quite a bit of consulting in the area of computer organization and design; I would be happy to donate whatever assistance I can to your readers. My response time is always a function of my business commitments. I encourage that requests be sent on cassettes; a phone number where the individual can be reached during the day will allow me rapid reaction to particularly time-critical or interesting problems."

Doug is a Principal Research Engineer/Scientist, in Computer Technology. His address is: E. Douglas Jensen, M.S. A3340, Honeywell, Inc. 2345 Walnut St., St. Paul, Minn. 55113. (That's Honeywell's Government and Aeronautical Products Div.)

CALCULATING WITH BASIC?

The thin, fuzzy line between computers and calculators seems to have been erased by the Wang Laboratories 2200, which is the first calculator that operates in Basic language. The 2200 looks like a terminal, with an 8-by-10½-inch CRT display, cassette data store, and keyboard. The keyboard has a key for each Basis instruction (which is fast and also reduced errors), numeric keys, exponential and math function keys, plus 16 special-function keys to which subroutines can be assigned by the user.

The microprogram architecture involves a 6-kilobyte braided-wire read-only memory, used instead of MOS because it's cheaper. The basic 2200 has 4096 program steps, expandable to 32K steps. The CRT shows 14 lines of 64 alphanumeric characters per line.

The 2200 is modular: the CPU with 4K programming steps is $3500; additional 4K steps are $1500 each. The combined CRT and cassette unit is $2500; CRT alone, $1500. The keyboard is $700. So a minimum 2200 is $6700; without cassette storage, only $5700.

Hewlett-Packard's 9830A (Model 30) calculator was announced a few weeks later. The Model 30 looks more like a combination typewriter and calculator, with integral 32-character LED alphameric display and built-in tape cassette.

The minimum 30 has 3520 8-bit bytes (1760 words) of read/write memory, expandable to 7616 bytes. The keyboard includes all typewriter keys, a set of numeric keys, edit keys, and 10 special-function keys. The single cassette can hold up to 80,000 bytes.

Add-on ROMs provide optional features such as matrix operations, plotter control, extended I/O and string

variables.

The minimum 30 is $5975. Each add-on ROM, $485. Peripherals include plotter, paper-tape reader, page-width printer ($2975), external cassette unit, Teletype, etc.

ELECTRONIC MUSIC CLUB

The Electronotes Newsletter appears every 20 days or so (!!) and covers construction, theory and use of synthesizers, etc., as well as reviews of literature, performances and products. For further information, write: B.A. Hutchins, 60 Sheraton Dr., Ithaca, N.Y. 14850. As he puts it, "Computers have lost some favor in electronic music, people preferring the synthesizers, but recently there is a trend back, as more and more computer equipment is available to more people, and also digital generation of sound is very big." ACS member John Bottoms is cited as having "teamed up with Gary Nelson at Purdue, using a CDC 6500 computer in a modified version of "Music V" called "Music 65."" A copy of the program from the line printer is 1½ inches thick. There is also mention of DECUS (the DEC Users Society in Maynard, Mass.) having "a couple of music-type programs in its program list."

TEMPLATE FOR DRAWING PC BOARDS

The Quad-Template by Kandu provides four types of symbols: (1) for PC boards: conductors, pads, card-edge connectors; (2) for logic, gate and function-box outlines; (3) for drill jig: lead-hole patterns for transistors, ICs and components; (4) for schematics: alphabet, components, arrows, etc. Made of a rather thin plastic, the Quad-Template is $2.50 from Kandu, Inc., 6115 Miller St., Arvada, Colo. 80002.

THE TRADING POST

Used PDPs

Ken Karow writes from Chicago that Newman Computer Exchange (222 S. Seventh St., Ann Arbor, Mich. 48103) offers a PDP-8 4K for $1500. Also a 4K PDP-8/L for $2640, 4K PDP-8/I for $2900, and a TU-55 DECtape at $1150.

Readout Samples

Barry Mulligan of New York writes about the limited-time offer by Dialight Corp. (60 Stewart Ave., Brooklyn, N.Y. 11237) of a number of readout modules (both segmented and dot-matrix) at around half-price, for prototyping.

Computer Equipment Source

For 50¢, a catalog from MNH - Applied Electronics (P.O. Box 1208, Landover, Md. 20785) lists used computer equipment such as control panels, RCA memory systems ($485), address registers, arithmetic units, cabinets, etc. Also a complete communications processor that needs some logic debugging and interface wiring. Also listed: TTL ICs, electric wire-wrap guns ($87), etc.

Surplus Burroughs Computers

Dick Breidenbach of Michigan writes that "Silverstein's, a surplus store in Detroit, has about 90 Burroughs B-200 computers for sale. The CPU with 4K storage is going for $150, the 132-position line printer for $150, and the card reader for $100....Documentation is hard to come by....Unfortunately only those who live near Detroit will be able to take advantage of these machines, as they are strictly cash and carry, and the printer weighs about 1700 pounds! I bought one door of the CPU with the core, all drivers and buffers, for $35."

The Amateur Computer Society is open to all who are interested in building and operating a digital computer that can at least perform automatic multiplication and division, or is of a comparable complexity.

For membership in the ACS, and a subscription of at least eight issues of Vol. III of the Newsletter, send $5 (or a check) to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.
Darien, Conn. 06820

The ACS Newsletter will appear every two months or so.

Logic Cards, Anyone?

Dave Digby (311 South Brown Ave., Orlando, Fla. 32801) writes:

"I have acquired a fair number of logic cards, discrete transistor type, of various brands (Milgo, Raytheon, Milgo, etc.) and would gladly part with them for little more than the cost of shipping. Not enough of any type to build a whole computer, but maybe enough to construct an I/O interface or supplement one's existing supply. Let anyone interested send me their limitations — connector type and contact spacing, number of pins, transistor types, card dimensions — whatever, and I'll let them know if and how many I have to match. And I have telephone-type relays by the pound! And some lab instruments."

Help Needed

Bob Harrington (2228 Ft. Stockton Dr., San Diego, CA 92103) writes:

"I'd be interested to know of anyone who has built a cassette drive for 3M's belt-driven cassettes. It looks like it would be easy, but may not be.

I'm having trouble trying to program the Signetics 8223 256-bit P/ROMs, They seem to be re-linking, as they do not take. Anyone else having this problem?"

Audio Heads for Drums?

Jerry Bryson (618 W. 33 St., Richmond, Va. 23225) writes, in part:

"Since I announced my intentions, I have received a lot of advice about core ("Don't try it!"). Indeed, the drum may be better, from the standpoint of expense, capacity and word size. I'm not interested in great speed. I'm wondering about audio heads for the drum. Will 20,000-cps audio heads work for 20,000 bits/sec? Will they work faster? Will they work at all?

"I visited the computer exhibit at the Smithsonian. Most of the relics were built by hand and should be an inspiration to "datamaniacs." The exhibit does leave something to be desired, however. Many displays are not yet labelled and most of the stuff is from space and military applications. An Atlas control system is still alive and does demonstrations daily. There is no 1401, which should certainly be there. And the miscellany of memory stacks, etc., is just so much junk without any captions, unless you already know what you're looking at. If the Smithsonian accepts volunteer help, Washington-area ACS members could make a contribution to both history and public education with their services."

FAST FLIP-FLOPS

Motorola has a new MECL III IC, the MC1690, a master-slave D flip-flop with a toggle rate over 500 MHz, at $55 each for 1 to 24.

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ROTHMAN WRITES AGAIN

Allyn Rothman writes from New York:

"I don't have much progress to report on the hardware side, but my logic design has undergone several revisions. My basic philosophy still remains that of implementing the machine instructions by means of a microprogram stored in some type of read-only-memory or alterable ROM. This neatly divides my work effort into two convenient sections. I can design and test the logic of my microprogram on another computer using simulation techniques, thus saving the expense and time of building complex logical functions with hardware. The hardware I require, then, becomes just the ROM plus relatively simple data busses and gates. I have redesigned the micro-logic several times, since as various ICs become cheaper on the market, it pays to take advantage of them in the overall design. Prices are dropping rapidly, so I tend to spend more time developing my "firmware," and less on the hardware. ROMs are still expensive, and with my computer depending heavily on them, the longer I wait to buy, the cheaper my machine becomes. For me, looking at the output from a successful micro-logic simulation run is just as satisfying as seeing the lights blinking on the finished machine.

"I have been lucky in one respect. My memory, which is a 10K x 12-bit unit taken from an IBM 1620, is working satisfactorily in a breadboard setup. It runs with a 10-microsecond cycle time and appears to be 100% reliable as far as errors are concerned. I see that Bob Carpenter is also making use of an IBM 1620 memory [Mar. 1972, p 3], which he obtained from the same source that I did, Herbach & Rademan. I regret not having bought additional modules, because the slow cycle time plus the core matrix switches used for drive-line selection make the unit relatively easy to operate. The 10-μsec cycle time also gives me plenty of room for micro-programming to control all the necessary functions between cycles. A 500-nsec cycle time may be right with the state of the art, but I'd sooner avoid the problems and aggravation from such high frequencies, and settle for a slower memory that works reliably. I think Bob is at a decided disadvantage using his 12-plane unit for a 12-bit word. Having a spare plane (which I would advise his somehow adding) provides a parity bit, and this is crucial to reliable operation. Not just by indicating obvious catastrophic failures, but for "tuning" the memory to operate in the middle of its error-free operatime area. I check the parity error count and I vary the select drive currents and the matrix switch bias current to develop a plot which neatly defines for me in what region my memory is most reliable.

"Steve Wiebking quotes an excellent text [Nov. 1971, p 5] on micro-programming concepts, but I submit that it is possible to implement the micro-logic to support the IBM 360 instruction set in a far more simple manner than the approach taken by IBM. IBM's micro-logic was not designed to minimize the number of separate functions needed to support its instruction set. It was designed, rather, for complete flexibility so that emulators for their older computers and a very complex I/O channel system could be included in the machine capabilities. The 360 micro-

instructions therefore control hardware gates, latches, and data channels at a much lower level in the machine hardware than is necessary to merely implement the instruction set. For the fun of it, I have partially developed microcode from which most of the 360 machine functions could be controlled, and it appears that far less than the 1408-word x 176-bit ROM which IBM presently uses is needed to actually support the instruction set. Leave out the floating-point instructions, and you are not left with an impossibly large task. As the book on micro-programming by Husson explains, Honeywell has taken the opposite approach from IBM, resulting in more compact microcode that controls the actual machine hardware at a much higher functional level. I find the designing of a microlanguage to implement machine instruction sets to be one of the most interesting aspects of computer design. To come up with optimal control microinstructions which minimize ROM requirements while maximizing control flexibility is tricky business, but far more satisfying (to me) than getting a shift register to work. I would like to know if anyone is seriously considering tackling a 360-like machine, especially with a microprogram approach.

"In the March 1972 Newsletter was a small blurb on the utility or necessity of using an oscilloscope in developing machine hardware. I find an oscilloscope indispensible; so much so that I am in the process of putting together a more adequate one than the simple one now at my disposal. A delayed sweep doesn't seem to be that essential, since you can always find some pulse in the system advanced enough to provide a trigger signal for the waveform you actually want to look at. What is a real convenience is a dual trace, because very often it is the time relationship between two pulses that is of interest. For those who want to build a kit, I recommend the Heathkit IO-105 Solid State 15-MHz Dual Trace Triggered Scope, at $429. I'm making it an even better buy by scratch-building it myself from Heath schematics and using a less expensive CRT (flat-face tubes aren't cheap). I expect to finish the job for about $100. And I started out building a computer!

"The longer I wait, the cheaper ICs become, so I feel very little pressure to rush my machine to completion. The software simulation of my micro-instructions provides me with enough of a sense of accomplishment for the time being. I would be interested in hearing from any members who have successfully used ROMs, especially the semiconductor types. Has anyone attempted a CRT I/O device? Many such units have been mentioned, but has anyone actually managed to build one? [Allyn Rothman, 19 Roberta Lane, Syosset, NY 11791]"

TWO WORKING COMPUTERS

D.A. Bowman writes from Arizona:

"I have built two computers from scrap parts in the past 4 years. Both are 12-bit, 2-μsec machines patterned after the PDP-8 instruction set. The first was built from second-generation discrete-component DTL NAND logic. The memory was of my own design. My second computer was built to get around the power dissipation problem (1.5W) of the first machine. It gets expensive to operate and refrigerate that kind of system in Arizona. The second machine is made out of 7400 series TTL and has an 8K x 12 main core memory.

"I have also designed and have operating the following extensions to my computer: high-speed reader and punch (General Electric); Calcomp 565 incremental plotter; 32K-word

x 12-bit extended core memory; ASR 33 Teletype; video display (16 lines of 64 characters, 1K refresh memory, 5x7 dot-matrix characters); X-Y D/A converter and storage scope.

"All of the PDP-8 software works on my system. This has saved considerable time, as you can well imagine. I have used the following DEC software: compilers (Focal - 8K, Basic - Poly, Fortran - 8K); assemblers (Macro 8, Pal III, Saber); maintenance programs, disk monitor systems (my 32K core memory looks like a DF32 Disk System).

"My entire system logics are mounted in a 19-inch rack and all of the packages are wire-wrapped together using 30-gage wire. I use wire-wrap boards on which you can mount 200 TTL packages. They are mounted upside down and soldered to pins that go through the board and are wire-wrapped on the other side. This allowed me to put my whole computer logic (registers plus control and timing) on one card. I have a module that holds 10 such cards, including: one for video display logic, one 32K interface logic, two core memory, one Teletype and high-speed reader/punch logic, one computer card.

"I have devoted most of my spare time for the last four years in accumulating the parts and developing my software."

THE TRADING POST & HELP WANTED

1101 RAMs

Dave Vednor (P.O. Box 1317, Tustin, Calif. 92680) writes: "I've had a mfr offer me 2700 pieces of a CMI 1101 256-bit RAM. These are new, but have been scrapped due to a product change." With at least 16, at $1.50 each, you've got a 4K x 1 memory, at $24. With at least 256, at $1.25 each, a 4K x 16 memory for $320. And with at least 512 of these, at $1.17 each, an 8K x 16 memory, for $600. "I need a total order of 500 minimum to get these prices. If I can move all 2700, prices would be about 10-15% lower. Again, these devices are new and are being offered to me by a computer mfr. However, I can offer no guarantee."

Time-Sharing Club

Frank Eperjesi (P.O. Box 221, Burbank, Calif. 91503) writes: "I would like to start a local club in either LA or Orange County. I live in Orange County but am in LA so much that I don't care which area — it depends on where I could drum up the other members. The purpose of the club would be to buy a small time-sharing system. I figure that if 20 people were to kick in $250 each to join, and possibly $250 a year thereafter, this would allow me and the other members to have a fairly powerful system at minimum expense, and expandable as extra members join. The other possibility would be for ten people to get together to purchase an Intel computer development system (about $1K) and a TI printer/dual mag-tape unit with keyboard ($2400) and misc. hardware at about $1K. This would be a fairly powerful mini-computer system at minimum expense."

727 Tape Drives

Alvin Marshall (412 Oakwood, Angola, Ind. 46703) says: "I have some 727 tape drives — with the books — $100; you haul 'em. These are tube, but worked when removed. They are stored at Pocomoke, Md., not at my place, but they can be picked up at almost any time."

727 Circuit Info?

Al Sinclair (941 Hedge Dr., Mississauga, Ont., Canada): "I acquired an IBM 727 tape drive in perfect

condition and spent the next four months tracing out all the circuits. Is there no way of getting this information? I use a 1½-HP 3-ph motor and a 240-to-208V autotransformer to generate the three-phase power to run the tape drive. I am dispensing with all parity and deskewing circuitry at this time since the relatively few errors don't matter to me anyway. The outfit sure generates a lot of noise in the house!

On a visit to Kingston, N.Y., dropped in to P&D Surplus [Mar. 1972 Newsletter] and picked up a card reader, keyboards, control panels and a host of other parts at ridiculously low prices."

Surplus Items

Gary Forbes (2028 W. Indian School, Box 100, Phoenix, Ariz. 85015) sent a list of items advertised in the Dec. 1972 Popular Electronics; he has a 2K x 1-bit core plane for $5, driver board for $3, sense amplifier for $2, IBM electric typewriter with solenoids, $50; ICs; IC mounting boards, core stack, etc. Write him for a copy of the list.

Any Readers Involved?

Dave Digby (311 S. Brown Ave., Orlando, Fla. 32801) writes:

"Over the past year or two here in Florida, I have been too busy designing computers at work to feel much like doing it also at home. Have not given up the project, however, but keep accumulating little bits and pieces. Let me list a few minor projects in various states of non-completion: (1) A one-pass assembler, hopefully tailored to very small computers. Few restrictions on features for paper tape object tape, but obviously requires an optional second pass for complete address data in listing. (2) An all digital modem -- except for line interface. (3) A display buffer and generator to display on conventional TV set.

Are any readers currently involved in accumulating orders for shift registers or other memories? Or in evaluating currently available logic lines for home computer use? Or in projecting possibilities coming up with MOS, CMOS, etc?"

KENBAK DROPS CASSETTE INPUT

Development of the cassette input for the Kenbak-1 training computer (March 1972 Newsletter, p 1) has been shelved, as it isn't needed in the educational field, toward which the Kenbak-1 is oriented. Kenbak is concentrating on the secondary and post-secondary schools, which can obtain Federal funding for such hardware.

Half a dozen of the Kenbak-1 (which is now $850) have been sold to private individuals, half of whom are programmers and EE's. As one programmer put it, "I have an IBM computer at work with half a million words of storage, but I didn't have a computer at home."

Kenbak Corp. is now at 12167 Leven Lane, Los Angeles, Calif. 90049, (213) 472-8347; John Blankenbaker, president.

A $695 COMPUTER KIT

The System One computer kit will soon be available from EPD, P.O. Box 1014, Glenwood Springs, Colo. 81601. There are 16 individual kits that make up the entire computer, with 1K of memory, and addressing for 8K. System One contains 82 ICs and has a control and display console that displays the contents of most of the major registers. Input is by pushbutton; output by lamps. There are 29 micro-instructions

and 28 combined micro-commands programmed in a diode matrix that is in the form of a read-only memory. This matrix can be altered by the user who wishes to try out his own instructions. The entire System One is $695. The plans, with all schematics and parts layout, is $25. The first ad will appear in the May Radio-Electronics.

You will need a good scope (at least 10 MHz), preferably dual-trace, for setting the core levels. System One has a data-bus terminator connector, and there are instructions for setting up I/O to anything that operates on an 8-bit binary code. Only 15 machines will be offered at this time, because EPD has only 15 IBM 1401 core memories, bought surplus, and no more are available. When the core is gone, they will switch to solid-state memory, either Intel 1106 or Signetics 2601 1024-bit types. This will add about $200 to the price; this machine will be System Two; another change will be from 8-bit with link to 16-bit with link.

System One is patterned after the PDP-8, but comes only with a list of commands. There is no user group yet -- only 11 of the original System One machines were made (plus 2 prototypes).

Also available is an 80-page Memory Core Booklet, MPB-1, for $5, on setting up a core memory, with values for the 1401 memory as used in System One, but with all the equations for adapting to any core memory.

IN PRINT

Cryptology and Computers

By coincidence, two articles on a subject quite rare in trade magazines appeared in January: "Computers and Cryptology" by Chesson in Datamation (Jan. 1973, pp 62-64, 77-81) and "How to protect data with ciphers that are really hard to break" by Geffe in Electronics (Jan. 4, 1973, pp 99-101). The first is about programs for cryptoanalysis and includes a Fortran program for simple work; the second describes enciphering methods.

ROMs in Digital Systems

"ROMs are versatile in digital systems" by Percival of National Semi-Conductor (Electronic Design, June 8, 1972, pp 66-71) goes into lookup tables, programming the ROM, arithmetic with ROMs, converting codes, and microprogramming.

LSI and Central Processors

In the Nov. 1972 IEEE Spectrum, "MOS/LSI launches the low-cost processor" (pp 33-40) is well worth reading (reprint is $1.50 from IEEE, 345 E. 47 St., NY, NY 10017; ask for article X72-112 within a year).

The devices outlined are the American Microsystems 7200, Fairchild PPS-25, Intel MCS-4 and MCS-8, National MAPS and GPC/P. The MCS-4 is noted as having an extensive software library compared with other processor families.

The article points out the slower execution times of MOS processors, the minimum applications support from the makers, and the need to buy large quantities of an IC to offset customized masking charges.

TV Set for Data Display

"TV set is display for data terminal," by Bratt of Motorola (Electronic Design, Sept. 14, 1972, pp 134-141), has an all-digital character-generation circuit; 1024 characters, each in a 5x7 dot matrix, with 16 rows of 64 columns; full set of 64 ASCII alphanumeric characters available. Six 1024-bit

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Darien, Conn. 06820

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RAMs refresh the display; a specialized ROM (MCM1131) generates the characters; the remaining circuits require much construction, on four logic cards.

Computer Logic Book

For your son or a young friend, "Beginner's Guide to Computer Logic" is a recent one from Tab Books (Blue Ridge Summit, Pa. 17214). By Gerald Stapleton, it has 192 pages, is $7.95 hardbound, $4.95 paperbound.

The first 96 pages are on logic theory. The rest is on building logic projects. A discrete-component breadboard (DTL) is built. Then come ICs, RTL and DTL, with breadboards for each. The final IC DTL experiment is an 8-bit binary adder-subtractor.

Laboratory Manual for Integrated Computer Circuits.

The paperback with this name, by Robert F. Coughlin (Prentice-Hall, 152 pages, $5.95) has a somewhat misleading title. The manual starts off with facts and principles about RS flip-flops, and then asks the student to design several of these with various parameters. It discusses and gives some applications of some ICs: NOR gates, Schmitt triggers, JK flip-flops, and counters, and describes some lab experiments for each. Some 25 pages are devoted to "Design and Build an Analog Computer" without going into much detail. The appendix provides circuits for a regulated power supply and an "IC control and readout board," along with photos of a breadboard using Augat sockets, subminiature banana jacks, and a Vectorboard with holes on $\frac{1}{8}$" centers.

Computer Structures: Readings and Examples

This is the title of a 668-page book, by Bell and Newell of Carnegie-Mellon University (McGraw-Hill, 1971, $16.50). It is a "case-study approach covering 40 distinct computer types."

In one convenient volume, the authors have collected a variety of historical and/or technical papers that cover the recent history of computers. Many of these papers are unpublished or difficult to obtain. Among the computers covered are the DEC PDP-8; LGP 30 and 21; IBM 1800, 1401, 7094 and 650; Midac; Illiac IV; and two desk calculators, the Olivetti Programma 101 and the H-P 9100A. Fine for browsing.

As Gene Witherup of Pa. puts it: "This is an excellent study of the development of computer systems, with emphasis on the language set and central-processor configuration. It contains 688 pages....It is not a "how to" book, but it is definitely of interest to the serious student of computer organization."

SURVEY FORM?

If you were sent a Survey Form and haven't returned it yet, please fill it in and send it to Darien.

ACS NEWSLETTER

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USED UNIVAC COMPUTERS

Ed Moakler (Moakler Electronics, 500 E. Chestnut St., Jeffersonville, Ind. 47130) has a Univac 0 File Computer, which he bought as scrap. Ed has the arithmetic unit, program-control unit, 90-column reader/punch, sort-collate unit, tape-drive program controller, and six magnetic tape units. Original value, over $164,000. Ed hopes to make it work, and maybe use it in his business.

The File 0 takes much power and air-conditioning. Ed writes, "I had figured to use the outside winter air to get it turned on and see what I've got, and just close down in summer. As to space, not too bad: only about 400 or 500 square feet, pretty compact. I'm presently having 220 V installed to begin to turn on some of it."

Univac says they can't provide schematics for any machine this old. Each machine was somewhat different, various changes having been made to each during its life, and careful documentation had to be kept as to what was inside each. Many of the old schematics and documentation have been thrown out, and "no amount of money" could provide relevant schematics for one of these old machines, antiques at age 16.

There are manuals available for the Univac 1108: 20 to 30, each three inches thick, each costing $50.

A fair number of Univac Solid State computers were given away, to schools, which then came to Univac for documentation. The situation turned out to be "impossible," as there were no records available on updated blueprints.

"Maintenance in those days was a tricky thing," says Univac, "and the man who did it has long since been assigned to newer equipment, so there is nobody available from us today who knows how to service the old machines."

As to whether there are still any File Computers in operation, Univac says anybody who has one must have bought it, and so it's out of Univac's control, both as to documentation and maintenance.

One company was getting rid of its Univac I, and wanted to give it away. But Univac found that to take it apart carefully and reassemble it elsewhere would cost $100,000, so the machine was scrapped.

At one time, Univac did give older vacuum-tube machines to schools and non-profit institutions, but there were so many headaches with proper documentation that this was dropped. Even with some of the older transistorized computers, it's hard or impossible to provide updated schematics.

Univac gets 50 letters a month asking for information about computers, mainly from students. Univac sends a couple of booklets and a list of helpful books.

HARRINGTON'S MICROPROGRAMMED UNIT

Bob Harrington writes from Calif.:

"I solved the problem with programming the 8223 P/ROMs (Nov. 1972, p 6). I tried more juice to the point of frying the chip with no success. It turned out that the transient on the +12 volts caused by the current rush thrcugh the V_{cc} pin was in effect de-selecting

the output I was trying to program. I solved this by using separate 12-volt supplies.

"My computer is nearing completion. It has been operating through the panel controls (no I/O yet) for a couple of months. I am working on the I/O board now and have some microprogramming to do. Here are some updated specs:

"Word length: 12 bits. Registers (12 bits): accumulator, accumulator extension, index (1), storage address, storage buffer, instruction address, 16 scratch, console switches. Core memory: 3200 words, 8-usec cycle time. Clock: 1.25 MHz. Addressing: direct, relative, index. I/O: 8-bit bus, 8 interrupts, 8 strobes.

"Instructions: block load/store to/from scratch (1 to 4 words), load accumulator, store accumulator, add operand in any scratch register (load accum., add, subtract, multiply, and, exclusive or, or, increment, decrement, decrement & skip if neg.), branch & store inst. addr., jump on condition (8 cond.), 4 shift right N, 2 shift left N, shift left and count (normalize), clear link, add & clear link, enable interrupt, load output buffer & issue strobe, issue strobe, input data.

"I'm using a 5-bit op code, 3 modifier bits, and 4 bits for scratch register address. Some instructions use a second word for an address. The op-code bits control the address of a 256-bit ROM, the output of which controls the address in an array of four 256-bit ROMs arranged to give 64 16-bit words. These 16 bits are decoded in groups of four to 64 control lines. The address of the 64-word ROM is sequenced at 1.25 MHz beginning at the location selected by the first-mentioned ROM. Each instruction occupies one to five microprogram steps. I made elementary loops by using one control line to reset the least two significant bits of the address counter. Another resets all bits, causing a branch to 000000, where the fetch-next-instruction instruction resides.

"I used ordinary logic in addition to the microprogramming to squeeze more out of it. The four types of shift-right instructions, for example, all use the same microprogram, the differences being generated by hardware logic using the three modifier bits.

"The control panel is an 8-3/4" by 19" rack panel. The computer is completely enclosed in a cabinet which is 16" deep. The panel has four 12-lamp displays plus six auxiliary. All working registers can be displayed by means of a selector switch. The instruction address register can be loaded manually with the contents of the console switches, and core locations then examined or loaded in sequence. There is provision for single-step operation, and a manual interrupt is available.

"I am planning to use my computer in scientific/enginerring applications mostly. One application I've used it for so far was for testing commas for use in a digital communication system.

"For any who are just starting or not too far along, I would highly recommend (a) microprogramming (which I did), and (b) planning for future expansion (which I did not do)."

REISS ON LSI AND MICROPROGRAMMING

Russ Reiss of Conn. wrote last year:

"For about seven years now I've been planning to build my computer. Finally last June [1971] I complet-

ed the PhD in EE/Computer Science and thought I might have time to get going. The courses I'm now teaching as Asst. Prof. at RPI-Hartford Graduate Center such as Compiler Design, Digital System Design, Digital Communications, and Minicomputers, have really spurred my interest.

"Cost-wise the CPU is no problem. This summer I bought 600 ICs from Gerber Electronics when the price dropped to 22¢, but still haven't found the time. Memory is the killer! I'm convinced that core is on the way out and would like to go with IC memory. The recently introduced Intel in-20 does look like a pretty good deal, but not exactly cheap. Perhaps in quantities a group of ACS members could make this an economical approach. The cost factor keeps telling me to use a shift-register memory (such as the 1402A), but the speed would be horrible. I am considering some "tricky" swapping schemes between small RAM and SR memories, such as the "cache" system, but this problem is yet to be resolved.

"Enter the Intel 4004 and 8008 CPU on a chip!!! Both are complete CPUs with quite a bit of power (45 instructions) and flexibility (internal address stack for subroutine nesting, etc.). The 4004 is not as desirable since it is more complicated to control and doesn't look as much like a typical computer. The 8008, however, is a beaut!....

"The only drawback I see on these devices is their slow speed (about 1 MHz clock), yielding about 75k instructions per second. For amateur (and many commercial) uses this should be no real problem. Whether we wait 1 sec or 3 sec for an answer does not really matter. But a cost of $5k or $1k does matter! I believe this approach would be ideal for a "conversational/interactive" system using FOCAL, BASIC, APL-type languages. Writing the interpreters are not THAT much trouble either. My students are finding this out in Compiler Design class where each student writes his own compiler for a special-purpose language he creates -- in about ½ semester.

"One other point I've concluded is that any computer (and especially an amateur job for experimental uses) should be microprogrammed and (dynamically) microprogrammable. Commercially available ROMs are now reasonably priced (one can build his own programmer), or one could go the diode-matrix route. But I see no meaningful justification for hard-wired instruction sets. The use of an IC ALU with two input buses which derive signals from any register through a multichannel MUX, and the use of microprogramming, offer a very neat, simple, and flexible arrangement for any computer. Through microprogramming such a computer could emulate any other computer. Sixteen-bit registers also seem like the most appropriate choice. But I really think something like the Intel 8008 is an even less expensive route. This might form the basis of a "general" ACS computer as was discussed in the initial issues of the ACS Newsletter. I'd be happy to work with others toward this goal." (R.A. Reiss, RFD 1, Box 176A, School Rd., Bolton, Conn. 06040.)

The Intel in-20 is a 1k x 12 memory system, 950-nsec speed, on a 6" x 8" PC board, one for $620. The in-26, announced three months ago, is tailored for the 8008: 4k x 8 bits, 900 nsec, same size board, $750 for one.

PROGRESS REPORT ON MOLASSES I

Richard Dickey writes from Calif:

"With integrated-circuit technology simplifying computers faster than we can get the old stuff to work, it takes some determination not to junk the carefully-built arithmetic unit and just buy a tiny lump for $15 which does the whole job!

"Molasses I is still making progress. In 1966 I bought the diodes for switching the drum tracks; last year I got them soldered onto the printed-circuit boards. I have acquired a complete photoreader from a G-15, and am modifying it so that all the control logic is located inside the box, including a rewind system it never had before. Now if I only had the rest of the G-15, I'd be happy.

"Right now I have access (including keys) to 8 G-15's, a CDC 046, Burroughs 205, PDP-8L, and an Athena, but there's nothing like having your own."

HARDWARE: LSI

Signetics PIP Chip

Durk Pearson (Calif.) says that Signetics has a PIP (Programmable Integrated Processor) chip. The data sheet says "all data operations are performed on 8-bit bytes, and an 8-bit bus is used for all memory and I/O data transfers. A 13-bit memory address is used for direct addressing of up to 8k bytes of storage. There are four 8-bit general-purpose registers." Unit price is less than $100 (the PIP may be as low as $25 by 1974).

Another Microsystems MOS LSI IC CPU

Ken Karow sends word from Illinois on the Microsystems International (Canada) CPS/1 Micro-Computer System. The bulletin says: "The CPU contains two memory pointers: the usual program counter (PC) and a data pointer (DP), which allows logical, as well as physical separation, of program and data. Both PC and DP are 12 bits long and can directly address 4096 memory locations. A memory-expander chip is available to extend addressing capacity to 256k. Each memory location contains 4 bits of data (one nibble, which is half a byte)." A nibble??

MI also has a MF7114 (4-bit parallel Arithmetic Unit & 12-bit memory reference unit & Instruction and Control Unit) and an MF8008 (8-bit parallel adder & six 8-bit data registers & 8-bit accumulator & two 8-bit temporary registers & four flag bits & eight 14-bit address registers).

Oriental Wizardry

Myron Calhoun (Kansas) found this in Modern Data:

"Tang Juan, 22, an undergraduate at the National Chengkung University (Chenta), has succeeded in making the Republic of China's first fourth-generation computer. Nicknamed "Tang Go Go" (Brother Tang), it cost all of $60 and took Tang Juan six months to build. Except for the LSI components, all parts were bought from junk shops in Taiwan."

PUBLICATIONS

Computer Architecture

This is the title of a 225-page book by Caxton Foster of the Univ. of Mass. (Van Nostrand Reinhold, $12.50). It begins with binary numbers, has chapters on logic, storage, addressing, I/O, speeding up the computer, parallelism, and tessellated computers. Chapter 5 is 30 pages on An Elementary Machine, describes a "very simple computer, one that might sell for about $10,000 or so. BLUE (named

for the color of the cabinet; the author says "I'm weary of acronyms") has 4k words of 1-usec core, 16 bits per word, 16 commands, and a common-bus scheme. It looks possible to build a machine from the black-box diagrams, although the last sentence says the computer is "so simple that probably nobody would actually want to buy one." As Foster puts it previously, "none of the 'goody features' present on most current machines, e.g., indirect addressing, index registers, interrupt, etc., are present."

Computer History

"The Computer from Pascal to von Neumann" (Princeton University Press, 378 pages, $12.50) is by Herman H. Goldstine, who helped create ENIAC. The first part involves the early pioneers: Babbage, Boole, Hollerith, Bush, etc. The second covers ENIAC and EDVAC at the Moore School, and the third is on the postwar years at the Institute for Advanced Study at Princeton, through 1957 (after which the author joined IBM). There are only a couple of simple schematics, and the text does not get very technical, as it was intended for an audience beyond computerniks, but it is an interesting and informative narrative by a man who was there at the beginning.

DEC Sells a Book

Digital Equipment Corp., which has been giving books away for years, now has a "Digital Press" that publishes books for sale. The first of these is "Designing Computers and Digital Systems," by Bell, Grason and Newell of Carnegie-Mellon University; 447 pages for $3.95. The ad for this book is slightly misleading, as it says only that this is a "guide to the design of digital equipment using register transfer modules as the basic component." The subtitle of the book itself is properly explicit: "Using PDP-16 Register Transfer Modules." So this is not a cookbook on computer design, but rather a lengthy application note on DEC's RTMs, and thus is of little or no interest to amateurs. Any comments?

Popular Computing

This is the title of a monthly publication by Fred Gruenberger, which began last month, and is "designed for those who are interested in computing for its own sake." The first issue is 12 pages long, contains items on the 3X+1 problem, the Wells/Ulam Conjecture, notes on the Hewlett-Packard HP-35, statistical data on the calendar system, a book review of "Program Test Methods," and a list of subfactorials. The cost is $15 a year (or $12 if remittance accompanies the order): Popular Computing, Box 272, Calabasas, Calif. 91302.

Logic Newsletter

The "Logic Newsletter," advertised in at least one electronics hobby magazines at $1 for a sample copy (and for each issue) from UTI (P. O. Box 252, Waldwick, N.J. 07463) is published 10 times a year (Sept. to June) and is a curious mixture of bits and pieces. The first issue (Sept. 1972) consists of a 4-page wraparound with a page on logic function generators in textbook style, five simple circuits (gate, flip-flop, latching FF, RTL NOR, clock circuit), a book review, and very brief news items on publications and ICs. The four inserts are: truth-table summary of functions; powers of two; logic function chart; table of combinations (of two variables). And a 6-page logic-design example: decimal-to-8421 BCD encoder.

The first issue states: "Starting next month, each issue will contain a 4-page application note on

The Amateur Computer Society is open to all who are interested in building and operating a digital computer that can at least perform automatic multiplication and division, or is of a comparable complexity.

For membership in the ACS, and a subscription of at least eight issues of Volume III of the Newsletter, send $5 (or a check) to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.
Darien, Conn. 06820

The ACS Newsletter will appear every two months or so.

the most popular UTI 7400 Series integrated circuits." A logic design example is to be included in each issue. The price is $9 for one year, $15 for two.

UTI also sells hardware, including 7400 ICs, a breadboard kit, semiconductor memories, etc.

HELP FROM TITUS ON INSTRUMENTS

Jonathan Titus (Titus Labs, P.O. Box 242, Blacksburg, Va. 24060) writes: "The logic probes that we are using here for trouble-shooting were developed here by our staff. They are better than the Hewlett-Packard probes and at least as good as the Kurz-Kasch probes that currently sell for $80 to $100. We have two designs for pulse and logic-level detection and one design for a pulser probe that allows in-circuit generation of pulses.

"We also have our own design for a logic clip, along the same lines as the HP type, but ours has only a couple of simple ICs inside and it still has the +5 and ground auto-seek features.

"We have been using two types of trace adaptors for some inexpensive scopes such as any of the Heath general-purpose scopes. One adapter uses a switched amplifier and the other uses a standard diode-switch arrangement. The diode switch is the one I would recommend. It has individual position and gain controls for each channel and it may be used with either AC or DC scopes. Chop rate is between 100 kHz and 1 MHz, and it can also be used in the alternate mode!

"Since we are in the business of doing special development of interfaces, we don't usually make our internal technical reports available to the public, but since there seems to be a need among amateurs, we have made an exception. Members of the ACS may obtain these reports from us for the cost of duplication and mailing. Please refer to the numbers and costs shown below:

"Technical Report #67, Logic Indicator Probes, $1; #68, Logic Pulser Probe, $1; #69, Logic Clip, $1; #72, Two- and Four-Trace Scope Adapters, $3. For $5 we will send all four Tech Reports. The reports contain a list of all needed parts (all standard) and full directions for duplication, along with schematics and checkout procedure."

About the Foster book (p 4), Jon says "It is an extremely easy to read, informative book that shows how a computer is developed. It is worth its cost many times over. Perhaps before any of the newer ACS members start on a computer they should read Computer Architecture."

FOR SALE: Jim Mims (307 Sudbury Rd., Linthicum, Md. 21090) has Ampex memories, 4K of 16 bits with read/write electronics, $300 or best offer; similar with 4K of 8 bits, half price; two Univac 1105 core stacks, 4K by 36 bits, $75 each, Bryant 7505 drum, asking $80.

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DICK SNYDER'S MININOVA 721

From Florida, Dick Snyder sent several dozen pages about his computer, and also his resume, whose last line says "Designed and built 8-bit computer." Dick says:

"The Mininova 721 is designed to be a miniature Nova 1200. I've used and programmed Data General's Nova 1200 minicomputer, and have been exposed to many other mfr's minicomputers. I feel the Nova is the finest mini available. I wanted to have a Nova for my very own, but couldn't afford it. I thought "someday when the price of ICs comes down I'll design and build my own minicomputer, a small-scale version of the Nova."

"Well, the prices of ICs came down tenfold or more in 1971-72, and that made my dream practical. The rest was innovation, enthusiasm, and a lot of careful planning. The result is my very own minicomputer, of which I'm really proud! The Mininova 721 has an instruction set very much like the Nova's. (The Nova has the finest, most powerful instruction set of any minicomputer on the market today, and I've carefully studied most of them.) The Mininova 721 has control switches very much like the Nova's. (The Nova's controls are the most practical I've seen on a minicomputer.)

"So I've incorporated very carefully the best features of the Nova instruction set and programmer's console, and designed the circuits to make a true stored-program, programmable digital computer (complete with loads of integrated-circuit MOS-RAM memory) that would execute 16 different very carefully selected instructions. These instructions were chosen so that some functions of the Nova instruction set could be performed directly, and others by a group of 3 or 4 instructions. For example, the Mininova instruction set includes a right-shift instruction, but no left-shift instruction. This is because it is hard to produce a right shift using other instructions, but easy to duplicate a left shift by adding two identical operands.

"After choosing my instruction set and control-panel-switch functions, I started (on paper) blocking out major registers. The instruction set was chosen to allow the machine to have two program-accessible data registers. These were set down, along with a few address registers. I determined what register transfers were needed to implement each instruction. Then I grouped related operations together, and placed them under the control of mode flip-flops. Then I began to assign the times when these operations would be enabled. I specified all the conditions and times to enable setting and clearing of the mode flip-flops, and then I was able to begin considering waveforms and circuits. I chose my logic family (7400 series TTL) and began to design. I chose my memory ICs (MOS-RAMs that require only the +5V DC power supply) and designed the circuits associated with the memory and major registers. I designed the circuits that implement the operations to be performed by the programmer's console control switches, and designed circuits to enable my computer to do DSA (i.e., DMA) transfers to and from a standard audio hi-fi cassette recorder. All this time I was involved in procuring, wiring, and test. I "design-

ed" my power supplies (I'm using a Lambda Power Kit and IC voltage regulators mounted on heat sinks for the +5V supply, and a home-brew rig with IC regulators to provide +12V for the lamps) and assembled these.

"All together I've put about five months worth of evenings and weekends, $360, and about 175 ICs and IC sockets, and a few hundred feet of wire into my minicomputer. I've made loads of plans for the future, such as new I/O capabilities like digital cassette and 4K of memory, all MOS RAM ICs, the kind that require only the +5V power supply. I've written and executed programs on my computer, and learned how painful it can be when you don't have indirect addressing, and when you have only two program-accessible data registers. Maybe I'll add an indirect addressing capability; I haven't decided yet. But anyway, it sure is rewarding! I've shown the Mininova to my employers and former employers, and friends, and received a wonderful red-carpet treatment wherever I've taken it.

"Most of all, I have the satisfaction of having done all this, and done it to the best of my ability. Some parts of the design of programs and design of machine timing took an awful lot of intense concentration on abstracts. I've got volumes of design notes, schematics, waveforms, etc., all carefully arranged, including every problem I encountered, and how I overcame the problems; the errors and overlooks in design philosophy, the wiring errors, etc. I realize that computers are easy to design, and kind of standard in makeup, but I started from scratch, with little more than enthusiasm and a desire to have a computer of my very own at any cost (except cost in money greater than about $500). I got a lot of general concepts and timing help from the old CDC 1704, which I know forward and backward, but most of it all I designed from scratch, and I'm very pleased with the result. I've learned a lot, and I'll learn lots more in the future as I continue the project. I don't intend to expand anything on this machine except memory size and address-register size (this will make all storage-reference instructions 4-word instructions) and I/O capability. To add more registers or enlarge the registers or add more bits to the instruction words (meaning add more bits per each memory location, more bits to the instruction registers, etc.); i.e., add more instructions, would change the machine too greatly and take it too far from the original challenge. Also it would require too much wiring! If I want a larger processor of the same (approx.) size, I'll buy an Intel MCS-4 system, based on the Intel 4004 computer-on-a-chip CPU.

"The Mininova is my dream come true, and also it is my resume in hardwired form. I've got a lot of initiative, ambition, and imagination, and I feel the Mininova clearly demonstrates my capability as a digital systems and circuit-design engineer."

The Mininova 721 is a mixed 4, 8 and 12-bit machine, with 4-bit and 12-bit instructions, 4-bit storage words, 8-bit operands (data words) and 8-bit storage addresses. The 16 instructions include 4-bit register reference instructions (shift, increment, complement, arithmetic, logical, test) and a control instruction (HALT). The storage reference instructions are three 4-bit-words; the first word is the instruction, the other two are storage address. There is a 4-bit I/O instruction. No parity checking, no interrupt system, no program protect system.

The instructions are HLT (halt),

JMP (jump), JSR (jump to subroutine), SMZ (skip if memory contents are zero), LDA (load A register), LDB (load B), STA (store A), STB (store B), RSB (right shift B), INA (increment A), CMA (complement A), MOV (move B to A), ADD (add A to B), AND (logical AND), SZC (skip on zero carry), SNB (skip on negative B).

The 721 operates on 8-bit single-word operands, handles signed numbers from -128_{10} to $+127_{10}$ and unsigned numbers from 0 to 255. The random-access memory has 256 storage locations, each containing a 4-bit word, addressed directly. The 721 executes about 300 instructions per second in run mode, 150 a second in mixed mode.

Future additions include changing the SMZ instruction to DSZ (decrement and skip on zero), the SZC to SCS (skip if carry is set), SNB to IOT (input/output transfer).

Dick asks if anyone's computer in the ACS does direct-storage transfers (DMA or DSA) to a cassette recorder or other magnetic-tape unit (Richard Snyder, 1910 N.W. 23rd Blvd., Apt. 181, Gainesville, Fla. 32605).

INTELLEC 4 AND 8 MICROCOMPUTERS

Two of the better-known CPU-on-a-chip ICs are the Intel 4004 and 8008, which are 4-bit and 8-bit, respectively. To help in developing hardware around these CPUs, Intel came out with the MCS-4 and MCS-8 "micro computer sets" of chips that can be combined and programmed to make a variety of microprogrammable general-purpose computers (see the June 1972 Newsletter, page 2).

Now Intel has gone a step further and "to make it easier to use these sets, now offers complete 4-bit and 8-bit modular microcomputer development systems called Intellec 4 and Intellec 8." They "provide a flexible, inexpensive, and simplified method for developing OEM systems. They are self-contained, expandable systems complete with central processor, memory, I/O, crystal clock, power supplies, standard software, and a control and display console."

The "complete table top development system" costs $2195 for the Intellec 4, $2395 for the 8. They come with system monitor, resident assembler, and text editor. At extra cost are a PL/M (derived from PL/1) compiler, and an assembler and a simulator, all three written in Fortran IV, and also available through three time-sharing companies (GE, Tymshare, Applied Logic).

Another option is a complete PROM programmer. After the program is firm, it may be placed in the non-volatile storage of the Intel 1702A PROM.

The cards making up the two computers can be bought separately. "The major benefit of the Intellec modular microcomputers is that random-access memories (RAMs) may be used instead of read-only memories (ROMs) for program storage. By using RAMs, program loading and modification is made much easier. In addition, the Intellec front panel control and display console make it easier to monitor and debug programs."

The Intellec 8 can directly address up to 16K 8-bit bytes of memory, which can be any mix of ROMs, PROMs or RAMs. There are 48 instructions, plus 8 input and 24 output ports (8-bit).

Intel has a Microcomputer Workshop in California for the MCS-4 (3 days, $350), MCS-8 (2 days, $250), and PL/M (2 days, $300); hands-on labs.

DIGITAL EQUIPMENT RTM BOOK

The May 1973 Newsletter had an item (page 5) about the DEC book, "Designing Computers and Digital Systems," saying it is a long application note on DEC's PDP-16 Register Transfer Modules, and so is of little or no interest to amateurs, and asked for comments.

Doug Jensen comments:

"In fact, this is a very important text in the professional computer literature, and should be of considerable value to the serious amateur. The register-transfer level of design has always been important but rather neglected; now technology (MSI, LSI) is forcing it into prominence. The book illustrates the concepts with the PDP-16 register transfer modules (which are the only ones commercially available as such), but the ideas apply directly to digital machines designed with conventional ICs. Almost no one designs their own gates from resistors and transistors any more (except for the fun or experience). Few professional engineers ever design counters, registers, etc.-- they use MSI and LSI. Design will continue to occur primarily at higher and higher levels; that's what designing with Register Transfer Modules is all about (there is an even higher level called the Processor/Memory/Switch level).

"If you recall, in a past issue of the ACS Newsletter I proposed that the Processor/Memory/Switch level (the use of commercially available microprocessors, memories, etc.) is the appropriate level for those ACS members whose primary goal is having and using their own computer. The only justification for getting involved with gate-level design is for the experience-- these days it is rarely going to be a cost-effective approach to acquiring a machine."

Glen Langdon also comments:

"On Foster's book, Computer Architecture (May 1973 Newsletter, page 4), it is true that in Chapter 5 on BLUE, it lacks many "goody" features -- but read on to the next chapter where he defines INDIGO with indexing. The book may not be as easy for a beginner to read as it seems to us....

"On the RTM book by DEC by Bell et al, don't sell it short. There is a lot of wisdom in it, involving their languages ISP and PMS, introduced in the book Computer Structures. The PDP-16 really isn't a computer, it's a set of cards. The timing philosophy one uses in applying these cards is "asynchronous" in the sense of "invitation" and "completion" signals controlling the sequencing of events. In this sense, it is not a cookbook on current practice, which uses a system clock."

DEC now offers the DEClab-RT, a training unit consisting of building blocks: arithmetic units, bus sense, memories, interfaces and controls, for learning to "understand digital system design utilizing the register transfer concept." The Basic Kit is $1425.

THE UGLY DUCKLING COMPUTER

Glen Langdon of upstate New York was loaned by IBM to the University of Sao Paulo in Brazil for a year ending June 1972. For the "Patinho Feio" (ugly duckling) computer project, Glen's group of graduate students designed "an instruction set to have about the power of the PDP-8, although the word size is 8 bits. The power supplies were designed and built by students. The 4K memory was imported from Philips. The circuits were T^2L from Fairchild.

We had a printed-circuit lab, and all the cards were done there. Some cards (the control cards) were mounted with 14-pin DIP sockets and wire-wrapped, to facilitate debugging. Having had success with making one-sided printed circuits, an attempt was made to do 2-sided ones with the plated-thruhole. We got two data-flow cards done with this technology (after much sweat; many necessary chemicals are not yet available in Brazil) before abandoning it and going to soldered wiring on the card. The cards plug into a Cambion rack, with wire-wrap sockets. The back panel was wire-wrapped; a computer program aided by listing the desired connections and their lengths.

"The I/O bus was sort of a cross between the PDP-8 scheme and the HP 2116B bus. A Teletype terminal, a plotter, and an optical paper-tape reader were interfaced with it. The panel display was LED, controls include read/write memory from switches/to display, plus single-instruction cycle, and single machine cycle."

NATIONAL SEMICONDUCTOR'S IMP-16C

Doug Jensen wrote further:

"R.A. Reiss' enthusiasm in the May issue over the primitive Intel 8008 is rather misplaced. For less than $500 in singles, one can purchase the five National Semiconductor GPCP MOS LSI chips and the two dozen TTL ICs needed to construct a 16-bit microprocessor. The resulting IMP-16C (as National calls it) has an instruction set similar to the Nova, although at about 5-10 microseconds per instruction it is quite a bit slower than a Nova. However, the IMP-16C is not only faster than an 8008 but also infinitely easier to program and to interface with. (Intel will shortly announce a much improved chip called the 8080.) Professional computer users are becoming more and more aware that programmability is crucial because software development usually requires far more time (and thus money) than hardware development.

"The subject of software brings me to the advantage that commercial microprocessors have over home-built machines, in that at least an assembler and some diagnostics and utilities are already available, although usually at a fee. Private individual members of ACS who have purchased the National GPCP components are welcome to contact me for a copy of the software listings at a nominal reproduction cost instead of the $2000 or so charged by National.

"If you are interested in the IMP-16-C approach, it is a worthwhile investment of $5 to purchase the application manual (4200021A) from National Semiconductor Corp., 2900 Semiconductor Drive, Santa Clara, California 95051.

"Because the MOS microprocessors are so inexpensive, it is tempting to consider how a more powerful machine might be constructed out of more than one of them. This is a very non-trivial task; I have extensive experience in this area (including using IMP 16Cs), and will be happy to discuss the matter with those interested. Incidentally, the GPCP parts can be used to build a full 32-bit processor at less than twice the cost of a 16-bit one.

"A couple of TTL LSI microprocessors are nearing introduction, as is a one-chip MOS replacement for the PDP-8 CPU.

"Let me close with a crass commercial mention that I still have a few 5 volt/48 amp power supplies

The Amateur Computer Society is open to all who are interested in building and operating a digital computer that can at least perform automatic multiplication and division, or is or a comparable complexity.

For membership in the ACS, and a subscription of at least eight issues of Volume III of the Newsletter, send $5 (or a check) to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.
Darien, Conn. 06820

The ACS Newsletter will appear every two months or so.

left for sale. These very high quality units are new, factory-sealed Lambda LMF-5s, which currently list for $475 each; my price is only $150." (E. Douglas Jensen, M.S. A3340, Honeywell, Inc, 2345 Walnut St., St. Paul, Minn. 55113.)

MORE FROM DICK SNYDER

Right at this point I found a later letter from Dick Snyder that I'd forgotten. Perhaps I should rewrite this Newsletter, but I'd hate to delete Dick's infectiously enthusiastic letter. Dick wrote:

"I'm pleased that you intend to print up a lot of my introduction, but after carefully looking through all the ACS Newsletters I've just received, I'm afraid I'd be embarrassed to see some parts of that intro in the Newsletter. Really, my machine is almost nothing compared to some of these people's machines; I have such a small amount of memory, and no program access I/O yet, only DMA access I/O, and only to one external device.... Perhaps I'd better just say I like the Nova best, better than other multi-accumulator machines with standard architecture and complex instruction sets.... The only thing I think any of your readers would be interested in is my DMA circuits, since I'm using a standard unmodified audio cassette recorder. I'd be glad to share the plans for that with anyone who is interested, for $1.50...."

Dick also asks if any info is available on the pins, voltage levels, etc., for R/W control and data, for an Ampex 1K X 16 core memory, model 1024 RVS 16, assembly #3223634-10A, serial #414.

THE TRADING POST

A Batch of Boards, ICs, etc.

Ed Kirkley (7-B Ridge Rd., Greenbelt, Md. 20770) has a number of DEC Flip-Chip boards, digital ICs, relays, keyboard, and core memory (2K X 16), all for $250, with data sheets, and mostly unused. Also a Tektronix 511AD scope for $130.

Core Planes and Amplifiers

Gene Witherup (8220 Michener Ave., Philadelphia, Pa. 19150) has 8 planes of core, each 18 X 8 words, 18 bits. Also 4 boards of sense amplifiers for these cores. And 22 new and 45 used Motorola RTL circuits. For a list of items, send a self-addressed envelope.

MNH - Applied Electronics

Digital computer equipment is available from MNH - Applied Electronics, P.O. Box 1208, Landover, Md. 20785. Their latest catalog includes a Dataraft core system, 512 X 9, with 7400 series TTL, $43; keyboard, computer control and I/O device, $77; tape transport, $118; computer backplane and empty cards, space for 7000 ICs, $33. MNH also sells ICs, connectors, chassis hardware, etc.

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TYING A COMPUTER TO A TAPE RECORDER

Norm Saunders (Mass.) wrote the following some time ago to help a member wanting to use tape:

"Perhaps I can help on the tying of a computer to a tape recorder. You have stated that you want to go between a computer and tape. You need to consider all the peripherals as well, before you start to tie the two together. As for card readers, I have had no use for them for the last 20 years since magnetic recorders became easily available.

"To give you an idea of what is involved, I'll tell you of my sequence of developments. This copy, incidentally, is printed from a 60-cent seven-inch reel of tape on a 15-year-old tape recorder by a Teletype SK33 or some such machine with speed of 3-3/4 inch/second on the tape. About five years ago I bought the Teletype new. The first priority seemed to be to make retrievable records. Hence I first built a modulator-demodulator (modem) to get to the tape recorder from the keyboard and from tape to printer. To get some editing facility, this was designed and built so that the keyboard could break into the print stream at any gap in the text and insert additional characters.

"The next need was found to be a motion-controlled recorder, so I built one. This lets me compress the rough and uneven entry of characters from the keyboard, or as played back from the real-time tape-recording, into substantially full-printer-speed capability. In my case this is especially necessary, since with only occasional use of the Teletype, some of the bearings tend to freeze when the machine heats up after long operation, and if this happens when a copy is being printed from an analog recording and I'm not around, I've got a 25-dollar repair bill.

"The next step was the buffers to go from real-time Teletype format to a simple 8 bits at computer speeds, and back again. I chose to build a special-purpose buffer for each direction, since this, among other things, made Teletype control of the computer easier, and allowed continuous recording (with subsequent printout when desired) of any portion of the computer operation. You will realize that this is a godsend in debugging and/or recovery, at low cost, of an operation that went sour somewhere before it was completed. At present under development is 8-channel input and output, to allow sort and merge using the almost unlimited storage of tapes. Eight of the basic input/output units would use half as much TTL as my whole computer (less the CRT store and display part) does. Whereas my design for 8 channels at a time uses only a few packages more. The next step will be to go to tape recording at a one-kilobit-per-second rate, and after that to five kilobits per second or possibly more.

"A typical recording sequence starts with turning on the power. It is necessary to load the thread the tape. The next actions are: start moving, get up to speed, locate working location, read or write, decelerate, stop, reverse (speed and distance, etc., are considerations here too; often you must reverse to re-read, because an error check failed or you missed the desired location), iterate, and shut down when finished.

"There are many types of decisions required:

A. How much of the above sequence is going to be manual and how much computer-controlled?

B. Is the data to be recorded and read incrementally, with stop and start around each block (which may be as small as a single character or even a single bit) or are read and write to be switched in while running?

C. How is the data going to be entered? One or multiple tracks? By blocks? Of what size? (1, 8, 64, 512-bit block sizes have proven useful to me.) With character parity? With bit-place parity per block? These last two are sometimes called row and column parities. Or is Teletype or some other special format to be used? (When I go to 1 Kbit/sec, I'll probably go from TT to a self-clocking format.) In any case, representation for the printer or display should be in ASCII if at all possible.

D. What means of synchronization is to be used? For bits? For blocks? If synchronous idle, 1001 0110, or null is used for block synchronization, there may be trouble if this gets out into a public carrier's lines at some future extension of your system.

E. What means of error detection is to be used?

F. What means of error correction is to be used? The TT format is of some help with both of these, but if synchronization is lost in a solidly-packed TT recording, the printout is real garbage. Parity is mentioned above. Multiplicity of recordings is another approach; that is, many copies of data in proportion to its importance.

G. What mode of recording is to be used? Amplitude, amplitude modulation, frequency modulation, phase modulation, pulse width modulation, etc. Duplication, parity, self-clocking, permanent clock, come in here too.

H. What quality of recorder is available? The 4LO Japanese recorder is in some ways my favorite (make that ten-dollar -- I'm not going to run this through the editing process but am going to keep the original and send you direct printouts from the tape so that you can see why I need the editing process). But it has many headaches, such as the lack of a capstan, and under-powered motor. The 100-dollar unit borrowed from the household is my mainstay. This is not really so cheap when your wife then goes out and buys a couple of her own. The three-motored solenoid-actuated deck was going to be my basic unit, but after getting optico-mechanical-electrical servos tied to it so as to get the one-millisecond starts and stops from high speed that I sought, I found that in overall operation these speeds, rather tremendous accelerations, were simply not needed and probably inadvisable since they stressed the tape to about a quarter of that which would begin to stretch it. When a data-processing system needs interface with only one man, the problems are quite different and some very simple and elegant solutions can be used. The wow, flutter and frequency response of the recorder to be used may dictate several of the choices mentioned. Speeds of 1-7/8, 3-3/4, 7-1/2, 15 inches per second and others are usable, but again, a choice is needed. A complete data-processing system for one man or one household could well use at least three speeds, but each speed would be used only on those units dedicated to it."

FREE COMPUTER

Mark James (Calif.) ran letters in two publications, asking for the donation of a computer, and this is what happened:

"Please excuse me for not writing

sooner; however, I had had very little luck in response to my letters in Computerworld and Datamation. Finally my long shot paid off. A company responded to my letter in Datamation by saying that they had some undisclosed computer equipment that they would be willing to give to me. What transpired was beyond my greatest expectations. The machine that was given to me is a 32K, third-generation, microprogrammable computer system with eight 556/800-bpi tape drives, a Selectric I/O unit, and a 100-cpm reader.

"The main memory consists of 32,768 locations in core, with a full cycle time of 2 microseconds, and access time of 800 nsec. The system is highly microprogrammable, with 1K X 36 bytes (used in 18-bit bytes) of microprogrammable core that cycles in one microsecond. After hauling the computer from Newport Beach, Calif. to Belmont, Calif. where I live, and moving the 1300 CPU, the tapes and control console to the lower level of our split-level home, with the help of several rather husky friends of mine, I was ready to start modifying the 208-volt, 3-phase power supply in the CPU. Very fortunately, once again I lucked out in that the power-supply design used a bank of three separate transformers to supply the main V_{CC} and V_{EE} voltages. Merely by rewiring the AC inputs of the transformers and adding an additional amount of filtering to the output of the power supply, I've been able to get V_{CC} and V_{EE}. Fortunately, all of the most critical voltages such as sense-amp supply and inhibit-driver supply came from single-phase supplies, and thus no additional filtering was necessary.

"The main frame uses approximately 6000 Fairchild CTL microcircuits, and is appropriately named an IC 6000. The system was manufactured by Standard Computer Corp. The unique capability of this system is that it can emulate other computer systems by the use of a microprogramming language called Miniflow. I presently have IBM 7094 emulation software on cards which I can read into the micro-memory. However, I also have a rather persistant parity error in the memory, which has defied my best efforts to locate. I suspect a sense-amplifier problem; however, I haven't been able to locate it because I haven't been able to get my hands on a wideband oscilloscope. Hopefully, though, as soon as I can borrow this, I'll be able to scope out the problem. One drawback in having a system with this architecture is that the microprocessor handles all I/O channel functions, and thus I can't load diagnostics or even display a register on the control panel until the microprocessor is functioning. However, this machine is going to have virtually unlimited potential in graphics processing. I have also had some rather drastic environmental problems, considering the fact that the entire system dissipates 48,000 BTU of heat per hour, and consumes approximately 14 kilowatts of electrical energy. However, I've been able to operate the CPU, one tape-control unit and two tape drives from the electric-dryer outlet in the house."

THE TRADING POST & HELP WANTED

NCR CRAM Memory

Buster Killion (2773 N. Winrock, Altadena, Calif. 91001) writes:

"I've got an NCR CRAM (Card Random Access Memory), which is basically a drum memory with a vacuum drum with 338 different surfaces in the shape of magnetic cards. Each card is held on a rack and can be individually selected, dropped, held

to the drum and read/written like a drum memory. I've got the complete mechanical transport. I don't have read/write logic or timing logic but I do have full documentation from NCR, including all diagrams, parts lists, maintenance manuals. I'm asking $300; pick it up at my house or trade for a dual-trace triggered-sweep scope (hopefully around 10 MHz)."

Buster would also like a Selectric I/O typewriter, will pay up to $500. He has an RC-70, and would like to hear from ACS members who have data terminals such that programs and data could be traded via a Data-Phone type setup.

Core Electronics; Software Needed

Sal Zuccaro (2116 Athens Ave., Simi, Calif. 93065) writes, in part:

"For the local member who may have a 4K core stack, I have a number of sets of Ampex R.F.6 memory electronics boards (2). The sets are complete for 18 or 36 bits, expandable to 20 or 40 bits. Stack and diodes are all that's needed. Cycle time is 900 nsec, but may be used at slower timing. I think the sets are worth $50 each, and any local who uses one can test his unit here on my equipment.

"Redcor Computer busted and I, the greatest scrounger of all time, just happened to be on hand and out of work. I have a complete data-processing center in operation and making money. I am presently on a tape operating system, and only time is needed for me to upgrade to DOS. From Ampex, I purchased ten mass memories of 5 million cores each. I plan to use these on DOS, using core instead of disc. I have all of the Redcor software. Locally there are about a dozen senior-level types who have Redcor systems in operation. We all share software and hardware info. The result is that we have an unbelievable amount of software in use. We are looking for source listings of BASIC, COBOL, and NASAP. If anyone knows where we can get cards or mag-tape copies, please yell.

"The ins and outs of system software is quite an education for a hardware type like me. Fortunately we have a couple of professional programmer types in our group. They help over the bumps."

Core and Keyboard

Steve Wiebking (910 Pleasure Park, San Antonio, Texas 78227) writes:

"I have nine of the 4096-word x 40-bit core-memory units that Gary Forbes was selling about two years ago. One has a single burned-out inhibit line; the rest are probably usable on all bits, although I have not tried any of them. The stack is mounted on a plug-in unit with space for 19 PC cards. The whole unit is about 12x12x4 inches and has four 50-pin connectors on the back. I have enough PC cards for about 3 units. Cards will go to first buyers at $80/stack, which is what I paid for them. I also have one of the Univac keypunch keyboards that I would like to sell for $20; the case has a slight crack."

Trouble with 8223 ROMs?

Steve Wiebking also wrote: "I may be able to help Bob Harrington, who was having trouble programming the 8223 ROMs (Nov. 1972 issue). I was having what I think is probably the same trouble programming some of these at work, until I noticed that the program won't take unless there is a bypass capacitor across the 12.5v supply (put it close to the ROM) -- I was using about 20uF."

Empty Tape Reels?

Tom Crosley (14-3 King Arthur Ct., Northlake, Ill. 60164) asks if anyone knows where he can get about 6 7-inch-diameter empty tape reels, for ½-inch tape, standard large hub, for use on his transports.

Modem Circuit?

Jim Hart, Jr. (101 N. 8 St., Murray, Ky. 42071) asks: "Does anybody have a cheap and dirty acoustic modem circuit?"

(Jim has quit working for NASA as a physicist and is now going to medical school.)

Info on a Fabri-tek Core Memory?

Gene Witherup (RD 4, Bloomsburg, Pa. 17815) asks: "Would any reader have information about Fabri-tek core, model 3509 (Rev. C)? This is a 16K-byte core with pulse transformers and diode circuitry intact, and so far I haven't seen any circuits using pulse transformers in the address lines."

Working on Computer Music?

Ned Lagin (Box 269, Fairfax, Cal. 94930) writes: "Would like to hear from others working on computer music projects. We will need software help or collaboration perhaps." Ned plans to buy a Nova 2/10 or PDP-11/40, "depends on funds."

COMMUNITY-GROUP COMPUTER

Resource One (1380 Howard St., San Francisco, Calif. 94103) is a nonprofit community group to which has been donated an XDS-940 time-sharing computer system. Projects in planning include using the computer for health care (accounting, billing and statistical reports for community clinics; developing information systems usable by clinics to improve and evaluate their services to health-care consumers), community-group services (helping with mailing lists, accounting and other time-consuming clerical work; developing a network of shared resources, information and cooperation among many different groups), etc. A Resource One member writes: "We desire only sufficient commercial applications to support our total operation." They would no doubt welcome assistance from any local ACS members in keeping the 940 in shape and in other computer and electronic projects. (According to their flyer, One is a "community of 200 artists, craftsmen, technicians and ex-professionals, living, working and sharing their skills in a converted 5-story warehouse in the south-of-Market area.")

IN PRINT

Computer Terminal

An article by Don Lancaster, "TV Typewriter," in the Sept. 1973 Radio-Electronics (p 43-45, 50-52) describes a construction project for a computer terminal using a TV set for CRT display. Complete construction details are available in a 16-page booklet (which includes the original article) for $2.00 from: TV Typewriter, Radio-Electronics, 45 East 17 St., New York, N.Y. 10003.

Parts are available from Southwest Technical Products: 5 PC boards for $32.75, keyboard for $18.75. A set of semiconductors will cost about $50.

Radio-Electronics may be running an article in a couple of months on a simple computer to go with the TV terminal, which generates and stores 512 characters, arranged as 16 lines of 32 raster-scan dot-matrix characters each. Any keyboard will work with this terminal, providing it can generate 7 bits

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of TTL-compatible ASCII code, and had a keypressed output that is normally high and drops to ground when a key is pressed.

Conservative Design

Elmer Beachley (Penn.), commenting on the "Computer Technician's Handbook" by Brice Ward (June 1971 newsletter), says "I have found that many commercial schematics are more conservatively designed than is necessary for the amateur, who usually must sacrifice reliability for cost. In this respect, industry designs can be misleading."

Computer in a Cornfield

Page one of Computerworld for Oct. 3, 1973, has an article titled "In Hoosier Cornfield Rises... a Computer?!" and it starts: LIBERTY, Ind. — In the middle of a cornfield, outside this sleepy town of 2,000, sits an old concrete barn. Rented by two men for $50/mo, the barn houses a $2 million computer system they built for $20,000 from surplus and scrounged hardware components and software so cheap "it might as well have been free.""

The two men are Bill Eaton and Gary Forbes, both ACS members.

Eaton, while with the Air Force in Phoenix, Arizona, worked in an electronics surplus store that bought and sold computer parts dumped by the GE Salvage Operation. Forbes, an old friend, sent him $800 to buy three tape drives, a controller, a typewriter and some circuit boards. Later Eaton bought a GE 645 Series line printer, the I/O control, and other components for $800. Later came 32K (36-bit-word) of memory for $800.

Out of the Air Force in 1970, Eaton bought a 645 CPU for $350. A fully operational 12,000 line/min printer was $750. A full set of cables for the 645 was 12 cents a pound, or $200 in all.

Eaton and Forbes bought a Datanet CRT terminal for $500 and 32K more words of memory for $300. Forbes took a job in Phoenix to be close to the "store" and Eaton quit his job to spend full time on assembling a system. Using Eaton's wife's salary and Forbes' salary, they bought all the missing power supplies, 64K words more of core, and a 50M-byte GE DSU 204 disk subsystem. The complete programming for the 645 was found being sold for scrap paper and scrap tape.

Eaton and Forbes are looking for "a buyer, a backer, a proposal, anything in the form of money." They claim the system is totally compatible with another 645 or 635. The last quote from Eaton: "We don't care who buys it; we know if bought from GE the system would cost more than $2 million. After six years it would be nice to get some money and stop living in a cornfield in Indiana."

Your Computer?

If you haven't written to the ACS about your computer, send details.

WANG PATENTS

ACS NEWSLETTER

a publication of the AMATEUR COMPUTER SOCIETY

Volume III, Number 8 (Serial Issue 31) March 1974

WANG PATENTS

The July 1969 Newsletter carried an item about the basic patent on the ingenious logarithmic circuit used in the Wang calculators.

Cdr. Lyle Pellock, back from duty in Vietnam, has been researching Wang patents. He is now stationed in Washington, so "getting to the Patent Office is no problem." His first letter:

"Patent 3,402,285 of Sept. 17, 1968, "Calculating Apparatus," gives the basic theory of the Wang log generation system, replete with examples. Patent 3,428,950 of Feb. 18, 1969, "Programmable Calculating Apparatus," gives details on the Wang card reader. Patent 3,509,329 of April 28, 1970, "Calculator," is very detailed and includes many logic diagrams and logic flow diagrams. There are 47 sheets of drawings and 17 pages of text. While I have not checked it out completely, it would appear that there is more than enough detail to allow building a similar system. All in all, a very good buy for 50¢. [To get a copy of a patent, send the number and 50¢ to the Commissioner of Patents, Washington, D.C. 20231.] Patent 3,511,974 of May 12, 1970, "Automatically Controlled Calculating Apparatus," is a further expansion of 3,402,285 and discusses card programming. Patent 3,524,970 of Aug. 18, 1970, "Automatically Controlled Calculating Apparatus," is a continuation of 3,428,950. It gives details of interfacing more than one card reader. Patent 3,573,746, "Calculating System," also continues 3,428,950 and subjects as branching and looping. Patent 3,594,734 of July 20, 1971, "Programmable Calculator," gives logic-diagram details on a tape-reader-controlled calculator. Also, patent 3,474,437 of Oct. 21, 1969, "Scanned Display Device," and patent 3,449,555, "Parallel Binary to Binary Coded Decimal and Binary Coded Decimal to Binary Converter Utilizing Cascaded Logic Blocks," are informative. Patent 3,474,437 includes a schematic of the system along with component values."

Later: "The Patent Office has an excellent cross-referencing system (just like a library). All you need is one of the following: patent, inventor, application serial number (prior to patent issuance), or assignee. I am not sure if Wang is coming out with any new patents; however, the P.O. is tight-lipped on pending applications."

Letter 3: "Made another trip to the Patent Office and found the latest assigned to Wang. In my experience (limited though it is), it is kinda rare to get so detailed a patent (3,727,201, April 10, 1973, "Information Storage System"); i.e., complete with core part numbers, current levels, access time, et al. Another recent Wang patent discusses an automated braided ROM wiring machine which I'm sure matches 3,727,201. The wire size suggested in the automated loom was 28-32 AWG.

"Also enclosed is the foreward page from a March 1973 NAVELEX (Naval Electronic Systems Command) publication. Volume I (of the Digital Computer Systems Handbook) would not be too useful to ACSers. Vol. II uses the Fabri-Tek Bi-Tran Six Educational Computer [described in the Aug. 1966 Newsletter] as the functional description vehicle, and covers the 6-bit, 30-instruction machine in great detail (func-

tional logic). I feel Vol. II would make a worthwhile addition to a technical library. I have noted the Gov't Printing Office stock number (0859-0010) and the price ($3.25).

"My latest job involves daily contact with all facets of shipboard naval electronic equipments, including, for example, NTDS, AN/UYK-7, AN/UYK-13, AN/UYK-15, etc. I am evaluating available information on Navy-used computers to see which way I want to go. The one problem with these computers is that, except for what is called the mini-UYK (AN/UYK-15), the machines are big. I am still looking at the Wang method, and may settle for a relatively simple programmable pseudo-calculator."

Letter 4: "I made another trip to the Patent Office and can bring you up to date on Wang. 3,760,171, "Programmable Calculators Having Display Means and Multiple Memories." This Sept. '73 patent addresses the Model 700 calculator and discusses the internal programming. Additionally mentions 3,727,201 (see previous letter) as covering the ROM of the calculator composed of 2048 43-bit words. 3,754,631, "Positioning Typewriter." This Aug. '73 patent discloses the Wang modifications to a Selectric to allow its use, primarily as an output device for graph plotting, etc. 3,470,542, "Modular Systems Design." Busing techniques, probably used in their old Model 4000 series. However, the details would have further applications. 3,567,911, "Sensor for Punched Cards." Details on the Wang card reader, whose basic concept is that of a non-moving card with multiple contacts for reading.

Non-Wang Patents

I have also found some interesting non-Wang patents. 3,781,820, "Portable Electronic Calculator." This Dec. '73 patent assigned to H-P uses a recirculating shift register concept for store/recall. Very detailed, down to the logic-element level, but only for addition, store, recall, enter, and sign change. A good start for a simple desk calculator. 3,676,656, "Electronic Digital Slide Rule." This is a very interesting device, assigned to G. E. [see the Feb. 1970 Newsletter, p 6], uses a pulse-rate generator and decimal rate multiplier to generate multiplication, division, squaring, square root, addition, subtraction, exponential, logarithm, sine and cosine. The idea is a replacement for your slipstick, with inputs and answers to 4 significant figures. The patent is very detailed, down to the logic-device level, complete with recommended devices such as 7490, 9307, and B-4021 Nixie tubes. Might just build one and throw away my K&E. 3,766,370, "Elementary Floating Point CORDIC Function Processor and Shifter." This Oct. '73 patent, assigned to H-P, has got to be the best 50¢ bargain around: 233 pages of diagrams, complete with logic-device identification (including pin assignment), parts values, etc. This embodiment of the CORDIC technique (see the article by Volder in the Sept. 1959 IRE Trans. on Electronic Computers, pp 330-334) is designed to interface with the H-P Model 2115/2116 minicomputer and thereby generate up to triple precision on 20 functions. 3,778,775, "Microprogrammed Terminal." This Dec. '73 patent, assigned to Computek, discusses a microprogrammed, alphanumeric, single-bus computer display terminal.

"Enough on patents. I have just about completed the implementation into TTL of Wang's 3,509,329 but am hung up on a ROM problem. Need three 256 X 4-bit-word ROMs from 8223's by cascading to reduce parts count. A real problem that has so far consumed untold hours

(and all to save a few bucks — I guess it's the challenge that this pastime is all about). The other option is to use 353 2-input ANDs and some ORs. Well, I'm still working on the problem. These ROMs are used to calculate ln, ½ ln (for square root) and 2 ln (for x^2), in accordance with the basic WANG method. I have also replaced the core memory described with 7489 RAMs, which is one heck of a lot cheaper (there I go again trying to save bucks) and simpler. I have been through a couple of iterations of the design (more than one to correct mistakes) but don't believe I have minimized parts count yet. For example, I decided to standardize on NAND logic, i.e., the 7400, but an OR application would be a lot easier (and cheaper?) with a 7402 and I do have a lot of OR/NOR needs."

THE NEWEST PDP-8

The latest DEC minicomputer in the PDP-8 line is the PDP-8/A, $895 each, or $537 in quantities of 1000. The 8/A has ROM, RAM and p/ROM memory options, a 1.5-usec cycle time, and is hardware and software compatible with the earlier 8/E, 8/M and 8/F models.

COMPUTER KIT

A modular computer kit has been offered since late last year by SCELBI Computer Consulting (125 Edgefield Ave., Milford, Conn. 06460).

The PC cards can be bought separately, or in combinations. The SCELBI-8H starter set of five cards — CPU, DBB (data bus buffer) and output, input, front-panel card, and RAM card (256 8-bit words) — is $440. One step up is the 8H standard card set, with 1024 words of RAM memory; $565. The standard computer consists of the standard card set plus card chassis (with console switches, card sockets, I/O and power connectors), separate power supply; $795 in kit form, $950 assembled. The 8H deluxe computer has 4086 words of RAM memory, and a higher-rated power supply; $1400 in kit, $1600 assembled. The memory can be expanded to 16K words, for about $2760 more.

Peripherals include oscilloscope alphanumeric interface (requires a scope with a bandwidth of 5 MHz or more), $200 kit; audio cassette tape unit interface, $100 kit; and an ASCII keyboard (reconditioned, less case), with interface, $100. The bit-serial interface for a 33 Teletype is $50 without relay for tape reader, $75 with relay.

The SCELBI-8H is a "fully programmable machine having a basic instruction set of 48 instructions, with variations of these ... allowing approximately 170 different instructions."

The machine has one full accumulator and six additional temporary registers. The CPU program counter is on a seven-level pushdown stack allowing subroutine nesting to seven levels. All eight output and six input ports are fully TTL compatible. The SCELBI-8H is 10 inches wide, 9.5 high, 12 deep.

Instructions require 3 to 11 "states" and a typical instruction requires about 5 states (20 microseconds) to execute.

SCELBI has a "wide range of programs and software support for the 8H and SCELBI-developed peripheral interfaces." Programs now available include program loaders, memory dumps, and CRT display programs. Editor and assembler programs and a "sophisticated calculator package" are being developed. The programs cost about $5 to $20; a listing of the calculator program

(with 2K of core) is $50; the object coding is $20. A program is available for assembling 8H programs on a PDP-8.

SCELBI stands for Scientific, Electronic and Biological.

MORE ON THE PDP-8/A; THE MPS

The $875 unit price for the DEC 8/A includes 1000 words of MSI memory. There are optional increments of 2K and 4K in RAM; 1K, 2K and 4K in ROM; and 1K and 2K in p/ROM. Prices for these have not yet been established. Maximum memory for the 8/A is 32K words.

Computers have become cheaper than a few K of memory. The 8/E, for instance, is now $4490 with its initial 4K; an additional 4K costs $2500. It will be interesting to see what prices DEC puts on 8/A memory.

Also new at DEC is the MPS microprocessor series, an 8-bit MOS/LSI processor for the low end of the controls market. Based on the Intel 8008 chip, the MPS has 48 data-oriented instructions, RAM memory with increments of 1K words, up to 4K words, PROM with maximum storage up to 4K words. Price is less than $750 each, with 1K RAM. Applications include intelligent terminals, process control, and dedicated controllers on industrial machinery.

THE TRADING POST & HELP WANTED

Core Memory, Sense Amps

Ron Carlson (7333 West 90 St., Los Angeles, Calif. 90045) has a 4K X 14-bit core stack with driver transformers and resistors, mounted in a 19-inch card cage ready for timing, sense and driver cards; $75 or trade. Also, 28 SN7529N dual sense amps by TI, cost $1.59 each, will sell at $1.00 each.

Ron also has "a note on my Intel 8008 computer. Proceeding slowly but sure hope to be running soon. Currently debugging the solid-state console; uses only touch switches and LEDs. If anyone is interested, will give them my circuit for it. Works quite nicely."

TV Typewriter as TTY Substitute?

Dick Snyder (621 Old Colony Terrace, Tiverton, R.I. 02878) asks "Do you know of anyone who has modified one of the Radio-Electronics TV typewriters to use with a computer as a Teletype substitute?"

Memory Chips

William Mitchell (39 Rockfield Cres., Ottawa, Ont. K2E 5L6, Canada) writes: "After a year of negotiation, I am finally able to offer "production drop-out" memory chips to ACS members. Both 2102 RAM and 1702 PROM units are available. The 2102 is a 1024-word by 1-bit MOS static RAM; single +5V supply, directly TTL compatible, fully decoded, 16-lead DIP. Typical access time is 500 nsec, but this may be one of the reasons for rejection.

"The 1702 is a 256-word by 8-bit programmable ROM, requiring +5 and -9V. Typical cycle time is 1.0 usec; TTL compatible.

"The price for the units is $11.00 per pair for the 2102's and $11.00 each for the 1702's, postpaid, and including Federal Sales Tax.

"Because the 1702's are rather difficult to program without the proper equipment, I am prepared to perform this operation for an additional $2.50 per unit provided that the required bit pattern is supplied on punched cards, coded in hexadecimal, 2 columns per word and 32 words per card, it will require only 8 cards. Use columns 73-

80 for a serial number so they will be in the right order, and double-check your coding as I can only provide what is asked for. An acceptable alternate layout for the card is to separate each pair of digits by a space for better checking, and using col. 1 to 72 as required.

"If I get a chance I will try to run some tests on the units before shipping, but the samples provided to date have been operable as represented. I'm busy designing my own computer around them, as you might imagine."

Later: "I have confirmed that the units meet all spec. tests except for cycle time: the 2102's operate between 1 and 3 usec, while the 1702's are between 1 and 2 usec."

Selling, Buying

Michael Guerre (204 Faxon St., Spring Valley, Calif. 92077) has these for sale: "one Clary 703 programmer without keyboard; this is an 8-level paper-tape punch operating at 20 cps; removable diode matrix board; $30. One Geotech 24888/14R magnetic tape head, 14-track, 1-inch, used, about 2/3 life left, $5. One FL Flexowriter, missing part of tape reader, needs some work done; $55. Buyer pays postage, or picks up.

"I am looking for: keyboard (non-mechanical); printer, alphanumeric, any type; incremental cassette tape drive; technical manuals (schematics, operation, etc.) for any of these computers: IME 86 SR, Unicom CP-8, Applied Systems 1100 and Home-Ec VII, Autonetics RECOMP (CP-266), H-P 2114 and 9100 A or B."

Who Has a Kenbak-1?

Tom Crosley (14-3 King Arthur Ct., Northlake, Ill. 60164) writes: "My computer is basically a Kenbak-1 [see the Nov. 1971 Newsletter], to which I have been making additions. Right now I am working on the memory addition; then will come the CRT, second TTY, and mag tape. Even with only the original 256 words of memory, I have enjoyed writing programs for the Kenbak-1, such as a line-by-line text editor for the TTY; games (e.g., Nim); and a Turing machine simulator. After adding the 2K of memory, allowing much larger programs, I still don't feel the slow cycle time will be a drawback; since most of my applications will be TTY-oriented, most of my programs will still be I/O-bound.

"I would be interested in corresponding with anyone else who has a Kenbak-1 and has made or is thinking of making additions to it."

NRI Computer Kit Manual

Robert W. Kelley (5806 Mt Terminal Dr., Waco, Texas 76710) writes that the NRI 832 computer reference manual 10KX once available from National Radio Institute (see the Sept. 1972 issue) is no longer available; he would like to buy or buy a copy. Note: NRI has dropped plans to sell a wired 832 separate from the course.

Wants IEEE and ACM Publications

Al Marshall (412 Oakwood, Angola, Ind. 46703) would like to obtain: IEEE Systems, Man, and Cybernetics Vol 1, #3; IEEE Trans on Computers Vol 20, #4 & #8; ACM Comm Vol 15, #1 thru #6; ACM J, Vol 16 #4, Vol 17 #3 & #4. Al adds: "For others who may be missing issues, I found some extras and I have some I'm not going to keep. Drop me a line if you have a hole in your collection."

IBM 705 for Sale

Willis H. Hard writes: "Although I have never seen your publication, I have been informed by some of my

The Amateur Computer Society is open to all who are interested in building and operating a digital computer that can at least perform automatic multiplication and division, or is of a comparable complexity.

For membership in the ACS, and a subscription of at least eight issues of Vol. III of the Newsletter, send $5 (or a check) to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.
Darien, Conn. 06820

The ACS Newsletter will appear every two or three months.

associates that, despite its rather small circulation, it does reach many dedicated amateurs.

"I have just decommissioned my IBM 705 computer and put it in storage pending its sale. Since it is a first-generation computer, it is unlikely to be sold to a commercial user because of its cost of operation and maintenance. Therefore, I would like to offer it to a more receptive group of potential buyers through your journal.

"The system consists of a 705 CPU with a 40K-byte core (7 bits per byte), a console (including typewriter), 745 power supply, and a card reader. It also contains a 754 tape-control unit and eight 727 tape decks (I just sold 2 of the original 10 to an amateur who is going to convert them to solid state). The system is for sale as an entity or by the piece, and my address is: P.O. Box 1132, Canoga Park, Calif. 91304."

IN PRINT

Modem Circuits

In response to Jim Hart's request for "cheap and dirty acoustic modem circuits" in the previous issue, several members sent him info.

Mark Messinger (New York) sent copies of several articles: "Low-speed modems are easy to design" (Electronic Design, Sept. 2, 1971, pp 50-52); "Design pruning trims costs of data model" (Electronics, July 20, 1970, pp 99-101); "Build your own acoustic coupler" (Electronic Design, Mar. 1, 1969, pp 68-73).

Jim Knock writes from Illinois, in part: "Another possibly useful piece of information is the product description available from Exar Integrated Systems, 750 Palomar Ave., Sunnyvale, Calif. 94086, on the XR-210 FSK modulator/demodulator. I believe there are companies selling modem kits for something in the range of $50. Ads can be found in occasional issues of EDN, Electronic Design, Computer Design, and Electronics. There are a lot of different considerations: frequencies, switchable speeds, number of bits per character, character representations of special characters, etc. One should also be aware of the fact that the typical ham RTTY setup is distinctly different from what is generally used in the field surrounding digital computer communications.

INTEL 8080 CHIP

Intel's new NMOS 8080 microprocessor is an improvement on the PMOS 8008, with a 2-usec instruction cycle and 74 basic instructions (26 more than the 8008). The 8080 can address up to 65K bytes of memory without an external address register. It can perform double-precision arithmetic, in BCD and binary, and costs $360 for 1 to 24. For a TTL I/O interface, the 8080 requires six ICs; the 8008 needed 20. The 8080 comes in a 40-pin package and operates from +12 and ±5-volt supplies. There are assemblers, editors, and simulators.

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MARK-8 MINICOMPUTER KIT

The July 1974 Radio-Electronics has a short article (pp 29-33) on a minicomputer kit. As with the TV Typewriter (see the Dec. 1973 Newsletter, page 5), a 52-page booklet containing the full details is available, for $5.50 (plus 7% tax for New York State residents) from Radio-Electronics, Micro-Computer, P.O. Box 1307, Radio City Station, New York, N.Y. 10019.

The Mark-8 is built around the Intel 8008 microprocessor and uses 7400-series TTL ICs, plus the 1101 (or 1101A or 1101A1) type 256-bit RAM as memory. Register readout is by four groups of eight LEDs.

A set of six PC boards costs $47.50 for the CPU, address latch, input multiplexer, 1K memory, LED register display, and output ports. The 8008 from Intel is $120, but can be had for $50 or so elsewhere. No cabinet is available. The 1101 is available in quantity for about $1.80 each. Since the 1101 RAMs are volatile memories, "information stored in them will be altered or lost if the power is shut off. If you want to save a program, leave the power on."

The six boards use a total of 74 ICs in the minimum 256-word version; for every additional 1K of memory, add 32 of the 1101 RAMs.

The Mark-8 can be used with the TV typewriter or with the ASCII Keyboard, the latter described on page 5 of this Newsletter.

According to the Mark-8's designer, ACS member Jonathan Titus (see the May 1973 Newsletter, page 6), a minimum Mark-8, with 256 8-bit words, is about $300. The Mark-8 circuits provide a basic capacity for up to 4 memory boards, for a maximum of 4K words; however, by adding external addressing decoders, up to 16K words can be addressed directly.

The Mark-8 is programmed in Intel assembly language, which has 48 instructions for the 8008. There is an Intel user's group; membership is obtained either by contributing software or by paying $100 a year.

Add-ons are planned for later, and include a modem, cassette-storage interface, and a calculator interface.

COMPUTER BUILDERS ABROAD

The ACS Newsletter has been the inspiration for two foreign ones. Mike Lord ran a letter in a British electronics hobby magazine asking if anyone was interested in joining a computer club. I sent him copies of this newsletter. In March 1973 the Amateur Computer Club Newsletter appeared, with a first issue looking very much like its American cousin. However, by Vol 1 Iss 3, it had established its own identity, and included a cartoon, flowchart, some "analogue computer" circuits, a page on the game of Life, part of a tutorial on cores, etc. The ACC Newsletter (7 Dordells, Basildon, Essex, England) appears every 2 to 3 months; Vol 1 is 50p.

Michel Dreyfus, an ACS member, is president of the AFACO, founded this spring in France (42, rue de la Barre, 95880 Enghien-les-Bains).

AFACO is the Association Française des Amateurs Constructeurs d'Ordinateurs. The newsletter is entirely in French; the first issue describes plans to establish contacts between those who want to and those who have built a computer, publish basic articles for beginners, publish technical articles on subjects such as memory, peripherals, and computing circuits, publish the characteristics of new ICs, try to get ICs from manufacturers at low cost or free, etc. There is a brief note on memory, stating that this is the most difficult part of a computer to get working; a few words about a Universal Computer being built with a read-only storage, to use PL/1; circuit for a 5-volt power supply; 3 pages describing the "Machine Originale Numerique et Logique," a paper microcomputer. No subscription price is given for the AFACO newsletter, which the founders intend to issue every two months. The AFACO is rather optimistic, declaring that "Building a computer is relatively simple; simpler, perhaps, than building an electronic organ."

SYSTEM ONE COMPUTER KIT

The System One computer kit, mentioned in the Feb. 1973 Newsletter (page 4) is no longer available. The company marketing it, EPD (Environmental Products, Glenwood Springs, Colo. 81601), has gone out of business. Rights to publish the User Technical Notes (see the Sept. 1972 Newsletter, page 6) were bought by Technical Publications Corp., Box 954, same town; plans are to publish them more often.

TPC plans to bring out a System Two computer kit, with solid-state memory, half the number of ICs, and at about the same price.

Jim Gaudreault of Maryland writes that he bought the plans for a System One, and says: "The System One is a nice simple machine for an amateur to try in ICs. A word of caution: the Boolean logic equations for the Programmed Logic Array that are given in the documentation have several errors. A machine wired according to the plans would never work. Even after the errors had been corrected, the resulting machine would lack several of the features (including four instructions and any type of programmed I/O) advertised for the System One. The designers obviously ran out of room in their PLA to implement all that they had hoped for. All of this is on top of great inefficiencies in the implementation of the PLA logic. Also, the diagram of the memory timing board was omitted."

ADDING TO THE KENBAK-1

Tom Crosley writes from Illinois: "To the basic Kenbak-1, so far have added interrupt system plus real-time clock (1 second interrupt); am just completing a full duplex TTY controller (at first I used serial I/O for the TTY); am adding a paging register to select one of (initially) 16 128-word pages (only in effect for addresses 204-376; the lower addresses — and all registers in memory — will be available independent of the page register). Am making use of the "don't care" bits of the NOP instruction to add 15 I/O instructions which will be single word (data set up in registers)." Tom will be using a TV Typewriter as a CRT terminal, and two mag-tape transports.

THE TRADING POST & HELP WANTED

<u>CRAM, Transports, Core, Etc.</u>

Buster Killion (2773 N. Winrock, Altadena, Calif. 91001) writes: "(1) Since I've acquired other

equipment, I no longer need my CRAM [see the Dec. 1973 Newsletter, page 3] and I am asking only $100 so I can get the storage space back. (2) Scientific Data Systems (Xerox) dual cartridge drive (two cartridge drives in one 19-inch rack mtg) minus plug-in cards but with some documentation, $100. (3) NCR thermal printer, 80 characters per line, 8½-inch wide paper (TTL state of the art), $250. (4) Marconi "IBM card" reader, about 400 cpm, $75. (5) Ampex TM-4 transport deck, ½-inch 7-track, sans head and vacuum assembly, $50.

Also I have brand-new Ampex 850-nsec core stacks, 18-bit x 4K words, $35 each. And I purchased the IBM 727's from the other amateur that Willis Hard mentioned in the last Newsletter and would like some help, if anybody has any diagrams for head R/W electronics I can build for these machines. Also I have some Century Data floppy-disc drives model 127 sans head & electronics for $75 each."

Core Search & Patents

Stephen E. Flocke (1407 Croyden Rd., Lyndhurst, Ohio 44124) writes:

"I'm in the process of building a 16-bit microprogrammed machine with a small core memory. My only major problem is finding some ferrite cores for a transformer-type read-only memory. The type I'm looking for have about a ¼-by-¼-inch cross-section core and about a one-square-inch opening. They were used in some rope memories made at MIT in the 1960's.

"I have been looking thru patents for computers; the Cleveland Public Library has a very complete file. One thick one, 3,400,371, has the IBM 360/30 complete with microprogram and internal logic diagrams. The Interdata Model 2, complete with microprogram listing is 3,675,214. For historical buffs, the ENIAC is patent 3,120,606, and the Univac 1 had patent 3,784,983 issued Jan. 8, 1974 — 22 years after it was filed."

8008 for $50

Steve Wiebking writes from Texas that there was an ad in 1973 offering the 8008 for $50, by Bill Godbout Electronics, Box 2673, Oakland Airport, Calif. 94614.

Equipment Source

Gary Colemen writes from Ohio: "I have finished wiring up my CPU for my little machine. Big deal, 15 chips. I have found that ham conventions are great sources of cheap equipment. I bought an IBM I/O typewriter at one for $50 in perfect condition."

Disc Controller Designs?

Owen Phairis (1908 12th St. Apt 1, Santa Monica, Calif. 90405) says: "I am working on a 16-bit machine and I have a Memorex 630A disc drive for it as well as two IBM 727 mag-tape units. Estimate one year before completion. Would be very interested in designs for a disc controller."

ACS Data Net?

Jim Hart (101 N. 8 St, Murray, Ky. 42071) writes: "I have often been frustrated by the need to ask the ACS membership about small things such as the availability of parts or information about a particular circuit, while realizing at the same time that these matters are of too little consequence to be carried in the Newsletter. In light of this, I would like to hear from ACS members who would be interested in designing a rather loosely organized data net to function as a readily accessible "bulletin board" for ACS members. The equipment could be

fairly simple: a 100-wpm modem and a mag-tape transport on a dedicated telephone number. Ideally, such a facility would be accessible to someone with a bare minimum of equipment, and would be intelligent to take care of itself most of the time.

"The cost of construction and maintenance of such an installation, given a little ingenuity in the design, could be made quite small and could be borne in several ways, including a subscription fee or, better, a small fee for posting "for sale" notices.

"It should be emphasized that such a facility would in no way diminish the importance of the Newsletter. Instead, it should augment it by serving as a medium for communicating items of limited interest and notices of short-lived interest which the time-frame of the Newsletter publication makes it impractical to carry.

"For the present, at least, I don't have the time or the resources to act as prime mover in such a project, but I would enthusiastically give what help and support I could to any person or group that cared to undertake, or at least to study, a project of this sort. I feel it would be of benefit to all of us."

Interdata 7/16

Dave Vednor (14914 D Newport Ave., Tustin, Calif. 92680) writes: "I have purchased five Interdata 7/16 CPU's at work. If any members are interested, I have sets of schematics for the CPU, memory, and many of the interfaces, and most of the software (BOSS, DOS, RTOS, assemblers, Basic, Fortran IV, etc.). If any members are contemplating the purchase of a 7/16 or have done so, they should contact me regarding hardware multiply/divide and memory parity options, as I can supply these for less. A copy of the Want 720 service manual can also be obtained from me."

Disk Heads?

Don Tarbell (144 Miraleste Dr., Miraleste, Calif 90732) writes: "I just got my disk operating system going good, and it really helps out in program development. I also have a simple version of BASIC going, and a modem has been added to the system. I was wondering if anyone knows where I could get a set of 2311 or 2314-type disk heads. I would like to experiment with that kind of drive, as it would allow me more storage capacity.

"In response to Dick Snyder's question, I have a direct memory channel operating on my computer for the disk drive. I will soon be adapting it to an IBM 727 tape drive, which a friend of mine has converted to solid-state. The channel operates thus: index register 3 is first loaded (by the program) with the block starting address; X5 is then loaded with the block length; an instruction (block transfer) is then given to write; the disk interface counts the number of 1's, module 256, and attaches this 8-bit byte on the end of the block; for a read, the same registers are loaded, and the read-block command is given; after the data is transferred into core, the last byte (check) is automatically put into the upper half of the 16-bit accumulator; the 1's counter, which also counts during a read, is then read into the lower half of the AC, and the two halves compared for the check. A separate CHECK-BLOCK instruction is used for checking the block integrity after a write without altering core. It works the same as the READ-BLOCK, except core is not tampered with. The main drawback to this system is that concurrent I/O is not possible, as with a

cycle-steal type of DMA. This is because the program counter is "frozen" at the instruction location until the transfer is complete. However, this is no problem in my system, because my disk data transfer speed is close to the cycle time of my computer. As far as the error-detection scheme goes, I realize it is not foolproof, but has worked quite satisfactorily for me. If anyone is interested in more detail, or has ideas, please feel free to write to me."

IN PRINT

TTL Cookbook

This is the title of the latest book by a new ACS member, Don Lancaster. Very little material is repeated from Don's previous book, the "RTL Cookbook."

After a chapter on the basics is an 84-page chapter on circuits, with a page each on 77 TTL ICs, mostly 7400 and 74100 types. The next five chapters are on: logic; gate and timer circuits; clocked logic; divide-by-N counters; and shift registers, noise generators and rate multipliers. The last chapter, "Getting It All Together," describes such TTL applications as a frequency counter, digital voltmeter, digital tachometer, TV Typewriter, etc., many of which are available in kit form from SWTP, which also has kits for TTL and RTL breadboard labs.

There are various circuits of interest to ACS members, such as Baudot-to-ASCII, keyboard encoder, keyboard debouncer, readout drivers, ASCII-to TTY-code, etc.

The "TTL Cookbook" is $8.95 from Sams, but Don writes that "Southwest has agreed to offer the text at discount for ACS members. The price is $7.95 from Southwest Technical Products, 219 West Rhapsody, San Antonio, Texas 78216."

Misnamed Book

The "Handbook of Computer Maintenance & Troubleshooting" (Reston, 366 pages, $18.00) should really be titled "Some Information on Maintaining & Troubleshooting Digital Circuits in Military Systems." The first 100 pages are general, and could go into almost any book on electronic maintenance. The machines involved in later chapters are not computers, but mainly the digital circuits in radar and other military systems. There are computer-oriented chapters, but on printers, programming, and military test equipment. The 39-page chapter on troubleshooting is of some value, going into Boolean algebra, logic analysis, patterns and waveforms, signal-tracing, and oscilloscopes.

Microcomputer Chips

"Current Microcomputer Architecture" by Holt and Lemas of Compata, in Computer Design (Feb. 1974, pp 65-73) discusses the recently introduced microcomputers. There is a chart of the operational characteristics of seven of them (AMI 7300 and CK114, Fairchild PPS-24, Intel 8080, National IMP-16, Rockwell PPS, Signetics PIP), the block diagrams of the 7300, CK114, and 8080, a discussion of the circuitry of all seven, and a 35-item bibliography.

HARDWARE

ASCII Keyboard and Encoder

An article with this title, by Don Lancaster, appeared in the April 1974 Popular Electronics (pp 27-31). A complete kit of parts is $39.50 from Southwest Technical Products, and includes two MC789AP hex

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Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.
Darien, Conn. 06820

The ACS Newsletter will appear every two or three months.

inverter ICs, 20 1N914 diodes, 49 keyswitches and keytops, etc. The user must supply the +5 volts. The keyboard is assembled on a single double-sided PC board. Details are included for using a Monsanto MDA-111 or MAN-2 as a single-character readout. The text notes that "the keyboard can be used as a computer timesharing terminal, either in commercial service or for home or school. The keyboard, with a simple parallel-to-series converter, forms half an ASR-33 Teletype at a very reasonable cost."

IC Digital Logic Memory Probe

An article with this name (Popular Electronics, Mar. 1974, pp 33-35) describes a penlite-size probe for checking 5-volt logic devices. The indicators are three LEDs; the ICs are a 9601 used as a triggerable multivibrator, and a 7404. Pulse-stretching keeps the center LED on for 200 ms, for pulses as short as 50 nsec, giving enough time to observe them. The top LED lights for logic 1, the bottom LED for logic 0. A switch allows the center LED to remain on permanently after a pulse. A kit of all parts is $17.50.

Teletype Model 40

A year ago, Teletype introduced a new terminal, the Model 40, $2500 to $3500 with keyboard and CRT display, $1000 more for a high-speed printer. The printer rate is five lines per second, with both upper and lower case. With its logic and memory circuits, the 40 permits editing text on the screen; when a word, line or letter is erased, the space is closed up automatically. And the 40 will store up to three 24-line pages of text without external storage, as well as formatted data.

Add $2K of logic and memory, and the 40 becomes a stand-alone minicomputer, although Teletype won't be going that route, leaving it to others.

Across the Counter

A variety of equipment is sold by Data Instrumentation Associates (208 S. Pulaski St., Baltimore, Md. 21223). They have test equipment (scopes, counters, generators), power supplies, ICs, and digital equipment (LGP-30, $250). "A number of items are so costly to pack that we offer them only on a pick-up basis, including magnetic-tape units. Open to the public Saturdays, 9:30 to 5:00."

1964 Digital Computer Kit

Back in the sixties there was a company called the Tesla Research Foundation, with offices in Salt Lake City, Utah, and Phoenix, Ariz. The manager was John Sehlmeier. Tesla offered a variety of analog and digital computer kits, plans for digital gadgets, and home-study courses. The DI-TR5 digital computer cost $365 in kit form, $440 assembled. The DI-TR5 used germanium-transistor NAND logic and diode ORs, had 15 instructions, and two registers. Input/output was with switches and lamps. Does anybody know whatever happened to Tesla and/or Sehlmeier, last heard from in 1964?

KITS

ACS NEWSLETTER

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COMPUTER KITS

Altair 8800 Computer Kit

The Jan. and Feb. 1975 issues of Popular Electronics will have a descriptive article on the Altair 8800 computer kit from MITS, based on the Intel 8080 chip, an 8-bit-word/16-bit-address machine with 78 instructions.

The Jan. issue will cover the $397 computer kit, which includes the 8080, 50 ICs, PC boards, a case (19 x 19 x 8), switches, 36 LEDs, and 1K of memory. The case is 3/4 empty, but there are 17 connectors on an I/O bus, for adding memory (65K words max) or I/O boards. The cost without case, switches or power supply is $298; assembled and tested, $498. MITS will send free the etching and drilling guides, component-placing diagrams, and misc. info., for a self-addressed 8½ x 11 envelope with 40¢ postage on it.

The Feb. PE issue will be about programming the 8800. Later in the year will be the PE "smart terminal," with built-in CRT, 32-characters, 16 lines, 4 pages, modem, and keyboard, for about $300 in kit form. There are plans to publish articles about a hard-copy device, a floppy-disk memory, and the Cyclops CCD solid-state TV camera that can be connected to the 8800.

The complete cost of an Altair 8800 with 65K memory and the CRT terminal is said to be under $1500. MITS is at 6328 Linn N.E., Albuquerque, New Mexico 87108.

More on the Mark-8 Computer Kit

The Dec. 1974 Radio-Electronics has letters about the Mark-8 computer kit (June 1974 Newsletter), with answers by the designer, including corrections and explanations, and also a letter about how to obtain certain parts. There is also an article on "computer modifications," on how to increase the input capability up to 8 input ports and how to use an additional 16 output commands to generate pulses for control.

SCELBE Computer Kit Prices

The prices of the SCELBE-8H modular computer kits (Mar. 1974 Newsletter) have been reduced, due to "some improvements in our manufacturing efficiency."

The standard computer kit is now $695; assembled, $750. The deluxe kit is now $1249; assembled $1295. The cost of expanding the memory to 16K words, which was about $2760 more, is now $2465 more.

The CRT interface and audio-cassette interface were available in kits; now, assembled and tested, they are each $25 more. The cassette-interface system is said to be "remarkably reliable" with cassette recorders costing $50 to $75, which do not have to be modified.

The SCELBE-8H User's Manual ($5.00) assumes no knowledge of computers, starts with 26 pages on basics, followed by chapters on the instruction set, operating information, and on connecting peripherals.

SCELBE now also sells "unpopulated" sets of cards, without the ICs: the five cards alone for $135; same with the master clock circuit installed, $149; and so on up to the set with clock, 8008 IC, eight 1101 RAMs installed, plus chassis kit, for $429.

As for software, 24 programs are now available, either in object code or as "source mnemonic listings," for editors, memory dumps, paper-tape loaders, mag tape read, mag tape write, etc.

There is now a SCELBI "Computer Digest and User's Bulletin," published quarterly, $7 a year for 8H owners, $12 for others.

TERMINAL KITS

MITS Comter 256 Kit

"First Computer Terminal You Build From A Kit" (Radio-Electronics, Nov. 1974) is a description of the MITS Comter 256 kit, which is $495 complete, or $395 without cabinet or power supply, or $695 assembled. The terminal has a built-in acoustic coupler, auto-transmit, cursor control, tape-recorder I/O jack, 32-character Burroughs display, standard ASCII-encoded keyboard, and an internal memory of 256 characters per page, with up to four pages of memory.

SWTP CT-1024 Kit

The SWTP CT-1024 terminal system displays up to 16 lines of 32 characters each, with a two-page memory capacity, and can be used with any TV set for display. Input may be any source of parallel ASCII code. The kit without cabinet or power supply is $175, power supply is $15.50, keyboard kit is $39.95, etc. SWTP is Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, Texas 78216.

HOME/SCHOOL COMPUTER

"A Practical, Low-Cost Home/School Microprocessor System," by Joe Weisbecker of RCA Labs, in the Aug. 1974 IEEE Computer (pp 20-31) describes a low-cost (under $500) system called FRED (Flexible Recreational and Educational Device), based on the RCA COSMAC microprocessor.

FRED is designed to be used in schools for educational games, simulation exercises, etc., and in the home for games, calculator, controllable TV puppet, low-fidelity music synthesis, shooting gallery, puzzles, etc. Some of these functions have already been developed. Over 30 programs are running on prototypes.

Program loading is via an audio cassette player, which also gives the computer its voice, music, and sound effects. After loading, FRED is operated with a 16-button keyboard. FRED is attached to the antenna terminals of any TV set, for output display, using a dot pattern to form letters, numbers, or simple pictures. The basic FRED consists of the COSMAC microprocessor, 1024 bytes of RAM, keyboard, cassette player, and a TV set.

The article mentions "adding a $25 punched card reader and $10 manual punch" and "adding a module for recording the contents of memory on cassettes turns the FRED system into a user-programmable computer for serious hobbyists. Other possible attachments include light guns, extra memory (RAM), prestored programs or tables (ROM), and output relays for control uses."

Reached by phone, the author said that further details are not available, as they are proprietary. He hopes that RCA may some day make chips for FRED available, although there are no such plans now.

DEC HOME COMPUTER

According to rumor, Digital Equipment Corp. is planning to market, in a year or two, a "Home Computer"

with 16K of memory, CRT, full keyboard, two floppy disks, and hard copy, for under $5,000. It will probably be based on either the PDP-8 or PDP-11; right now, both the 8 and 11 groups at DEC are lobbying for their designs to be used in the new machine, so there are two prototypes. It is said the system will cost DEC about $2200 to manufacture.

ONE WAY TO BUILD YOUR OWN

According to Computerworld, an 18-year-old programmer at DEC stole parts of a minicomputer and put the system together at the place of business of his father, who thought the parts were salvaged. Police estimate the equipment could be worth up to $75,000.

DEC PDP-8/A

Prices for the PDP-8/A, described in the previous Newsletter, have been established. The 8/A with 1K of semiconductor RAM is $1745; with 2K, $2100; with 4K, $2600. For more than 4K of mainframe memory, the memory extension board must be used; that board, which also includes power fail/auto-restart, time-share control and a 128-instruction bootstrap loader, is $500. Memory can be expanded up to 32K, using various combinations of 2.3-μsec RAM in 1K ($480), 2K ($835), 4K ($1335); 1.5-usec ROM in 1K ($480), 2K (760), 4K ($1300); and 3.4-μsec PROM in 1K ($995). The boards are available separately; for instance, the CPU and 1K of RAM are $895, for the two boards. The I/O option board is $500, and the programmer's console another $400. So an 8/A with 4K of RAM is $3500; 8K RAM, $5335.

IN PRINT

The Origins of Digital Computers

This is the title of a book of selected historical papers (most of them printed from the originals) edited by Brian Randell, who provides much connecting text (pub. Springer-Verlag of Berlin, and in New York at 175 Fifth Ave., 464 pages, 120 figures, $23.90). The 32 papers include a dozen that are unfamiliar to most of us on this side of the Atlantic, such as two by Torres y Quevedo, on automatics and on an electromechanical calculating machine, and two by Couffignal on calculating machines. Two by Zuse are a little better known here. There is an 1889 paper by Hollerith on a tabulating system, a 1946 one by Aiken and Hopper on The Automatic Sequence Controlled Calculator, several on relay computers, a 1946 paper by the Goldstines on ENIAC, a von Neumann EDVAC report, and the last two are on EDSAC. There is an excellent, annotated 42-page bibliography.

Rather expensive, but most of these papers would be difficult to locate today, so this is a fine Christmas present for the computer-history aficionado (or aficionada).

Microprocessor Roundup Article

"Focus on Microprocessors" is a 17½-page article in Electronic Design (Sept. 1, 1974, pp 52-69) that includes a table listing 19 microprocessors, 11 of which are available off the shelf or as samples, 6 have been announced, one rumored (Intel 4014), and one custom-made (Burroughs Mini-D).

Of particular interest is the announced Intersil ISD-8, "designed to be a CMOS/LSI equivalent of DEC's popular PDP-8 minicomputer" and which "benefits from the sizable software support that exists for the PDP-8.... However, the unit's repertoire of eight basic

memory-reference instructions tends to limit the range of applications.... Intersil plans to develop a full set of circuitry and memory, all using CMOS, to operate with the processor. Conceivably, the end result could be a pocket-sized, portable PDP-8."

Microcomputer Software

"Microcomputer software makes its debut" (IEEE Spectrum, Oct. 1974, pp 78-84; reprint $1.50) is a fine tutorial on microsoftware, with a chart of what 10 companies (from Control Logic to Toshiba) have currently available, in self-assemblers, editors, loaders, debuggers, simulators, and other programs. Intel has many of these, but many are available only to development system users. National Semiconductor has many; some come with the prototyping system.

Intel has set up a microcomputer user's program library, with membership costing $100, but free to those who submit a program. National is planning a similar library.

Interfacing a TTY with an IC µP

"Interfacing a teletypewriter with an IC microprocessor" (Electronics, July 25, 1974, p 96) says that "the lengthy software service routine generally required" for an interface to such as the Intel 8008 "can be eliminated.... A shift register and some control logic are all that it takes, bringing total component cost to only about $6.50."

16-bit µP on a Single Chip

"Single monolithic chip holds 16-bit microprocessor" (Electronic Design, Dec. 6, 1974, p 105-6) is a new-product item about the National Semiconductor processing and control element (PACE) that "offers all the basic features of the company's multichip model. Though not as fast nor as flexible as the older version, PACE provides the convenience and cost savings of single-DIP packaging. And it can be used for either 8 or 16-bit data processing." Tentative prices are under $400 in single quantities, below $100 in very high volume. "Excluding memory, only six ICs are needed when PACE is used, compared with 20 to 25 for the IMP-16. When special circuits become available, PACE and just 10 other ICs will constitute a microcomputer with 1K words (each 16 bits) of ROM and 256 words (also 16 bits each) of read/write memory."

Microcomputer Digest

This new monthly started in July 1974, has 12 to 16 or more pages, is $60 a year, published at 2368-C Walsh Ave., Santa Clara, Calif. 95050. The third issue has a page on Japan's first microcomputer (Toshiba TLCS-12), technology items about SOS, TI's I^2L µC, etc; microcomputer-based products; memories and peripherals; literature, meetings and people.

Creative Computing

This is a new, non-profit magazine of educational and recreational computing, published 6 times a year, $15 a year to institutions, $8 for individuals, $6 for students, from P.O. Box 789-M, Morristown, New Jersey 07960.

THE TRADING POST & HELP WANTED

Amateur Computer-Builder Workshop

Jeffrey Viola (846 Spring Valley Rd., Maywood, N.J. 07607) writes: "I am very interested in an idea to start an amateur computer-builder workshop in my area. The ACS Newsletter fulfills its purpose, but for people like me with relatively little experience in

computer building, we need something more. I think a workshop-type thing would be invaluable. Anyone who is interested, please contact me. I would like to, for transportation considerations, limit the New York City - northeastern New Jersey area to any effort as such."

Terminal Help Wanted

Derrell V. Foster (Dept. of Computer Science, Duke U., Durham, NC 27706) writes: "I am currently trying to design an interactive-type computer terminal which satisfies these criteria: (1) it works and is sufficently flexible (baud rates, keyboard characters, etc.), (2) it minimizes my time for construction, and (3) it minimizes my cost for construction. If you have any ideas for this type of project (say used terminals, kits, PC boards), please let me know."

To Sell & Want List

Write to Michael Guerre (204 Faxon St., Spring Valley, Calif. 92077) for a full list of his offerings (including a display terminal, Nixie tubes, B-Tran 6 manuals, Nova operating manual, two books) and wants (information on the HOME-EC VII minicomputer, the Intersil "PDP-8" microprocessor; a 32-character Burroughs Self-Scan panel, 8-digit LEDs etc).

4-Bit ALU

Gary Coleman (3227 N. Vernon St., Arlington, Va. 22207) writes: "To support my habit I'm selling 74S-181's, the Schottky version of the 4-bit ALU, for the amazing price of $2.50. I also have a boxful of Signetic Utilogic TTL ICs which make good bus receivers; DEC uses scads of them in the PDP-11; the price on these is negotiable."

Card Racks?

Tom Mintner (P.O. Box 2598, Iowa City, Iowa. 52240) asks: "Does anyone have, or know where to get, card racks and/or smaller backplane assemblies with cards?"

"I have built several modular devices for sound processing which have digital control. These are such items as envelope generators, sequencers (really an analog memory device), gating and panning controls, etc. These are hybrids with the facility for digital specification of their operating parameters. These will then be coupled to a large (by electronic music standards) SC memory system."

Tape-Transport Controller Boards

Gary Coleman also has some CES tape-transport controller boards, "in case some members have the CES tape transports sold by Meshna, and by MNH-Applied Electronics."

Demo Computer?

Colin S.L. Keay (U of Newcastle, New South Wales 2308, Australia): "I am responsible for an undergraduate course in Electronics and Instrumentation in which I am endeavouring to give the students some insight into the working structure of small computers. I would like to build one or two small demonstration computers (wherein the cost of the processor circuitry would run to no more than $200 or $300 at the most), and I believe that members of your Society have developed systems which would fall within this cost range. ... The PDP-11 (of which we have 4 on campus) is a honey of a machine, and if I could find a small-scale demonstration computer kit with some of its features, I would be very pleased."

RAM and ROM Chips

The Amateur Computer Society is open to all who are interested in building and operating a digital computer that can at least perform automatic multiplication and division, or is of a comparable complexity.

For membership in the ACS, and a subscription to Vol. III of the Newsletter, send $5 to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.
Darien, Conn. 06820

The ACS Newsletter will appear every two or three months.

William Mitchell (39 Rockfield Cres., Ottawa, Ont. K2E 5L6, Canada) writes: "Just a note to confirm that I still have 2102 RAM and 1702 ROM memory chips, as mentioned in the March 1974 Newsletter. The 1702's, however, are now production rejects due to single bits being unprogrammable. Each is marked with the location of the "stuck" bit, so I will select a suitable one if you send along a copy of the pattern you are going to use. Otherwise they meet all specs, including speed. The price is still $11 per pair of 2102's or per 1702 (payable in Canadian dollars, please)."

Identify ICs?

Jeffrey Viola (address p 4) has a prototype CPU with 436 ICs, some of which he can't identify. Anybody recognize these?: ceramic chips labeled M134, marked Op Code and Addr; S8889, S8883, RM944, SN5580, SN74948.

Help Offered

John Youngquist (899 Niagara Blvd., Fort Erie, Ontario, Canada) is one of the newest members, and writes: "I have considerable hardware and design and would be glad to help anyone needing it with designs or with Intel 8008 or PDP-8 related projects."

More Terminal Help Wanted

G. Deprè (V. Beauduinstr. 91, B3300 Tienen, Belgium) writes: "I am developing a Video-Terminal (CRT Display), connected to a local Computer, but also including a CPU and ALU for using it as an independent calculator with possibility of vector-display. I would welcome any information at all on this kind of terminal, even at a charge."

Commercially Available

MNH—Applied Electronics (P.O. Box 1208, Landover, Md. 20785) has a 1900-baud modem for $45, power supply (+5, +12, -12) at $45, 7400 series TTL rejects at $15 for 1000, computer key switches, LEDs, etc.

A MEMBER'S COMPUTER

Bob Robbins of Ohio has completed 90% of his 8-bit, 8K-word machine, using DDL Utilogic, TTL, and MOS/LSI. Memory is Datacraft core. It "uses same instruction set as Intel 8008; 5 tape drives, one of which is IBM 9-track compatible; all registers and memory locations are accessible from maintenance panel." Input/output is with TTY, modem, tape drives, plus keyboard, CRT display, and tape reader. "The basic processor is complete with the exception of interrupts, and all I/O devices are interfaced and working with the exception of two of the non-compatible tape drives."

HAVE A SCELBE OR MARK-8 OR ALTAIR?

If anybody has a SCELBE-8H or a Mark-8 Radio-Electronics computer, or will be getting an Altair 8800, please write the ACS about your opinions of the machine, pro & con.

MORE ON KITS

ACS NEWSLETTER

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MORE ABOUT COMPUTER KITS

Altair 8800

Popular Electronic's Altair 8800 computer kit from MITS, described in the previous Newsletter, gets a whole page in the Dec. 1974 Computer Decisions, where it is said to be "comparable to (and in many respects better than) the Nova II mini from Data General, from a hardware viewpoint." Although the basic cycle time of 2 microseconds is slower than the 1 μsec of the Nova II, Ed Roberts of MITS notes that "it is still possible for the PE 8800 to outperform the Nova.... It a particular problem requires decimal arithmetic and a lot of I/O capability, then the MITS mini has the advantage because the 8080 contains a decimal converter that makes it easy to perform arithmetic on BCD numbers.... If the problem is a cpu-related problem that requires speed, the Nova may be significantly faster."

The 8800 can directly address up to 65K words of memory. The memory is expandable in blocks of 256, 1K or 4K 8-bit words, at about $200 for each 4K of words.

MITS is working on a disc operating system for the floppy-disk memory; the controller will cost about as much to build as the computer; the drive will be $600 to $700.

According to Roberts, "a stand-alone unit that will consist of a processor, terminal and several disc drivers will be available for about $3,000. That would be comparable to a system that now lists for 15 to 20 thousand dollars." That's a processor with 16K memory. (The previous Newsletter's assumption of $1500 for a 65K machine with CRT was from an overly optimistic PE editor.)

From the Top

Ed Roberts says (by phone) that MITS generates all the software for the Altair 8800, because programs from Intel are expensive: the 8080 assembler is $1500 to an individual; to MITS, it would be $5000 for the licensing fee, plus $25 per unit.

About 700 of the Altair 8800 units were shipped in February. The industrial percentage of the mix is going up. The production 8800 is different from the PE model, uses 100-pin plugs, not ribbon cable.

The disk controller will be about $450. Software will be featured in the next Altair catalog. There is a resident assembler, which requires 8K memory and some sort of I/O device. The assembler is free with a system that will support it. BASIC (extended version) is coming along, could be used with 8K, although very little memory would be left for programming. FORTRAN is also in preparation, available sometime after May.

Nathaniel Wadsworth of SCELBI says there will be a SCELBI book on machine language this Spring. A third of the SCELBI computer kits are sold to schools, a third to businesses, a third to hobbyists.

Comments on Computer Kits

These comments have been received:

"The Altair 8800 was hastily thrown together. Very little thought has been given to interfacing it with the outside world. The availability of peripherals is a lot of hot air.

Some Altair owners are finding it extremely difficult to interface to. It uses 256x4 memories, great stuff, but impossible to add on to the original system; you have to buy another memory board. For amateur use, they should use memory that amateurs can go out and buy; they use ROMS that are not easily available."

"It's ridiculous to make a higher-level language for such a machine. Why duplicate the effort already made, as on the PDP-8 and others?"

"The 8800 is a better machine than the SCELBI, a much more powerful chip (8080 versus 8008); however, the Altair has a poor interconnection design, seems to be soldered-on ribbon cable!

"I don't think much of the 8008, it's slow and not very good. As for the Mark-8, it has problems, such as the difficulty of adding more than 1K of memory, the I/O problem, and it's also a mechanical nightmare."

"There's a rumor—repeat, a rumor—that the price dip of the Altair 8800 is due to the chip not having the full temperature range; in other words, it's a temperature fallout."

Microcomputer Newsletter

The Micro-8 Newsletter is published by the Micro-8 Computer User Group (Cabrillo Computer Center, 4350 Constellation Road, Lompoc, Calif. 93436). It was originally the Mark-8 user group, but widened its scope to include all microcomputer systems. A subscription is $6 for six issues.

The Micro-8 Newsletter mentions The Digital Group (Box 6528, Denver, Colo. 80206), which has been working on modifications to the Mark-8 micro. Dr. Robert Suding has developed pluggable boards, octal readout, large power supply, keyboard data entry, and an FSK cassette interface.

The Micro-8 Newsletter writes of the Altair 8800: "More and more people keep wondering about the Altair 8800 and how they can make the kit prices so low. A lot of people have gambled on it. (Several thousand back orders, according to one report.) I suspect that it's a loss leader, to try to lock people into buying their add-ons. At least one rumor is floating around about them using factory-fallout 8080's.... With the kind of backlog they are supposed to have, you may have to wait many months for delivery and then you will still be stuck with the problems of memory and peripherals.. .. If the future articles on peripherals in Popular Electronics are glorified advertisements as the last two have been, then what?.... Even the information pack didn't contain any real construction information."

JOHN FREDERICK'S MICRO

John Frederick (306 West 100, #81, New York, N.Y. 10025) writes: "After much backing and filling, I've gotten on the microprocessor bandwagon for my computer project. I'm using an Intel 8008 from Bill Godbout and 2102 memory. The design is a mixture of the SIM8-01 one-board system sold by Intel, the Radio-Electronics Mark-8 and the PDP-11 Unibus. The 8008 has memory address bits for 16K bytes but I/O addressing for only 8 input and 24 output devices. Adapting the Unibus idea, the I/O devices are connected to the memory bus and referenced by addresses whose high-order 4 bits are all ones. Bits 0 and 1 address four 8-bit device-control, status and data registers associated with each device, and the middle 8 bits

allow 256 devices to be addressed. Doing it this way adds to the parts count, but should make life easier later.

"My first objective is a flexible controller for all my peripherals, which include (at this point) a Tally 420 tape punch, a Tally 424 tape reader, acoustic coupler and the first Radio-Electronics TV typewriter. If I can use this to emulate the PDP-8, the PDP-11 and an ASR33-compatible CRT terminal, I can utilize software which already exists.

"I have some advice for ACS members who are concentrating on sophisticated architectures and homemade instruction sets. It is that writing good software is very difficult and time-consuming. You'll get more computing done with a slow, simple machine for which free software exists.

"There's a boom right now in the use of microprocessors as dedicated peripheral-device controllers. Those of you who have surplus I/O devices but no controllers or convenient interface to the rest of your system might look at this approach. I'd be happy to correspond with anyone who wants to try it. I'm trying to set up a flexible prototyping lab for this sort of thing."

THE TRADING POST

Buster Killion (2773 Winrock Ave., Altadena, Calif. 91001) has a core FIFO buffer designed to buffer tape drives, $50; two IBM 727 drives with all manuals, $150 each, $250 both; Century Data floppy-disk drives, $250 each; 4K word x 18-bit Ampex core stacks, $35 each; card cages with connectors, $15 each; plus documentation on several computers, and wire, cable and Amphenol connectors. Write for details.

Tape Decks

John Marshall (Box 242, Renton, Wash. 98055) has several extra Wangco tape decks, model 7's, both 7 and 9-channel, brand new. Write for detailed specs or make offer.

Digitizer

Mark Messinger (85 East End Ave., New York, N.Y. 10028) has a Summagraphics digitizer with an 11"x11" tablet and binary display; cost $2150, is a few months old, Mark would like $1300. He can also supply the wiring list and diagrams for a PDP-11 interface using a DEC M1710 module.

Core Stack

Steve Marum (Westwood Manor Apt. 136-J, Howe, Texas 75059) says he now has enough MOS RAMs for his main memory, will sell his core stack, 16K by 24 bits, Fabri-Tek, $300 or best offer; he'll "even throw in 34 TI 7528 core sense amps extra."

"If you know of anyone using a TI 980 who might want to trade programs, let me know. At a surplus sale I got an old one, which appears to be the grandaddy of TI's present 980 and looks to be program compatible."

COMMERCIAL HARDWARE

M & R Enterprises (Box 1011, Sunnyvale, Calif. 94088) has an 8008 with application manual, $60; 8008 with all the resistors, caps and 15 7400's for the Mark-8, $75; plus 1101A RAMs starting at $5 each, 2102 RAMs starting at $10, and the 1702A pROM starting at $40 each. Send for a price list.

Al Sardo (2032 S.W. Expressway, San Jose, Calif. 95126) sells the 1101A RAM for $2, 2102 at $7, 1702A

for $13, 8008 for $40, 8008-1 for $60, 2516 64x6x8 character generator for $3; $5 to program the 1702A with listing included.

WALK IN AND COMPUTE

The public library in White Plains, New York, has what may be the first walk-in-and-compute installation in the country. Since the beginning of 1975, a Wang 2200 hard-wired BASIC computer has been available at 25¢ for five minutes. Input is magnetic-tape cassette. There is a library of tapes for games, math, statistics, etc. Anyone who wants to write his own programs and save them has to buy a data cassette.

Because there is no off-line preparation of programs, as with an ASR33, a lot of machine time (at a nickel a minute) can be used up in preparing input.

IN PRINT

Designing Microprocessors With Standard-Logic Devices

This is the title of a two-part article by Robert Jaeger of Signetics (Electronics, Jan. 23, 1975, pp 90-95; Feb. 6, pp 102-107). The author notes that although MOS microprocessors are growing in popularity because of the few ICs required, there are drawbacks such as being slower and less flexible than random-logic TTL systems. "But there is a third design route available to meet certain system requirements: the small, applications-oriented processor built with standard high-speed logic devices, either ECL 10K or Schottky. ... Although they require more ICs than MOS microprocessors, they can replace random-logic TTL designs that need five to 10 times as many devices."

Part 1 outlines the requirements for the three basic processor elements—the register/arithmetic/logic unit, the control memory, and the input/output circuitry. Part 2 discusses how proper selection of the microinstruction format can minimize control-memory size, and also covers memory branching and outlines some designs for standard-logic processors.

For Teaching or Learning Digital

E&L Instruments (61 First St., Derby, Conn. 06418) has a new LR Innovator series for teaching (or learning) digital electronics. The series includes preassembled modular hardware, called Outboards, which plug directly into the SK-10 solderless breadboarding socket, allowing for quick set-up and interconnection.

The Outboards are used as input and output to standard ICs (mainly 7400 series), and consist of logic switches, LED display, pulse input, clock, and power. The basic system is $247.70. The two manuals, called Bugbooks I and II, are $16.95; in their 750-plus pages they cover experiments with gates, truth tables, counters, decoders, multiplexers, sequencers, displays, Tri-State logic, flip-flops, one-shots, memories (RAM and ROM), registers, and arithmetic elements.

The preface gives credit for significant participation in the design and implementation of the Outboards to Jonathan Titus, designer of the Mark-8 microcomputer kit and an ACS member.

The Origins of Digital Computers

This book of historical papers, described in the previous Newsletter and printed by Springer-Verlag at $23.90 in hardcover, is now available in a second printing for only $14.80, also in hardcover.

A FOURTH MICROCOMPUTER KIT

Several microcomputer kits are being offered by companies that specialize in selling ICs at low prices. One of the better known is the MIL MOD 8, made in Canada by Space Circuits and sold here by Mini Micro Mart, 1618 James St., Syracuse, N.Y. 13203.

The MIL (Microsystems International, Ltd.) MOD 8 costs $85 for the seven basic boards, "uses a minimum of components, provides for a good deal of expansion, is designed around a TTY as the I/O device, has no front panel and you probably can get by without one. And if you want to go to an 8080, you put in a new CPU board, eliminate the buffer board, and it is an 8080 system."

Mini Micro Mart has this to say about other micros: "SCELBI is the most expensive route and probably the best—surely the way to go if you don't WANT to build your own, or even if you want to build your own and have a minimum of technical or software background. Good boards, good design, and most important, FULL support, even to the systems level.... The Altair 8800: the first of the 8080's attracting the amateur market, the best packaged, and the slickest promotion, and a rich man's toy as far as I am concerned. If you take their basic kit, add 3 memory add-ons, 3 I/O, and a TTY interface, the extras come to $549, more than the kit itself, and you still have only a 1K microprocessor. Buy MITS boards, come to us for the parts, and save about 50%. My blood pressure was starting to rise, because I started thinking about the stories in Popular Electronics. I quote "but it can be economically expanded to 65,000 words." That economical expansion will cost you a mere $4224 if you order the economical version of their memory (which I don't think they are delivering). Assembled MITS memory is about the same price as DEC's memory boards. ... If you've gotten the impression that I'm partial to the MIL MOD 8, you have reached the right conclusion: 8008 system that modifies to an 8080, software, audio cassette interface, TTY interface, a floppy disk interface SOON."

Mini Micro Mart sells IC kits for the Mark 8, Altair 8800 and SCELBI, as well as memory ICs, keyboards and other hardware, and the MIL MOD 8080 for $294.50 (1Kx8 memory), without power supply or front panel. The MIL MOD 8, with 6 PC boards, all the TTL, 8008, and 1Kx8 memory (no ROM board or mother board) is $219.95 plus $2.50 for postage, etc.

Another MMM quote: "The Mark 8 — surely not the best but it started it all — the mass interest started with this — the boards would have been nicer with plated-through holes — but is still the least expensive way to start for a novice; $5 gets you the manual, the boards are available, and there is support to get you out of trouble (thanks to Hal Singer."

MACHINE LANGUAGE PROGRAMMING BOOK

SCELBI Computer Consulting, Inc. (1322 Rear, Boston Post Road, Milford, Conn. 06460) has just announced their new manual, "Machine Language Programming for the 8008 (and similar microcomputers," containing a detailed presentation of the 8008 instruction set, and coverage of flow-charting, mapping, editing and assembling, search and sort routines, mathematical operations, multiple-precision arithmetic, floating-point-package, I/O programming, and many other areas.

The price is $14.95 until April 30, 1975, after which it will be $19.95.

The Amateur Computer Society is open to all who are interested in building and operating a digital computer.

For membership in the ACS, and a subscription to Vol. III of the Newsletter, send $5 to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.
Darien, Conn. 06820

The ACS Newsletter will appear every two or three months.

LATEST ON MICROSYSTEMS INT.

Microsystems International is part of Northern Electric (the Western Electric of Canada), which decided to stop making ICs, so MIL is in shut-down mode and will close May 30. However, Mini Micro Mart says MMM will still offer the MOD 8, will design its own board for the MOD 8080, and hopes to have software for the latter before long.

One of MIL's customers designed a discrete version of the 8080 with 7400-series TTL, for only $90. Although it uses more power and takes more space than the 8080, it is a great deal faster. And proprietary.

It should be noted that MMM kits are sets of PC boards and ICs, without full construction plans, for engineers and advanced hobbyists.

JOHN YOUNGQUIST'S TAPE CONTROLLER

John Youngquist (899 Niagara Blvd., Fort Erie, Ontario, Canada) writes: "I have completed my low-cost tape-drive controller and interface. Designed around a two-track digital tape drive and 4K PDP-8/L, it emulates TD8E DECtape with a one-page (128-word) handler program. The DEC TD8E handler is twice as long. The standard PDP-8 DECtape format is fixed-length 129-word blocks, each numbered and individually addressable, much like disk format. Thus my interface and software allow bi-directional searches for any block without counting file gaps. Address error detection and verification is done before a block is read or written, to prevent accidental loss of data. A parity bit for each 6-bit byte is written and verified for all data words. Blocks with parity errors are re-read up to three times before the appropriate error exit takes place.

"The interface is based on a phase-locked UART chip (i.e., General Inst. AY5-1013). Data is written serially with start-stop bits on one track and reference clock on the other. When read, the clock is phase-lock multiplied and applied to the UART. The data rate is 10K baud and tape speed is 15 ips, but could change to suit a particular tape drive. The tape drive used is a two-track and uses 8½-inch reels of ½-inch IBM tape. It was made by Computer Entry Systems for a special application.... The complete interface and controller contains only 20 ICs, a MOS LSI UART, some CMOS and TTL, at a cost of $20. It can of course be applied to a variety of tape drives and CPUs. I can provide schematics, software, and application assistance to anyone interested. Please enclose $1 with inquiries, to cover duplication costs, and request PDP-8 program listings if you need them.

"To support the tape drive, I have written a series of tape commands in FOCAL 69. I can read/write blocks of integer, 3 or 4-word floating-point variables, and chain to new programs, starting execution at any line number. This allows FOCAL to run in "batch mode" unattended for hours. I can provide the software.

"I have an Intel 8008 CPU (new, not surplus) for sale or trade. I wish to acquire some floppy-disk drives, preferably in complete working order."

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COMPUTER KITS, PART 3

Altair 8K BASIC Special

Until Sept. 15, 1975, MITS is offering the Altair 8800 computer kit, two 4K-word memory boards (kit), your choice of interface board, and the Altair 8K BASIC language, for $995. That's a saving of $139 to $175, depending on the interface you choose.

Altair 8K BASIC uses 6250 words, leaving 1750 words for programming and storage. There is also a 4K BASIC, and an Extended BASIC (12K). The 4K BASIC has 15 statements, 6 math functions, and 4 commands; the 8K BASIC has 4 more statements, 8 more functions, 1 more command, and advanced string functions. The Extended BASIC adds PRINT USING, disk I/O, and double-precision math. BASIC is available on either paper tape or cassette tape.

Altair Systems

The April Computer Decisions carries a full-page MITS ad that looks more like an ad by a mini-maker than by a kit company.

According to the ad, "... we're selling our BASIC Language System for $2,461 (fully assembled Altair Computer with 8K of memory, a serial interface, computer terminal and BASIC language software). We're selling our EXTENDED BASIC Language System for $2,806 (Altair with 12K of memory, serial interface, computer terminal, and EXTENDED BASIC software). Our DOS EXTENDED BASIC Language System goes for $6,649 (Altair with 16K of memory, serial interface, computer terminal, disk controller and 2 disk drives, DOS and EXTENDED BASIC software).... we're selling our Advanced Accounting/Engineering System for $10,489 (Altair with 32K of memory, serial interface, teletype [or terminal], line printer, disk controller and disk drives, DOS and EXTENDED BASIC software)."

Sound like they intend to compete with DEC. In fact, part of the ad reads, "It's almost embarassing. We've only been on the computer scene a short while, yet we're selling more computers and peripherals than many of our long-time, established competitors."

MITS is said to have sold over 2500 Altair kits, and has opened two regional sales offices, in Orange, Calif. and Miami, Florida, "with the ultimate goal of maintaining operating service centers and display areas at these locations."

Altair Experience #1

Doug Penrod writes from California: "I ordered a MITS Altair 8800. It has been coming in bits and pieces, especially after I wrote Mr. Roberts (pres.); he called me on the phone, to get the order straightened out. Their paper-work crew is overloaded and gets things all mixed up.

"Yesterday UPS brought 2 boxes from MITS. One contained a 4K dynamic RAM board kit and a 4-slot expansion to the bus board. And a note saying that 8 chip sockets had been backordered. The other box contained two 4K dynamic RAM kits, complete. Now I have 3 manuals for the 4K RAM. Now all I lack are the 8 chip sockets and the software: the assembler and utilities package, and the 12K BASIC package.

"As you no doubt know by now, they have 3 versions of BASIC--for 4K,

8K, and 12K. No source code is available for any software, only object code, and that only in paper or audio mag tape form so far. So modifying their software won't be easy.

"I have some criticisms of the Altair. I notice that the new ads mention the use of fans, and all of the four machines at a local MITS "seminar" had fans. However, they aren't much more helpful than the blower on the motor of a Teletype, which has no air inlet or outlet. The MITS has inlets all along the top of the sides of the cabinet, and the motor blows out an outlet in the rear of the cabinet. Better. But there is no airflow pattern in the board layout or cabinet design.

"In particular, the front-panel PC board has a heat sink for the 8v to 5v regulating transistor mounted on the front side of the PC board, where the sink is trapped in a narrow space between the PC board and the aluminum sub-panel which mounts the switches. The sub-panel, in turn, is behind, and in contact with, the thin aluminum dress panel. At any rate, there is no way for air to circulate around that heat sink, which is mounted on the top of the board, thus precluding even normal convection in the space between panels. So I changed mine, and mounted the heat sink (augmented, in my case, by a copper addition to increase the area by a factor of 2) on the rear of the PC board, where it can get some air.

"I also expect to design and build some baffles to systematically channel air-flow through the PC boards in a manner determined to keep the chips cool and keep the heat-sink air away from the chips. Actually, I feel that appropriate thermal design would have obviated the need for a fan, even in a full-house machine. I think that the bulk of the gross regulating could be done outboard, with just enough on-board to keep the glitches away.

"I wish the MITS had an optional 18 or 19-slot bus board available in 1 piece. Now you have to use 100 jumper wires to connect each pair of 4-slot boards together, max 16 slots. Need 16 to handle the max 64K memory, plus a CPU and at least one I/O board. In my Altair, every chip has a socket; I think they ought to come stock that way.

"At the MITS "seminar" in Van Nuys, the MITS guys were saying that another Popular Electronics cover story will be coming out, presumably with a successor or alternate to the Intel 8080 machine. They said they were working with Motorola 8-bit chip, and didn't deny the National Semiconductor IMP-16. It is obvious that the cheap computer world is changing radically and rapidly this year and next. It hardly pays to design and build your own computer anymore, if results is what you're after. Especially if you consider the time and effort involved in the software. It ain't every solder mechanic who can write a compiler.

"Pretty soon it ought to be possible to buy slightly-used Altairs cheaply. Unless the buyers want to up-grade to BASIC. Incidentally, I found that their machine won't accept program input from paper tape. Too slow. Apparently doing line-by-line diagnostics. Also, there's the matter of a Line Feed on the paper tape and another one from the computer; they don't have a TAPE mode of entry. I tried some experiments to see if this can be bypassed. But for computer-generated listings, the only cure is to get at the software. I suspect that a tape which had no Line Feeds (only Carriage Returns), and nulls or rub-outs for

time between lines, might work."

Altair Experience #2

Dick Schwanke writes from Illinois: "I am now well along in the construction of my Altair 8800, thanks to rainy weather. The construction section of the manual seems to be entirely adequate for anyone who will read the instructions carefully and can identify the parts. The theory of operation section covers the operation of the parts they added, but the explanations are not easy to follow unless one is quite familiar with this type of design. The debugging section is nearly useless, and the almost complete absence of explanation of the CPU chip itself means that trouble can be anticipated in locating the reasons for not working. There is also a very obvious lack of application data, including failure to indicate how I/O is accomplished.

"The answer to the I/O question is, of course, that a tap must be put on the data, address, and control busses; and an interface controller must be constructed. I have not done sufficient research to know if there are family members (8080) designed for the specific job, but I am sure that I will sooner or later find the applications data that I need.

"The Motorola 6800 applications manual contains designs for both static and dynamic memory modules as well as huge quantities of information on I/O with or without interrupts and priority schemes. I have not yet figured out how to get a front panel on the 6800.

"Back to Altair. I am not particularly happy with the method of hooking the panel to the CPU and bus. It looks very subject to noise and crosstalk. The CPU and memory boards looks as though they were noisier than had been anticipated and have had many capacitors added to soak up the noise.

"I do expect to get my 8800 working although I have no idea as to the problems I may run into. If I have too much difficulty figuring out the I/O problem, I can always purchase the manuals from Altair and see how they did it.

"P.S. There is a shortage of wire and solder in my kit. The panel is going to be very difficult to repair in case of difficulty because all of the switches are bolted down.

"There are some new 4K static RAMs which cost $22.75 each for 10-99."

Altair Experience #3

The writer of this letter asked that his name not be used: "I have just received my Altair 8800. I was extremely skeptical from the advertising but decided to gamble anyway.

"The printed-circuit work is of very good quality, with plated-thru holes, and takes solder well. The case is excellent and expensive, and can be disassembled as required to work on the circuitry. The bus is constructed of two rails with PCB wiring and 100-pin connectors and card guides which ought to make an adequate mechanical and electrical assembly. It is sold in increments of 4 positions but came with only 2 connectors. While it is not clear, it appears that MITS hopes to make out by selling memory and peripheral adapters to people who will be unable to expand the bus by any other means. I believe most builders would be put to it to construct such a nice package for less than twice the price I paid for the basic machine.

"It is well known among computer types that lots of memory and an

assortment of input/output devices are needed to do any useful computing in a reasonable length of time. Short word lengths and limited instruction sets do not prevent good results but make the memory requirements more difficult and expensive and cost a lot of time. Orbits for cyclotrons were calculated on a machine with 256 words of memory at one time (when there was nothing better).

"Unfortunately, static memory is not the way to go in these microprocessors. The cheap 1101's take up a lot of board space and will undoubtedly produce bus problems before the memory reaches a satisfactory size. The recent-design static chips are too expensive. It is hoped that the new 4K dynamic RAMs will produce a digestible solution.

"Motorola has introduced an evaluation package which includes seven compatible chips, a CPU, a ROM with a monitor program built in, 256 bytes of RAM, two parallel interfaces, and one serial interface. The system devotes one parallel interface to a Teletype machine to be used as the console, leaving the other parallel interface and the serial interface to the user. The monitor program uses some of the RAM (possibly as much as half). The bus loading rules are such that these seven chips can be connected together without any bus drivers, so getting the whole thing working can probably be done with less than $50 worth of parts plus an 8-level Teletype or similar console. A panel is not needed.

"Any attempt to expand the machine will require spending considerable money and effort on the bus driving and receiving arrangement, and the memory problems are the same as above.

"The Motorola instruction set is much better than the 8080 set as far as economical use of memory is concerned. The 8080 is much better than the Motorola in the input/output interrupt structure area, as it can point to 8 separate locations in memory, compared to one for Motorola.

"It is a temptation to use the empty space in the Altair cabinet to install a Motorola 6800 and try to interface it to the 8800's panel and memory.

"I likely will not ever try to make a large useful machine out of my Altair, but will use it as an educational tool to study the programming problems of this type of machine, the results of which I can use in my job."

Altair to go Motorola?

According to a rumor in the July Computer Decisions, "the next version of the Altair... will be built around the Motorola 6800 chip.... Intel's 8080 was judged less powerful than the Motorola micro...."

Seems that the two best bets for a company going into the computer-kit business right now are the Motorola 6800 (for which there isn't much software) and the Intersil IM6100 microprocessor ($394 in 1-24 quantities) which, as the ad says, "recognizes the instruction set of a popular minicomputer, the PDP-8/E. No need to generate complex special software. No need to learn new languages. It's already there in software everyone knows and understands. ...the most extensive software library of any microprocessor."

Two More Kits

In addition to the MITS Altair, Scelbi-8H, Radio Electronics Mark-8, MIL MOD 8 and MOD 8080, there are also the Sphere I and the Martin Research MIKE 2. (Actually,

there are now some 13 kits on the market; more in the next issue.)

Sphere (96 East 500 South, Bountiful, Utah 84010) offers a 4K "Hobbyist" computer kit, based on the Motorola 6800 microprocessor, with 512-character TV terminal, keyboard and power supply, for $650 ($870 assembled). Memory is expandable to 64K, at about $240 for a 4K board, $400 for 8K, $750 for 16K memory-board kit.

An assembler, editor, debugging aid, and drivers for the CRT are built into a read-only memory. Available software includes Extended BASIC (with string and matrix manipulation, machine-language subroutine calls, trig functions, and disk-file I/O, plus FDOS—flexible disk operating system).

The "Intelligent" kit adds serial communications and audio-cassette capability at $750 (until Sept. 1975; $999 afterwards). The "BASIC" system kit adds 16K more of memory, for $1345 ($1765 after Sept.); the "Classic" system kit includes 65-lpm printer, two IBM-compatible floppy disks, and DOS, at $5250 ($6100 after Sept. 1975).

Sphere also has a paper-tape reader/perforator, and will have a network operating system, RPG II, and an integrated data-base system. Plus "unique developments in process control for the home and industry and an ultra low-cost mass storage system" by early 1976.

According to Mike Wise, president, "Sphere was started by computer professionals, and their computer was started as a system."

Martin Research (1825 S. Halstead St., Chicago, Ill. 60608) has the MIKE 2-1 CPU board, with 8008, crystal-controlled oscillator, and all the timing for the system, at $55 kit, $75 assembled. The MIKE-2-20 console board has a six-digit display and 20-key calculator-type keyboard; "unlike systems with banks of toggle switches and lights, this micro is easy to program, since codes are easily visualized." The kit, $69; $84 wired. The MIKE 2-3 PROM/RAM board has room for up to 1K of RAM and 2K of PROM; handles up to eight 2112's and up to eight 1702A's.

The basic system, the MIKE 203, uses 256 words of RAM and 256 words of PROM; $230 kit without 8008, $270 kit with 8008, $276 kit with 8008-1 and fast XTAL. A memory board with 2K RAM (450 nsec) is $108 kit; 3K, $137; 4K, $165 kit.

Options under development include a CRT display interface, cassette recorder interface, Teletype interface, PROM programmer.

THE TRADING POST

ECL Source?

D.B. Lamkins (Magnolia Ave, Manchester, MA 01944) "would like to buy unused, tested ECL 10,000 ICs in small quantities. If anyone has a source at below distributor's list prices, please send type numbers, prices, and quantities."

Peripherals for Sale

Dan Miller (1191 Risa Place, Santa Ana, CA 92705) has several line printers, mag-tape drives, disk drives, card readers, tape punches and drums. Send for his price list.

DEC Modules for Sale

Steven Roy (Electronic Assembly Associates, P.O. Box 3711, Amity Station, CT 06525) has various DEC modules, including M8300 (major registers), M8310 (maj. reg. control), M837 (extended memory control), etc. Write for price list.

The Amateur Computer Society is open to all who are interested in building and operating a digital computer.

For membership in the ACS, and a subscription to Vol. III of the Newsletter, send $5 to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.
Darien, Conn. 06820

The ACS Newsletter will appear every two or three months.

Steven also has some fixed-head, 4-platter disk drives, with 30-in. platters, 256 R/W heads per side; $200 per unit, you cart.

New Address for MNH

MNH-Applied Electronics has moved, to PO Box 367, Jamul, CA 92035. Their latest catalog includes an FSK modem card for $30, small power supplies from $5 to $8, digital cassette-tape cartridges at $2, etc.

Chips, ICs, Transistors

At 128 N. 81 St, Mesa, Ariz. 85207, Electronic Discount Sales offers the Intel 8080 at $155, and a wide variety of transistors, RAMs, digital and linear ICs, switches, etc.

IN PRINT

Another Newsletter

One of the newest hobby publications is the "Homebrew Computer Club Newsletter," Fred Moore, editor, 568 Santa Cruz Ave., Menlo Park, Calif. 94025.

Computer Column

Starting with the June 1975 issue, Popular Electronics magazine is running a column called "Computer Bits" by Jerry Ogdin. The column was intended to be a quarterly feature, but readers are said to be demanding that it run every time.

Computer Hobby Magazine

Scheduled to appear on the newsstands in September is BYTE!, an 8½-by-11, 150-page monthly magazine for the computer experimenter, at $1.50 an issue, or $12 for 12 issues ($10 introductory) from Green Publishing, Inc., Peterborough, New Hampshire 03458

BUYING MINIS IN QUANTITY

A member has suggested that the ACS look into the possibility of buying a mini in quantity for ACS members, to take advantage of the quantity pricing. Well, the prices would still be rather high:

The Fabri-Tek MP12 (which is almost software-compatible with the PDP-8) with 4K core has been advertised at $990 in quantities of 100. That machine is without power supply or I/O interface, and costs $1340 for one. An MP12 with I/O interface and power supply is $2395 each for 1-4, $2258 for 5-9, $2181 for 10-24, and $1922 each for 100.

The PDP-8/A from DEC, with 8K of core memory (and including programmer's console and I/O option board) is $3695 for one, with discounts of up to 30% for quantities of 100, bringing an 8/A down to about $2600. The same 8/A with 8K of RAM memory is $3895 for one.

FASTER INTEL 8080 CHIPS

The Intel 8080A chip operates at a 1.5-usec cycle time, compared with 2.0 usec for the 8080. Intel also plans to market a 13-chip processor set for $250, including 8080A CPU, two 256x4 RAMs, two bus drivers, a 1Kx8 erasable ROM, decoder, priority interrupt control unit, etc.

KITS: PART 4
ROSTER

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KIT ROSTER

Over a dozen microcomputer kits are now on the market, so maybe it's time to make a list.

1. One of the first (non-micro) kits was the 832 (March 1971 Newsletter), still offered by National Radio Institute as part of their computer electronics course. Built with 7400-type TTL, it has a memory made up of slide switches, for simplified teaching of bit storage. Input/output is by switches, lamps.

2. The Scelbi-8B is about the same as the 8H (March 1974 NL), but uses 2102 RAMs, "which allow the 8B to be directly expanded up to 16,384 words of memory at a cost comparable to that of 4,096 words of memory in an 8H." The 8B kit, with 8008 MPU and 1K memory, $499; empty 4K RAM card, $49; eight (1024 words) type 2102 RAMs, $59.

3. Radio-Electronics' Mark-8 (June 1974 NL) is also build around the Intel 8008 microprocessor unit.

4. The MITS Altair 8800 (March 1975 NL), based on the 8080 MPU, can directly address up to 65K of memory, has a variety of peripherals, and can be programmed in assembly language and in BASIC.

5. The Sphere (July 1975 NL), using the 6800 MPU, is now offered at $860 for CRT display, ROM monitor, real-time clock, typewriter keyboard, 4K memory. Extended BASIC is available (more memory needed). The CPU board, with 4K RAM, "512 times 8 PROM," serial TTY interface and hardwired ROM monitor (console emulator) is $350.

6. The Mike 2 from Martin Research (July 1975 NL) is based on the 8008; kit is $295, with monitor PROM and 256 bytes of RAM. Expandable to 16K bytes. For $12, a kit of ICs for a 16-channel display on a triggered-sweep scope, for debugging and educational purposes.

7. The Mike 3 kit is $395 ($445 after Dec. 15), with 8080, monitor PROM, 512 bytes of RAM.

8. The E&L Micro-Designer System (E&L Instruments, 61 First St., Derby, Conn. 06418) is an 8080 system, composed of three plug-in cards, control panel (with LED displays and control switches), interface board, power supply, and software. Can use up to 65K of memory ("can mix R-W or PROM"). The basic unit is $1,695, for a microcomputer also known as the Mark 80.

9. The MOD 8 (March 1975 NL) from MiniMicroMart is based on the 8008, sold as unpopulated boards or as a kit with 1K memory.

10. The MOD 80 from MMM uses the 8080 MPU. The C-MOD6800, a 6800 MPU on a board, is compatible with the MOD 8 and MOD 80 bus structure, input, output, etc., is for the owner of an 8 or 80 who wants to plug in a 6800 and try it out.

MMM's R-M terminal is a surplus hotel reservation terminal, with 9 electronic boards in it. Any of the MMM micros fit in it; a Teletype 32 or 33 printer also fits inside, for another $330 or so; the RM terminal is $109.95.

11. MMM's RM6800 MPU "is for the person who is starting from scratch and who doesn't want to try to try the other MPUs," according to Maury Goldberg of MiniMicroMart. It will also fit in the R-M terminal, which has modem and TV-display options.

12. RGS Electronics (3650 Charles St., Suite K, Santa Clara, Calif. 95050), has the 008A kit, with an 8008 MPU, 1024x8 memory, all ICs and parts except cabinet, $375; ASCII keyboard input kit, $135; audio cassette adapater kit; $100.

13. The Godbout kit, called "George" (because "it seemed nice and friendly") based on the National Semiconductor 16-bit PACE MPU, has been delayed a little, now has a delivery date of 1-1-76. The projected price is to be just under $600, with 1K words of memory, provisions for 7K more, editor and assembler, provisions for 4K ROM and for serial cassette interface, for 3 audio cassettes, and with keyboard rather than toggle-switch input. With 8K of RAM, the price is "still under $800." There will be no peripherals; the cassette interface will be supplied with a cassette containing editor and assembler.

Contrary to rumor, there is no relationship between the Godbout kit and the kit to be offered shortly by Radio Shack, also based on the PACE microcomputer.

For a "complete data packet" on the kit, send $2.50 (refundable) to Bill Godbout Electronics, Box 2355, Oakland Airport, Calif. 94614.

14. Details on the MITS Altair 680 kit, based on the 6800 MPU from Motorola and American Micro-Systems, were withheld until the publication of the November Popular Electronics article.

The 680 is less than a third the size of the Altair 8800, only 11 x 11 x 4 3/4. This "makes internal expandability significantly less," which means, although the article doesn't say so, that the chassis will hold only three more boards, such as two 12K RAM boards (still in design) and an interface board. Most of the 680 is on one PC board, which has a built-in Teletype interface, and which plugs directly into the front-panel board. The 680 is TTL-compatible, and uses only one 5-volt power supply. The 680 is slower than the 8800, with a 4-usec minimum cycle time, compared with 2 usec.

The software for the 680 includes a monitor on PROM, assembler, debug, and editor. The 680 has three interrupt levels; the 8800 has 8. Both can be expanded to 65K bytes.

A $293 kit ($345 after 12-31-75) includes 1K bytes of RAM. Options are: I/O socket kit, $29; fan kit, $16, PROM kit (256 x 8-bit), $42; there are provisions on the main PC board for another 1K bytes, of ROM or PROM, mainly for dedicated versions of the 680; there is a blank front panel for turnkey use.

The 680's main PC board will be sold separately for $180 ($195 after 12-31-75) for OEM use or "for the experimenter who wishes to purchase an absolute minimum."

As the latest MITS "Computer Notes" puts it, "MITS has decided to await customer response to determine the course of further 680 development in both the areas of software and hardware." If enough users ask for a BASIC compiler, it will be provided. No price has yet been set for the 12K RAM board. Also being considered is a board containing half RAMs and half ROMs. Anything requiring more than three additional boards will also require an expander chassis, which is in design. The 680 seems to be aimed primarily at OEM controller applications.

15. SWTP (Southwest Technical Products Corp., Box 32040, San Antonio, Texas 78284) has announced "The computer system you have been waiting for," its 6800, which contains a ROM with "the program necessary to automatically place not only a load-

er, but also a mini-operating system into the computer's memory."

The 6800 is controlled by any ASCII-coded terminal. The basic 6800 includes the ROM, a 128-word static scratchpad RAM, 2K memory, serial control interface, power supply and case, plus test programs and the Motorola Programmers Manual, at $450.

16. The Micro 440 by Comp-Sultants Inc. (P.O. Box 1016, Huntsville, Ala. 35807) is based on the Intel 4040 chip, and is available with 256 bytes of RAM, power supply, case, I/O port and Teletype interface, for $275 kit, $375 wired.

The 440 features 60 instructions and 24 on-chip registers. For $175 you can get the full CPU board, front-panel controls and displays, and the 256 bytes of RAM. The case has room for 8K of RAM or PROM, in 2K increments.

17. The SRI-1000 by Systems Research Inc. (P.O. Box 151280, Salt Lake City, Utah 84115) uses the PACE MPU, and includes full keyboard control, 4K RAM, $599 assembled and tested. Options include more RAM; interfaces for cassette, video, TTY, RS-232, TTL; floppy disk, line printer, and tape reader.

18. Imsai (IMS Associates, Inc., 1922 Republic Ave, San Leandro, Calif. 94577) has the Imsai 8080, "compatible with the Altair 8800." The basic computer includes CPU, 1K RAM, front panel, control panel with 8 extra LEDs to indicate the output port, all lights and switches, power supply, expander board and case, $439 kit, $621 assembled.

Imsai also sells boards that are interchangeable with Altair's, including CPU, 4K RAM, 1K RAM on 4K board, 2K EROM on RK board, etc. And a multiprocessor/shared memory facility that "allows up to 3 Imsai 8080's or Altair 8800's to share the same memory"; $295 kit, $335 assembled.

Are there any others?

OEM EVALUATION KITS

Many microprocessors are now available as part of a PC board marketed for engineering evaluation, in kit or wired form, usually with a minimum of memory, and without power supply, chassis or case.

1. The JOLT (Pehaco Corp., Microcomputer Associates, Inc., 111 Main St., Los Altos, Calif. 94022) has a $249 CPU card kit built around a MOS Technology 6502, which can address directly 65K of memory. ROM program memory on the CPU card consists of 1K bytes of monitor/debugger with an automatic power-on bootstrap program. A 4K RAM card kit is $265; I/O card (peripheral interface adaptor) kit, $96; power supply (will support CPU, I/O and a 4K card), $145 kit. An accessory bag, with enough parts to connect one JOLT card to another, is $40. That would make a 4K kit cost about $850. The 6502 has 58 instructions and 11 addressing modes, and sells for $25.

2. The Mostek F8 Evaluation Kit, at $297, includes the 3850 MPU, a ROM, static memory interface, 1K x 8 of static RAM, crystal, 2 CMOS buffers, and a 6.75" x 5.5" PC board. A Teletype or CRT can be connected directly to the board. The ROM software permits "program loading, storing, modification, debugging (with "traps") and even hexadecimal arithmetic--all from the Teletype."

3. Cramer Electronics (85 Wells Ave, Newton, Mass. 02159) offers three evaluation kits, built around the Intel 8080A, Texas Instruments 8080, Motorola 6800. These are $495 each, and include eight 1024x1 sta-

tic RAMs, a 1024x8 erasable ROM preprogrammed with system monitor, controls (toggle, pushbutton, and DIP switches) and displays (LEDs and 7-segment) for programming with or without a terminal. Includes both current loop and RS-232 interfaces for any terminal, and an audio cassette with test programs (audio cassettes can also be used for extra program storage). "The erasable ROM contains a system monitor that makes your microcomputer useful as soon as you turn it on.. ..A cassette full of other useful programs is included to help you debug and demonstrate your microcomputer."

Power supply is not provided. Memory is expandable to 12 additional 1K RAMs. Coming up: kits based on the AMD 9080, Mostek F8, and RCA COSMAC. And in early 1976, bipolar Cramerkits using the Intel 3001, AMD 2901, TI SBP 0400, and Motorola 10800.

The $495 does not include a PC board. The Augat boards shown in the brochures are about $275 each.

4. Pro-Log Corp. (2411 Garden Road, Monterey, Calif. 93940) offers a variety of assembled cards, for logic processing (using the 4004 or 4040) and for microprocessors (8008, 8800, 6800, F8), all using "1702A MOS PROMs or equivalent."

WHERE IS KENBAK TODAY?

The Kenbak-1 (June 1974, Feb. 1973, and Mar. 1972 Newsletters) $850 training computer is no longer being marketed by its designer, John Blankenbaker. It is now in the hands of C.T.I. Education Products, Inc. (695 Coleman Blvd., Mt. Pleasant, S.C. 29464), and is the Model 5050 Digital Computer Systems Trainer, at $1,035. CTI also markets logic labs and a variety of electronic training devices.

8080 AND 6800 PRICE CUTS

In October, Intel cut the prices of the 8080 family; the new 100-lot price for the 8080A MPU is $40; 25-99, $60 (was $110); under-25, $75 (was $150).

Advanced Micro Devices offers its 9080A version of the 8080 MPU at $29.95, in lots of 100.

Motorola's M6800 MPU is $69 for 1-99 (was $175 for 1-9). The MCM6810 1K RAM is now $5 for 1-99 (was $15 for 1-9). The Design Kit, with PC board, is now $149; it was $300 before, without a PC board.

PACE HIGH-LEVEL LANGUAGE

National Semiconductor, makers of the 16-bit PACE MPU, will soon have a Disk Operating System (DOS) and SM/PL, a resident high-level language; "this makes PACE the only fully supported one-chip microprocessor in the industry," according to the advertisement.

IN PRINT

Designing Your Own Microcomputer

This is the title of an article in the Sept. 27 Electronic Design, on how to use bipolar bit-slice microprocessors to build, for example, a 16-bit processor with 24 ICs, built around four 6701 4-bit MPUs (by Monolithic Memories?), and featuring 16 general-purpose registers, ability to address 65K words of memory, and instruction execution times from 0.9 to 1.2 usec.

"Increase microcomputer efficiency" by the same author, David Wyland (ED, Nov. 8), shows how to add interrupt and DMA (direct memory address) capabilities with only seven extra ICs, six new instructions, and nine extra control-ROM bits.

The schematic shown is basically the same as in the previous article, with the required additions.

Micro Depts.

Starting with its Nov. 22 issue, Electronic Design will have a "Microprocessor Design" section in every issue.

And Digital Design started a "Micro Notes" department, in its Sept. 1975 issue.

ALTAIR-TYPE PC BOARDS

Jim Garrett (322 Rollingridge Ln., Garland, Texas 75041) writes: "In contacting MITS about the availability of their Altair 8800 PC boards I have found that they are no longer going to supply them to the hobbyist. If there is enough interest, I will make an equivalent improved set of boards for us at cost. The purpose of this letter is to gauge interest.

"Everyone interested in Altair-8800-like boards, drop me a postcard (or letter) stating their needs. These are improved boards (DISCLAIMER: I do not offer Altair products or kits; I sell parts and accessories which can be used in the Altair 8800).

"The display board will contain the necessary mods to provide an octal display (for about $15 more in components you can read octal instead of binary), AC switch improvements will be instituted, grounding on all boards will be improved, mods to the CPU boards will include reducing switch noise and a more conventional connecting to the display board. The memory boards will have provisions for a DIP switch for address selection (no more jumpers), etc.

"Tentative prices are: CPU, $18.50; 4K memory (static or dynamic), $18; power supply, $13.50; display and control, $33; SET I (1 each CPU, PS and D/C), $58.50; SET II (4 each, static or dynamic), $65; SET III (SETS I & II), $115. This includes postage, insurance and full documentation of all mods.

"I am willing to produce any other boards if there is enough demand. Along the same lines I may be able to supply the DIP switches, connectors (both 100-pin and IC) and miniature switches, if there is enough interest, at OEM prices."

BUILDING FROM SCRATCH

Despite all the activity in microkits, many ACS members are still building their machines from their own design, or copying a commercial machine. Billy H. Pettit (1277 Indian Rd., Mississauga, Ontario, L5H 1K7 Canada), writes: "I'm building a 12-bit, 8K machine completely compatible with the CDC 160-A/8090. Using TTL, naturally, with a solid-state RAM memory. Been playing around with 1103's, but finally gave up. They just aren't worth the extra interfaces. Will probably go to 74S206's. [CDC = Control Data]

"Have always felt the 160-A had about the best instruction set and versatility of any 12-bit machine. In my opinion it is superior to the PDP-8 set, and easier to use. Plus, for me, the big advantage of software. For 10 years, I've used the 160-A and now have hundreds of programs. Especially useful is a very, very sophisticated FORTRAN for a 12-bit machine. There is a second FORTRAN, more primitive and similar to DEC's 8K version. Also a pseudo-COBOL and half a dozen floating-point simulator packages.

"All of which means that when it is built (my version), I can use it for something. All of the software

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For membership in the ACS, and a subscription to Vol. III of the Newsletter, send $5 to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.
Darien, Conn. 06820

The ACS Newsletter will appear every two or three months.

is in the public domain, and the user's group is still active.

"If any reader ever buys a scrapped CDC component and wants some info, have him write. I can probably get a schematic of anything likely to be on the surplus market."

SURPLUS IN SWEDEN

Eskil Hedetun writes from Sweden: "As you probably know, computers are manufactured in Europe by just a few, and very big, companies; i. e., Siemens-Philips, IBM-Europe and perhaps the Swedish SAAB (same company that makes the car). This means that surplus is very scarce, and if the "goodies" ever come out of the factories, they go to various schools and universities. Surplus to amateurs is "zero." As regards components and "rejects," it is mostly sold in England, and due to the EFTA-EEC free-trade it is rather easy to get a shipment from England. For more complicated ICs like RAMs, we have to go to the US to get them. Most US dealers are very speedy and efficient. The inflated dollar has made it favourable to buy components and even computer kits from the States. In this region (southern Sweden) I know at least two persons who have bought the Altair."

TOOLS

An excellent catalog of "more than 2500 tools for electronic assembly and precision mechanics" comes from Jensen Tools and Alloys, 4117 North 44 St., Phoenix, Ariz. 85018. Some of the prices may seem high, but that's because these are all first-quality tools, including over 60 pliers, 10 pages on soldering equipment, and many fine tool kits.

THE TRADING POST

Gary Coleman (14058 Superior Rd., Apt. 8, Cleveland, Ohio 44116) has acoustic couplers, modems, keyboards, CES tape drives, etc. For a price list, send a SASE.

NEW COMPUTER CLUBS

Doug Penrod (1334 La Cima Rd., Santa Barbara, Calif. 93101) has started a new computer club.

John Vullo (230 Main St.,Rte. 28, North Reading, Mass. 01864) is president of the Boston-area Alcove Computer Club.

IBM'S MINI

The IBM 5100 "portable computer" looks more like a CRT terminal than a mini, with a 1024-character display screen, typewriter keyboard, and an integrated cartridge tape drive. Memory ranges from 16K to 64K characters, and prices from $9K to $20K, depending on memory size and on choice of printer, auxiliary tape-storage unit, and other options. The 5100 comes with either APL or BASIC, or both. Three program libraries, each consisting of two mag-tape cartridges and a user guide, are $500 each, for business analysis, math problem-solving, and statistical problem-solving.

KITS: PART 4
ROSTER II

A C S NEWSLETTER
a publication of the
AMATEUR COMPUTER SOCIETY

Volume III, Number 14
(Serial Issue 37)
February 1976

KIT ROSTER (continued)

Many more microcomputer items have been advertised or announced since the listing in the previous issue. Here are over a dozen:

19. From Sphere, the Micro-Sphere 200 is sold as a wired unit only, with 4K RAM, ROM cassette loader, 128x128 black-and-white dot-matrix graphics system, and a games package; $860. The MPU is a 6800.

20. The Systems Research SRI-500 is also a wired-only unit, with F8 MPU, available as modules: board with 1K RAM, TTY interface, debug in ROM ("Fairbug"), $325; power supply, $55; keyboard, $100; etc.

21. Wave Mate's Jupiter II comes in both kit and assembled forms; with 6800 MPU, 8K dynamic RAM, RS-232 interface, software (editor, debug, assembler, BASIC), wirewrap tool, $1299 kit. (1015 West 190 St., Gardena, Calif. 90248).

22. The EBKA 6502 Familiarizor has a hex keyboard and two-digit display on the same PC board as the circuitry, so it doesn't require a terminal for a beginner to learn the basics. For the MOS Technology 6502 MPU, 1K-byte RAM, 256-byte PROM (monitor): $229 kit, $285 wired. (EBKA Industries, 6920 Melrose Lane, Oklahoma City, OK 73127)

23. The OSI 300 from Ohio Scientific Instruments (P.O. Box 374, Hudson, Ohio 44236) is a wired trainer using the MOS 6502 MPU with 128-word RAM, 7 address switches, 8 data switches, displays that indicate data, address, and program execution, lab manual with 20 experiments; $99.

OSI has an interesting alternative: Send in $110, get a 315 computer trainer (identical to the 300), return it within 60 days, and you receive three PC boards (superboard, I/O board, video board) and software for TV typewriter and audio cassette monitor, for a system based on either the 6502 or 6800 MPU. To quote from the OSI Feb/Mar flyer: "The 6502 is currently the fastest N-channel microprocessor available.... It is also very inexpensive in small quantities and features an internal clock. These features are very important to the hobbyist on a budget, especially if he doesn't have a good scope. The 6800 is somewhat more expensive and requires an external clock. It is rated for a 1-us cycle time and therefore can operate at only one half of the speed of the 6502. It does feature two accumulators and a more extensive instruction set than the 6502. Therefore, the potential user should carefully consider it when real-time applications are not anticipated."

24. Techtra Corp. (130 Webster St., Oakland, Calif. 94607) will offer the TMC 112, "a replacement for the PDP-8," with operator's control panel, up to 32K of core or semiconductor memory, "a complete range of peripherals," etc. Based on the Intersil 6100 MPU, the TMC 112 is still in prototype, they tell me.

25. The Micro-68, from Electronic Product Associates (1157 Vega St., San Diego, Calif. 92110) is a wired unit with 6800 MPU, integral hex keyboard and 6-digit display, 512-word "John-Bug" PROM, 128 words of RAM; $430.

26. The KIM-1 from MOS Technology is a similar unit, with 6502 MPU, 23-button keyboard and 6-digit display mounted on the PC board, 1K

RAM, monitor in 2K ROM; $245.

27. The Dyna-Micro kit will supersede the Radio-Electronics Mark-8. A microcomputer learning system, it comes with a series of books on learning the 8080 and the system, and is scheduled for introduction in the May-June R-E.

The Dyna-Micro will be marketed by its manufacturer, E&L, as the Mini-Micro Designer, MMD-1, featuring the 8080A MPU, with everything on a PC board, including 16-key keyboard and 24 LEDs, plus a built-in interfacing breadboarding socket. Keyboard entry is controlled by a ROM, and the 256 words of RAM are expandable to 512. The complete set of parts and boards is $350; assembled and tested, $500.

28. Hamilton/Avnet offers the Pacer, with the 16-bit PACE MPU, 1K ROM monitor, 1K RAM, two 4-digit displays, 32-key pad, power supply and case; $695; assembled, $160 more. For assembly-language programming, a TTY interface/program assembler is $175.

29. The PCM-12, from PCM (Box 215, San Ramon, Calif. 94583), uses the 12-bit Intersil IM6100 MPU, has a full set of switches and lamps, and is software-compatible with the PDP-8/E. Price: $400 to $600, depending on options. DEC's 4K BASIC is included, and is the only software available from PCM right now.

30. According to the Micro-8 Computer User Group Newsletter, the Astral 2000 kit (M&R Electronics, Box 1011, Sunnyvale, Calif. 94080) is based on the 6800, features 8K of memory, serial TTY I/O, and comes with BASIC. It has a 12-amp power supply, DMA, real-time clock, binary and hex front-panel display, and front-panel switches that can be used as I/O while running. Availability was scheduled for Dec. 1975, at under $1000.

31. HAL Communications (807 East Green St., Box 365, Urbana, Ill. 61801), best known for their RTTY CRT terminals, has taken the 8080A board out of their DS-3000 and DS-4000 KSR/RO terminals, and offers it as the HAL MCEM-8080 microcomputer system, a "complete operating system on a single PC board, exclusive of power supply and Teletype or CRT terminal." Included are LED indicators, switches for system control, a break-point register, 1K bytes of PROM with system monitor, 1K bytes of RAM, for $375. Options include keyboard/video display, power supply, ROM programmer.

32. From Texas Instruments (Box 5012, M/S 54, Dallas, Texas 75222), the Microprogrammer is the first in a series of Microprocessor Learning Modules. The 3-pound hand-held TI Microprogrammer (LCM-1001) comes in a plastic case, only 6⅛ x 5¼ x 1 3/4 inches, has 20 toggle switches for entering instructions, data and addresses, etc., and 29 LEDs. Available wired only, with rechargeable batteries and charger and 148-page manual, at $149.95, it has a 40-pin IC connector for expansion; future units will include a controller (with PROM), memory, input/output.

33. The UT 8100 microprocessor from Infinite Inc. (P.O. Box 906, 151 Center St., Cape Canaveral, Fla. 32920), using the RCA COSMAC MPU, will be available in June as a "completely self-contained microcomputer," with built-in keyboard programming, 256-byte RAM expandable to 4K-byte RAM or ROM on-board, external memory expandable (via 16-bit address) to 65K bytes of RAM or ROM, 4-digit hex readout, 16 keyboard switches. Available wired or kit, prices to be announced.

NOTE: The Techtra TMC 112 may not be the only unit still in prototype. There is no way of knowing from an ad if the advertiser has units all ready to ship, or has only a proto-

type and is waiting for enough response to start up production.

MICROKIT UPDATE

As new as it is, the microcomputer scene has already witnessed some major changes:

Scelbi Drops Hardware

Scelbi Computer Consulting is no longer manufacturing either the 8H or the 8B, but is concentrating on software, and at the moment is working on BASIC for the 8008 and 8080 MPUs. Other MPUs are being considered for future software.

Incidentally, the Scelbi "Machine Language Programming for the 8008 (and similar microcomputers)" is highly recommended by many microkit manufacturers; and is now in a second edition, typeset on both sides of the page (the first was all in Teletype capitals, on one side of the paper), still $19.95 (1322 Rear, Boston Post Road, Milford, Conn. 06460).

MITS Upgrades Both Micros

The 8800B "is an entirely new Altair, the control and display panels are an entirely new design and contain PROM memory.... The clock width is crystal controlled as well as the frequency.... The interface card and front panel are connected by pluggable ribbon cable. The system bus has 18 slots.... the new switches have longer, flat handles." Four new front-panel functions are available for accumulator control: display, deposit, output, input. A Slow function single-steps the processor at 32 instructions per second. Front-panel functions can be redefined by reprogramming the front-panel PROM. "Existing Altair owners will be able to purchase a kit from MITS to upgrade their existing Altair to a B at significantly less cost than purchasing a new machine."

The new design of the 680 includes an automatic PROM loader, and a BASIC interpreter is being developed. (The original 680 had some bugs, and only two or three were sold before they were all recalled.)

SRI-1000 Delayed

The Systems Research SRI-1000 (Nov. 1975 Newsletter) was designed around the PACE MPU, but there were component delivery problems, so the wired-only SRI-500 is now being offered, with the Fairchild F8 MPU.

MICROCOMPUTER TYPES

The microcomputer scene seems to have settled down to seven basic types:

1. Box with full set of switches and lamps: Altair 8800, Altair 680, Imsai 8080, PCM-12, etc.

2. Box with very few switches or lamps: SwTP 6800, Jupiter II, etc.

3. Box with keyboard, but no switches or lamps: Micro-Sphere 200.

4. Box with keyboard and CRT: the Sphere.

5. PC board without keyboard or display: Wintek, engineering evaluation boards (JOLT, Cramerkits, Pro-Log), etc.

6. PC board with keyboard and display: MRE Mike-2 and Mike-3, EBKA 6502 Familiarizor, EPA Micro-68, MOS Technology KIM-1.

7. Surplus: Viatron.

VIATRON COMPUTERS

Verada 214 (38 French St., Box 438,

Lowell, Mass. 01852) got 20 of the Viatron 2111 Microprocessors, hopes to get more. The 2111 "is a complete computer with keyboard input, two cassette tape drives built-in, a video display, an operating system on ROM.... Guaranteed working when they left our plant": $699, FOB Lowell.

Meshna (E. Lynn, Mass. 01904) is offering the "System 21," which appears to be the same unit offered by Verada 214, "sold as it; due to 4 years of storage, may require some adjusting/cleaning"; $425, FOB E. Lynn.

Note that these units are no longer being manufactured, and that most of the mechanical parts (and perhaps some of the electronic parts) are thus not available if needed for repairs. A letter to Interface cries out: "HELP! I have a Viatron model 2101 that doesn't work. Would appreciate contact with anyone who could provide technical information or programming assistance...." Caveat emptor.

FIVE MPUs

Gregory Peterson says, in the Dec. 1975 Denver ACS Newsletter, in part:

"The PACE chip from National... is in a class by itself, a 16-bit machine whereas the other chips mentioned are all 8-bit units. Therefore, it handles more data at a time, but uses a relatively slow semiconductor technology and loses some of what it gained in data volume in relation to speed of execution. It has 48 instructions but only three addressing modes. It is also quite expensive in comparison to the other chips mentioned, costint more than twice the others...."

"If you are of the opinion that any computer worthy of the name is at least 16 bits in word length, consider the LSI-11 or the monolithic implementation of the PDP-8 offered as the IM1600 by Intersil. The initial investment in these machines may be greater, but the availability of software is unparalleled.

"There is a large following of people devoted to the smaller 8-bit machines. The 8008 was the first microprocessor available with which to construct a home computer. It is also probably the most prolific of the microprocessor chips. There is a fair amount of home-generated software available to a person who constructs with one of these chips. Unfortunately, the internal architecture can now be considered archaic.

"The 8008 requires a fair amount of supporting TTL logic to make it work, and thus could never be considered for a minimal design effort. The 8080 is very popular too. ... As with any chip, software support is at least as important a consideration as the actual chip itself. In this regard, the 8080 is one of the better chips available. There is a large number of homebrew programs for these chips, and there is a very powerful BASIC interpreter package available from MITS. A FORTRAN package is available from another source. It does require 16K of memory to run, tho. The 8080 is a serious and powerful chip with a large community of users. Yet, even this chip is only a scaled-up and improved 8008. Recent trends in microprocessor design have rendered even this chip obsolete, though it will continue for some time on the sheer momentum of its usage.

"The 8080 is not as integrated a machine as the 6800 and requires that more chips be added around it to enable it to function. The 6800 also differs radically in input and output approach from the 8080. Whereas the 8080 is parti-

tioned along the classical lines of computer architecture, with input and output functions being clearly defined in relation to the flow of other data within the system, the 6800 places all input and output on the data bus as addressable memory locations. Some of the benefits gained from this are the availability of all memory reference instructions to manipulate the input and output ports. The decoding and accessing of input and output locations is easier in this system, and it requires fewer chips to support the microprocessor chip.

"There is also available a read-only memory chip for the MC6800 containing a very nice little monitor system for control of a 6800. This chip is what makes possible the stark front panel of the MITS and SwTPC 6800-based microcomputers. All the lights and switches that are synonymous with data processing are replaced by a small operating system in a ROM chip. This controls operation of the microcomputer and allows one to display memory locations and register values, and alter them at will as one develops his programs. This chip also costs a lot less than all those lights and switches, and simplifies the design of a computing system. Therefore, a computer constructed along these lines is less expensive, but at no sacrifice in computational power. It does predicate the ownership of an input and output medium which speaks serial ASCII code, though. A modern Teletype or a TVT with suitable interface board works well, but tends to drive up the initial investment in equipment for a functional system....

"I chose the MOS Technology 6502 chip for my design for several important reasons.... It is possibly the least expensive of the available microprocessor chips (don't forget all that support TTL for the 8008). It ranks as the most powerful chip available now to the home constructor, having 55 basic instructions selectively operating over 13 distinct addressing modes. This addressing flexibility gives the chip unparalleled ease in manipulating data in memory. The chip follows the 6800 in assigning all input and output to locations in memory. It is also the only chip discussed here that incorporates an on-chip clock oscillator. This convenience should not be overlooked. The complexity added by the high-level clock drivers the other chips require, and the increased wiring complexity, can be appreciated only after one uses the 6502.

"The 6502 is strictly a plus-5-volt machine, requiring no multiple supply voltages for chip operation. It interfaces directly to TTL. It is also very fast.... The 6502 is the only chip considered here with two distinct true index registers. This little convenience makes for unmatched ease in constructing programming loops. It also allows data to be easily shuttled about in memory with minimal programming effort. The internal architecture also incorporates an 8-bit accumulator, a fairly standard stack capability, and a good selection of testable status bits to monitor internal operations and allow the chip to alter its processing on the results of its computations. The multiplicity of on-chip registers that 8008 and 8080 users are accustomed to are absent. Computation in this machine is intended to take place between the accumulator and memory, and in a sense the addressing flexibility gives one a whole memory full of registers to use in their computations. One cannot overstress the programming ease the multiple memory addressing modes convey. Rather than having to cleverly juggle the data in on chip registers to trick the chip into accessing the portion of memory you are interested

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The ACS Newsletter will appear every two or three months.

in, there somehow always seems to be an addressing mode to do just what you want...."

TRADING POST -- For Sale

John L. Marshall (Box 242, Boston, Mass. 98055) writes: "Well, I finally broke down and bought a box from IMSAI. I sure hope that it is as good as advertised. I also bought memory and CRT interface from Processor Technology.

"I have a few items for sale. Interested persons may inquire and make offers: Wangco 7 tape drive, MFE cassette drives, 4Kx12 memory systems, line printers, paper tape reader, paper tape punch, TMS 2105 NC, 3002, 3003, 3113, 7491, 1414L, 710, 741."

HARDWARE -- ICs, MPUs, etc.

Cybertronics (Box 18065, Louisville, Ky. 40218) has a 28-page catalog of ICs, MPUs, and wirewrap and packaging items, including the 7400 series, CMOS DIPs, op amps, voltage regulators, 7-segment displays and LEDs, 8008 ($19.95), 8080 ($50), PACE ($125), PROMs, RAMs (2102, $2.50), EROM kits, IC sockets, power supply kits, capacitors, etc.

THE TARBELL CASSETTE INTERFACE

Don Tarbell (144 Miraleste Drive #106, Miraleste, Calif. 90732) says: "I have been using an inexpensive audio cassette recorder in my home-designed computer system since 1972. I have over 600 files on cassettes, mostly about 4 Kbytes each. My estimate is that the error rate is less than 1 error in 1,000,000 bits. I say this because I can usually record 30 4-Kbyte files on one side of a C-60 cassette without any errors."

The letter goes on to say that the speed is up to 540 bytes per second (2200 bytes per inch); 187 bytes per second for ANSI standard 800 bits/inch; 30 bytes per second for "Byte/Lancaster" standard. Cost: $100 for kit, $150 built and checked out. Write for further details on the Tarbell Cassette Interface.

ONE MORE MICRO

34. Just learned of the RCA COSMAC Microtutor that uses the 1801 MPU (which has 16 16-bit registers), $349 wired. The Microtutor may later use the new 1802 MPU, and may later be available as a kit, cheaper. The small box, about 5 x 7 x 2 inches, has 256 words of RAM memory, 8 input toggle switches, and a two-digit LED output display.

A TALL ORDER

Most questions asked of the ACS are reasonable, but this one from upstate New York a couple of years ago, asked one that I just couldn't answer: "I would also appreciate some information on the structure, current and past activities, general state of development, and overall orientation of the organization. A run-down on the various levels of accomplishment of the major computer building projects and the "state-of-the art" within the group would also be appreciated."

LAST ISSUE OF VOLUME III

ACS NEWSLETTER

a publication of the AMATEUR COMPUTER SOCIETY

Volume III, Number 15 (Serial Issue 38) June 1976

TIME AGAIN TO RENEW

This is the last issue of Volume III of the ACS Newsletter. If you would like to subscribe to Volume IV, which will consist of at least eight issues, please send $5.00 ($6.00 overseas).

The first issue of Volume IV is scheduled to appear during August 1976, the month of the tenth anniversary of the publication of the first issue of Volume I.

KIT ROSTER (PART III)

Several more kits have appeared on the market since the last Newsletter, and I've gotten info on several that have been around awhile. These should bring the list up to date. If you know of any not included in these 42, let me know.

35. The ETC-1000, from Electronic Tool Company (4736 W. El Segundo Blvd., Hawthorne, Calif. 90250) is a wired-only system based on the MOS Technology 6502. The front panel has an 8-digit segmented alphanumeric display and 40 switches for data/address entry (hexadecimal), control, and special functions. Word length is 8 bits; instructions are 8, 16 or 24 bits. The basic system includes 1K bytes of RAM, current-loop interface, and a 256-byte EAROM containing the system control programs, for $575. A 1K RAM expansion is $118, 4K for $235. Other CPU modules are available (8080A, M6800, and F8) for "sharing system resources," meaning main memory and peripherals.

36. The Micro-88 (formerly the Micro-Altair) from Polymorphic Systems (737 S. Kellogg, Goleta, Calif. 93017) consists of a video board with graphics capability, CPU/ROM/RAM board, backplane with power supply, and cabinet. The CPU board includes an 8080 MPU, 512 bytes of RAM, space for 3K bytes of ROM, and vectored interrupts. Several CPU boards may be plugged into the same backplane for parallel processing. Data may be entered in octal, hex or ASCII, and edited on a TV screen. The Micro-88 is compatible with MITS Altair peripherals and software. The complete system, including operating system on PROM, is $575 in kit form. Boards are available separately.

37. The AMT 2650 from Applied Microtechnology (100 N. Winchester Blvd., Suite 260, Santa Clara, Calif. 95050) is a self-contained card micro using the Signetics 2650 MPU. The control panel, mounted directly on the PC board, has 14 mini toggle switches, a run LED, and four sets of 8 LEDs for ADDRESS, DATA I, DATA C and DATA D. The 256-byte RAM memory is expandable to 32K bytes via the 62-pin edge connector. Price is $195 wired-only; an optional 5V/3A power supply is $39.95.

38. From Computer Shack (P.O. Box 662, Littleton, Colo. 80120), the 8080+ is a wired-only all-on-one-board microcomputer, requiring only a 5-volt power supply (the "single 5v supply is internally stepped to -5, -9, +12 and tapped for +5v, all available in wire wrap area"). On-board RAM is 1K, monitor is in two 256-byte EPROMs, MPU is an 8080. The control panel includes 16 hex keys, 4-digit LEDs, address/data display, Teletype interface. Price is $995, plus $18 for shipping and handling.

39. Mikra-D (30 Main St., Ashland,

Mass. 01721) has these: VT-1920 is a CRT terminal with monitor, keyboard, housing, interface for 8080 CPU, and power supply, $695 kit. MTS-8 includes the VT-1920 plus 8080 CPU, 1K bytes of ROM, 4K bytes of RAM, serial interface, cassette interface, assembler, editor and debug software, $1195 kit. BASIC-8 includes the MTS-8 plus 4K more of RAM plus BASIC software, $1695 kit. All systems have 80-character by 24-line display.

40. The Digital Group (P.O. Box 6528, Denver, Colorado 80206) has a computer kit that can take any one of three different CPUs: 8080A, 6800, or 6501/6502. "You can change from an 8080 to a 6800 by literally unplugging the 8080 card and plugging in the 6800 card. Switch on power, read in the 6800 operating system and you have changed your system to a 6800.... Each of the CPUs is completely interchangeable at the CPU card level with any other." An 8080 3-board system with 2K RAM is $425 kit, $645 wired; 4-board 8080 system with 10K RAM, $625, assembled $895. The 6501/2 system with 2K RAM is $375/$595, 10K RAM $575/$845; 6800 system with 2K RAM, $425/$645, 10K RAM $625/$895. A 3-board system consists of CPU card, I/O card, TV readout and cassette-interface board, and mother board; the 4-board system has an additional 8K of memory. Options include power supply, video monitor, etc. A case is underway, may be available this summer.

41. Moducomp Inc (75 California Ave., Brockville, Ontario, Canada K6V 5Y6) has wired boards for the MOD8 microcomputer: CPU board with 8008, $135; PROM board with Monitor8 software programmed into 8 PROMs, $233; TTY I/O board, $62; RAM board with 2Kx8 RAM, $120; input board with 3x8-bit channels, $51, output board with 3x8-bit channels, $62; backplane with PROM programmer, $272. "typical minimum system is $720." (These prices are as of last year, may be more now.)

42. OSI (new address: 11679 Hayden St., Hiram, Ohio 44234) now has the 400 computer system: several boards now, more boards (and 2 enclosures and 2 power supplies) to come later. The 400 Superboard alone is $29; with 6502, $54; with 6800, $69. The 412-A is a 400 with 6502, eight 2102 memory, monitor PROM, 6850 ACIA "and all miscellaneous parts to talk to a Teletype," $139. Same but with 6800, $159. The 420 memory expansion board is a 4K of 2102 memory, $119. The 430 Super I/O board has high-speed analog I/O, with A/D converter and two 8-bit D/A converters, serial and parallel interfaces, $29 (must be an empty board). The 440 graphics board is $29; 470 floppy disk (GSI 105 disk drive, OSI bare interface board and operating system), $599; 495 prototyping board, $29; 480 backplane board, $39.

Coming: 460 PDP-8 emulator using 6100 MPU, to be used with 6502-based 400 board; Superboard that will take the Z-80 MPU; 450 PROM calculator-chip board, an interface to an MOS Technology calculator chip; 490 distributed-processing network backplane boards, which will support four processor systems.

THE REST OF TI'S LEARNING SYSTEM

The Texas Instruments Microprogrammer (Feb. 1976, p 2) has been joined by three new Learning Modules: Controller Module, to "progress from micro to macro-level programming," $189.95 wired; Memory Module, read/write, with 1K of 12-bit words, $189.95; Input/Output Module, 4 input and 4 output ports, each 4 bits, can be combined for 8-bit ports, $109.95. Also new is the TI book, "Software Design for Microprocessors," 500 pages for $12.95. (The modules are wired, no kits; each has its own battery/

charger system; modules are interconnected by ribbon cable.)

FIX-KIT FOR ALTAIR 800 CPU CLOCK

Parasitic Engineering (P.O. Box 6314, Albany, Calif. 94706) asks, "Is your Altair 8800 slow to start up? Writing all 0's or 1's into memory? Producing the wrong STATUS? Having troubles running BASIC? Then your Altair may have CPU clock problems." They offer a "permanent fix-kit" that includes a "special bi-polar M.S.I. integrated circuit" for $15.

"MICRO-8 NEWSLETTER" PHASE-OUT

That's the heading of the sad-news paragraph in Hal Singer's fine newsletter that packed so much information into its always-welcome pages.

As Hal notes, one of the main factors contributing to his decision was the time required. Anybody who has started a hobby-computer newsletter soon discovers that there's a point where the growing number of subscribers will make it necessary for him to either have his list of subscribers handled by a professional "subscription maintenance" organization, or else find volunteers who will spend a great deal of time changing addresses, taking care of renewals, etc. And there's also the big (and expensive) problem of getting the newsletter printed, collated, and addressed. This all costs money, but the subscription price has to be kept reasonable, so that unless the newsletter sells advertising (which is a whole new--and hairy--game), it may lose money. So it all has to be a labor of love.

All this helps explain why I've kept the ACS Newsletter subscription list at a minimum of several hundred, and have run it entirely by myself for 10 years. By doing the collating, folding, stuffing and addressing myself, I save enough money to give subscribers more issues of the newsletter than otherwise, and by not using outside help, I have only myself to blame if anything goes wrong. Having been the editor of magazines or professional newsletters for many years, it's nice for once to know exactly who did what wrong.

TRENTON COMPUTER FESTIVAL

The Trenton Computer Festival, held at Trenton State College in New Jersey on May 2, was very well run, and should serve as a model for future events. There were dozens of exhibits along the engineering-school halls, including Byte, EPA, Hal, MOS Technology, OSI, RCA, and a number of computer stores. The halls were narrow and not very well lit, but this seems to be typical of many engineering schools (besides which, the halls weren't designed for computer festivals).

A Flea Market operated in the parking lot, with tailgate sales of anything and everything, some old and some new, including CRTs, ICs, TTY tape, capacitors, power supplies, MiniMicroMart, PC boards. One had Scelbi's BASIC for 8008/8080, for $43.95.

Two dozen "forums and talks" were presented, on computer music, Altair 8800 rap session, writing a systems monitor, RCA Microtutor tutorial, microprocessors in amateur radio, computers in the home, computer graphics, interfacing, computer games, data recording, etc. Some were interesting, some were dull, some too far out with predictions....

The DEC setup included a computer with disk memory and video terminal.

During the day a 13-year-old sat down at the terminal, and with fingers flying accessed the batch processor, wrote a program to put a message on the CRT, using the editor, put it out from file to execute. It came up fine the first time, and the boy walked away with a smile. Later the DECmen found he'd also dropped out the bootstrap loader, and although there was a hardware loader, nobody knew its starting address. It took half an hour to find a listing for the loader, which was then keyed in so the computer could get back into operation.

A clever gimmick to get people to stay around: drawing for door prizes, at 4 P.M.

The Altair 8800 Rap Session was given by Dennis Dupre, who repairs Altairs and other kits that their buyers can't make work, at $5 to $10 an hour, on an informal basis; average job takes about two hours. The most common problems, he said, are solder bridges, the Altair clock, bad ICs, and ICs that were put in backward.

Much of the big, old stuff didn't sell, such as the huge old Ampex tape drive, offered for $50, free delivery, but no takers.

Next Computer Fair

Upcoming is the "Personal Computing 76 Fair," the weekend of August 28 and 29, at Atlantic City, N.J. For a "Trip-Kit," write: Personal Computing 76 Fair Headquarters, Shelburne Hotel-Motel, Box 1138, Boardwalk and Michigan Ave., Atlantic City, NJ 08404.

Admission is $5 in advance, $7.50 at the door. I've signed on to talk about "Current Trends in Hobby Computers," and will have much more time than the 23 minutes I had at the National Computer Conference on June 8 to give a paper on "Building Your Own Computer."

SCIENCE FAIR

If the Student Computer Fair at the 1976 National Computer Conference in June is any criterion, there may not be many scratch-built or even kit-build computers being entered in science fairs these days.

The 1976 NCC Fair included 58 exhibits selected from some 300 entries. There were 4 computer stories, 6 drawings, 1 poem, 1 ventriloquist, 1 dancer, 1 pianist, 1 synthesizer, 2 scratch-built computers, and 41 software exhibits.

Both computers were complete homebrew, using 7400-series TTL, no MPU, and the designer's own instruction set. The 11th-grader from Scarsdale had 10K of semiconductor memory, vectored interrupt, DMA, and two addressing modes (present page and indirect). The 11th-grader from Florida had 8K of 16-bit core memory, and used wirewrapping.

The software exhibits included 3 music-writers, 2 simulators (plane cockpit, factory-machine usage), 2 graphics, 1 maze, 7 games (Life, 2 Monopoly, poker, pinball, football, Battleship), 2 financial, 3 physics, 1 biology, 2 astronomy, 1 language translation (Latin), 2 translators (BASIC to APL), 1 dating, 4 for school use (library system, class lists, school inventory, attendance), and 3 programming (batch processing, multi-language system, minicomputer system simulator).

The grand prize, an Altair 8800 kit, went to a 9th-grader from Pennsylvania who developed a "computer prediction of the spread of fire," a simplified model based in internal energy, heat capacity, ignition temperature, and total combustion time of the material in each posi-

tion in eight 10x10x10 matrices. (The student uses a time-sharing system evenings at the Univac plant in Blue Bell, Pa., where his father is a chemist.)

The initial 300 entries showed the same low proportion of hardware to software. Many of the hardware entries were too elementary, such as binary counters, and a circuit, made up of knife switches, that could count from 1 to 8.

A SPHERE EXPERIENCE

Allen Solomon writes from Brooklyn: "I wrote to you a few months ago concerning the Sphere System 3 I had ordered and was waiting for. Well, after waiting 4 months and making many long-distance calls to Utah (Sphere never called or wrote to me) to find out why they hadn't delivered my system within the 90 days they had promised when I paid for it (remember, they were holding almost $2,000 of my money all that time), after all that aggravation, I received my computer in pieces.

"They had packed it so poorly that the circuit boards had smashed into each other and also broken the CRT. The power supply was in equally bad shape. I called Sphere, and they said to send it back, and they would fix it. I told them to either ship out a new one or send my money back.

"A week later, a second Sphere computer arrived. This time, because they hadn't used lock washers in mounting the transformers in the power supply, one of them was laying loose inside with a wire broken off.

"I still was stupid enough to deal with Sphere, so I called them and agreed to make repairs myself if I could. I fixed the power supply. It still didn't work properly. I called them again. They recommended adding caps to the CRT board to stop the image from shaking, and to add heavier bus wire for the power connections between boards (even they admitted that the connectors and wiring used to connect the boards together was causing problems in other Spheres as well).

"I tried everything they or I could think of for two weeks. It just wouldn't work reliably. I finally gave up and sent it back again, with a letter saying to either fix it properly or send my money back. I didn't hear from them. After another week, I called Sphere again. They said that my system had had a power supply problem caused by the transformer having broken something inside, that nothing I had done in trying to make it work had caused any problems, and that it was 100% checked out and being shipped back to me.

"Two weeks later, I got another broken Sphere. This time, somebody had left one of the bus cables attached to the keyboard, and this resulted in a broken keyboard connector. I gave it one last chance.... I bought and replaced the connector. The thing still didn't work properly (shaking CRT image, assembler failures, random characters popping up... just like before). I packed it up, shipped it back to Sphere, and sent a letter telling them that I didn't want to deal with them any more, send me my money.

"Another week went by, but no word from Sphere. I called Utah again (this was costing me a fortune), and told the operator at Sphere that if somebody from Sphere didn't call me back that day, I was taking legal action. Lo and behold, Sphere called me (the one and only time). I was told that, if I insisted, they would send my money back (they tried to talk me into letting them fix it again...ha ha!). They also told me

The Amateur Computer Society is open to all who are interested in building and operating a digital computer.

For membership in the ACS, and a subscription of at least eight issues of the Newsletter, send $5 (or a check) to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.
Darien, Conn. 06820

The Newsletter will appear about every two or three months.

they would deduct 10% of the refund amount for "restocking" charges. I told them to do what they liked, but I would take them to court if they gave me anything less than the full amount I had paid.

"Now, a week later, I received a check for $245 less than I had paid. On top of that, it had cost me almost $50 in long-distance calls, plus the interest lost on my money while Sphere held it for 6 months. I am furious...."

IN PRINT

An Introduction to Microcomputers

This outstanding book, published by Osbourne & Associates (2950 7th St., Berkeley, Calif. 94710) at $7.50 is well worth every penny.

The first six chapters cover the fundamentals, of binary and Boolean, microcomputer organization, the MPU, CPU logic, and programming. Chapter 7, the 138-page meat of the book, covers seven of the top MPUs: F8, PACE and SC/MP, 8080, M6800, PPS-8 (Rockwell), 2650. It goes into, for each MPU, the registers, addressing modes, status flags, pins and signals, interfaces, interrupts, DMA, instruction set, and a benchmark program.

This is not an easy book to read, as it's so terse as to be sometimes confusing unless you've carefully read every word. And the type is too small. But the brainstrain and eyestrain are worth it; no other book on the market today contains so much information about microcomputers in such a small package.

Dr. Dobb's Journal

The full title is "Dr. Dobb's Journal of Computer Calisthenics & Orthodontia," published by People's Computer Company (Box 310, Menlo Park, Calif. 94025), at $10 a year.

The emphasis here is on software, with each issue offering, for example, a system monitor, or a Tiny BASIC, or a memory-test program, or a computer game (all these and more are in only two issues--April and May!).

There is no Dr. Dobbs; his name is a contraction of the first names of the two PCC people who are listed as "Watchdogs" on the journal's masthead: Dennis Allison and Bob Albrecht.

Although there may be other hobby-computer software journals coming up soon, they'll have a long way to go to equal this one, the first of its kind. Thank you, Dr. Dobbs.

TV Typewriter Cookbook

Another in the Sams series of computer Cookbooks by Don Lancaster, this $9.95 paperback tells all about "low-cost television display of alphanumeric and graphics data for microprocessor systems, computer hobbyists, ham RTTY, TV titling, word processing, and video games," to quote from the front cover. The 256 pages cover basics, ICs for TVT use, memory, system timing, cursor and update circuits, keyboards and encoders, serial and TV interfaces, and hard copy and color graphics.

FIRST ISSUE OF VOLUME IV

ACS NEWSLETTER

a publication of the AMATEUR COMPUTER SOCIETY

Volume IV, Number 1 (Serial Issue 39) August 1976

TENTH ANNIVERSARY

The first ACS Newsletter was published in August 1966, ten years ago this month, and has seen many changes in the field of hobby computers, especially the flood of kits in the last year and a half. Until then, it was all home-brew, and although many of us are still building from scratch, the emphasis today is on kits, which certainly do help cut down on time.

KIT ROSTER (PART IV)

Although I thought the list was pretty much up to date with Part III, several more microkits have turned up, including several that were introduced in Atlantic City at the end of this month.

43. The Sol Terminal Computer, by Processor Technology (6200 Hollis St., Emeryville, Calif. 94608), is based on a single Altair-bus-type board that includes an 8080 MPU, 1k RAM, UART, video display circuit (identical to PT's VDM-1), parallel I/O port, keyboard input port, audio-cassette interface, and a PROM/ROM stored-program "personality module" with up to 2k words. A CONSOL program in PROM permits simple terminal operations. The optional second level is the SOLED editing terminal. A third PROM, SOLOS, turns Sol into a stand-alone computer, with BASIC included. The Sol-PC board alone is $475. Sol-10, with cabinet, power supply and 70-key keyboard, is $795. Sol-20 is Sol-10 plus 8 more amps of power, five-slot expansion chassis and card frame, 15 more keys (arithmetic keypad). The SOLED or SOLOS modules can be added to Sol-PC, -10 or -20 for $100, if bought at the same time.

44. The Quay 80A1 uses the Z-80 MPU, with a 2.5-MHz clock, "so you can run Altair 8800 software." The kit includes the Z-80, PROM monitor, 1k static RAM, parallel port, EPROM programmer, sockets for up to four 8k EPROMS, parallel ASCII keyboard, and interfaces for RS-232C and 20-mA current loop; $450 kit, $600 wired.

Quay also has a Q-8Ø OEM micro, on a larger board, with 4k dynamic RAM, on-board expansion room for memory, I/O ports, counter timer, DMA controller; $695 wired. Quay is at P.O. Box 386, Freehold, NJ 07728. (That's Quay Corp.)

45. OSI's Challenger uses their 400-series boards in a case with only one switch. The 65-1K model, with 6502 MPU, serial interface, 1k memory, is $439 wired; 65-4K, $529; 65V-4K, with video board, $675. The 68-1K, with 6800 MPU, is $439; 68-4K, $529. (OSI, 11679 Hayden St., Hiram, Ohio 44234.)

46. CGRS Microtech (P.O. Box 368, Southampton, PA 18966) offers the µ-PUTER, with 6502 MPU, as bare boards, kits, and wired units. The complete system, at $539.95, includes CPU board, control panel with 7-segment hex displays, mother board with 7 connectors, I/O module, power supply, wooden cabinet.

47. The Veras F8 (Veras Systems, Div. of Solid State Sales, Inc., Box 74D, Somerville, MA 02143) has a CPU that includes the F8 MPU, Fairbug monitor, programmable timer, 20-mil loop and/or RS-232 interface, 1k RAM. The CPU, plus buffered

motherboard, power supply, and cabinet, is $429 kit, $679 assembled (after Sept. 15, $459 kit, $709 wired). Motherboard accepts four 4k static RAM boards, at $149 kit each. Under development: UV PROM board, DMI and DMA board, cassette, modem, video board.

48. Three 6800 evaluation boards from AMI (American Microsystems, Inc., 3800 Homestead Road, Santa Clara, CA 95051), feature a built-in EROM programmer: EVK100 kit, with PC board, minimum of parts, $295; EVK200 kit, with 512-byte EROM, $595; wired EVK300, with 2k EROM and Tiny BASIC, $950.

The EVK99, advertised by Advanced Micro Computer Products, is the same as the EVK100 but with less to it, made for hobbyists and computer stores, sold only in quantity to computer clubs and stores.

49. EPIC 2, from Burkeshire Systems (P.O. Box 512, Mountain View, CA 94040) features a board with 8080 MPU, 2k RAM, 256-byte PROM bootstrap, 16 I/O lines, video interface, cassette interface, programs including monitor, text editor, Life, blackjack; separate keyboard; $775.

50. Intercept Jr. from Intersil (10900 North Tantau Ave., Cupertino, CA 95014) is an all-CMOS "low-cost tutorial system" using Intersil's IM6100 CMOS MPU and related CMOS devices; it recognizes the DEC PDP-8/E instruction set. Basic module is a 10-by-11-inch double-sided PC board, with multifunction alphanumeric keyboard, two four-digit LED displays, resident micro-interpreter, and battery power; $281 wired. Memory can be extended up to 12 non-volatile IM6518 1024x1 CMOS RAMs; $145 per RAM module. A power-strobed PROM module supplies up to 2k words of user program; $74.65. Serial I/O module with both RS-232 and Teletype interfaces is $81.70. Terminals permit using external 5- or 10-volt power supply.

51. The Data Handler from Western Digital Systems (3650 Charles St., Suite Z, Santa Clara, Calif 95050) uses the MOS Technology 6502 MPU and a single 13.75-inch by 11.5-inch PC board. "The Data Handler is plug-in compatible" with the Altair 8800; "even the 8800 CPU will plug right in." The bare-bones kit, with PC board, 26 switches, wooden stand, is $79.95. The complete kit includes this plus a full set of ICs, 1k RAM, resistors, capacitors, LEDs and 1-MHz 6502. The Data Handler can directly address 65k of memory. There is an "easy to use full-function hardware-controlled front panel."

"The Data Handler has dual interrupt lines (one maskable), slow-down circuitry for slow memories, DMA (direct memory address), and also contains one 8-bit parallel-input port, one 8-bit parallel-output port, separate I/O address control and memory-control lines, single voltage, and cycle times to 250 nsec."

52. The Apple-1, from Apple Computer Company (770 Welch Road, Suite 154, Palo Alto, CA 94304) is an assembled board using the 6502 MPU, comes with video generator, 4k bytes of RAM (board will hold 8k), monitor in PROM, breadboard area; $666.66. Also available: cassette interface, which includes a tape of pseudo-compiled Apple BASIC; $75. 4k RAM expansion, $120.

53. Gnat Computers (8869 Balboa, Unit C, San Diego, CA 92123), offers a dozen boards, and five assembled systems, based on the 8080 MPU. System 1, with CPU, 1k RAM, 512 words of ROM, Gnatbug, serial and parallel interfaces, hardware package (power supply, card rack with motherboard and five connectors); $925. System 2, "minimum

system for hardware checkout," has CPU, 1k RAM, front panel, hardware package; $985. System 3, PASIC-oriented, has CPU, 8k RAM, 768 ROM words, Gnatbug monitor, interface, hardware package with 6 connectors; $1695. System 4, "minimum for PROM programming," has CPU, 1k RAM, 1k ROM, Gnatbug, interfaces, PROM programmer, hardware package; $1695. System 5, the "complete development system," has CPU, 16k RAM, RAM/ROM for floppy-disk drivers, 4k ROM for monitor, interfaces, front panel, 19-inch cage, cabinet; $2995. Adding to System 5 a Lear Siegler ADM-3 terminal, Teletype 40, iCOM floppy-disk system and high-speed paper tape reader brings the total system to $10,320.

54. BABY! is a wired micro in an attache case, from STM Systems (P. O. Box 248, Mont Vernon, N.H. 030-57), using the 6502 MPU, comes with 2k RAM, 512-byte bootstrap loader and monitor in PROM, DMA, video interface, audio cassette interface, 63-key keyboard with upper and lower case (plus Greek with control key), power supply, speaker, audio cassette tape with dump program, text editor, three games, music program, for $850. Same with 4k RAM, $1000. Optional video monitor, $150. Floppy diskette with power supply and controller, $750. Maintenance contracts available!

55. The SC/MP PC-board kit from National Semiconductor uses the SC/MP MPU (ISP-8A/500D), features static operation, 46 instruction types, single- and double-byte operation, 512 bytes of ROM with "Kitbug" monitor and debug program, 256 bytes of RAM, crystal clock, TTY interface, 62-pin edge connector, at $99.

56. The PS-810 from Pronetics Corp. (P.O. Box 28582, Dallas, Texas 75228), is an assembled PC board, 4.5" x 6.5", with 1k RAM, 1k firmware (Fairbug monitor), 32 bidirectional latched I/O ports, Teletype interface, $179.

57. The M-8 Educator, from Technical Communications, Inc. (11495 Lenexa Dr., P.O. Box 306, Olathe, Kansas 66061) uses an F8 MPU, has 4k bytes of RAM (expandable to 16k), 2k bytes of RAM for CRT refresh, 1k Fairbug monitor, with CRT, keyboard and electronics in plastic housings. The 12-inch CRT has 31 lines of 64 characters each; keyboard has 53 keys. Serial 20-mA loop for Teletype, 300-baud I/O for mag tape, parallel port for high-speed tape reader. Optional: resident assembler in 3k ROM; ROM board has space for additional 5k. Price: $1895.

58. The Intecolor 8001 kit, from Intelligent Systems Corp. (4376 Ridge Gate Drive, Dulugh, Georgia 30136), although advertised as an 8-color intelligent terminal, is actually a computer, based on the 8080 MPU, with 25 lines of 80 characters each on a 19-inch 8-color CRT, 4k RAM/PROM software, baud rates up to 9600 baud, ASCII keyboard; $1395. Options include RAM to 32k, 48 lines of 80 characters each, light pen, limited graphics mode, background color, special graphics characters. Later this year they'll offer check-balancing and inventory programs, and will advertise the 8001 as a personal computer.

CHANGES IN THE COMPUTER ROSTER

There are some changes and corrections to be made to the computer rosters in the last three issues of Volume III.

The PolyMorphic Micro-Altair name was changed to Poly-88, not Micro-88, as reported in the June 1976 issue, item #36.

A couple of computer companies may be out of business, or relocating:

Systems Research, Inc. (SRI-1000, #17, Nov. 1975 Newsletter, and SRI-500, #20, Feb. 1976 NL) has a disconnected phone. Techtra (TMC 112, #24, Feb. 1976 NL) is having its phone number changed, new phone not in yet....

One of the very first microcomputers was the RGS 008A (#12, Nov. 1975 NL), which is now available only on special order, as RGS is now working on a new system, using many of the same boards, such as for RAM and ROM, but with new CPU boards, for the 8080, 6800, 6502, 1802 (COSMAC). Availability date depends on capitalization.

Computer #38, the 8080+, listed in the June 1976 NL as coming from the Computer Shack, is actually the MSC 8080+, a product of Monolithic Systems Corp. (14 Inverness Dr. East, Englewood, Colorado 801-10), and is one of the best-looking micros available, with a very neat and functional-looking control panel. This wired-only two-board (stacked) micro has a big brother, a four-board OEM and evaluation-type system, which adds to the 8080+ an OS board (static RAM with battery, and strapped write-access) and a 16k memory board; $1976.

PERSONAL COMPUTING '76

The two-day Consumer Trade Fair, Aug. 28 and 29, at Atlantic City, New Jersey, was hectic, crowded, and had 80 or more booths crammed with computer goodies. Between 3000 and 3500 people attended, and nearly 40 papers were presented, ranging from "The KIM System" to "Software for Speech Synthesis."

Multiprocessing with Microprocessors

This paper, by Mike Cheiky of OSI, was about the new 460Z CPU expander board, which allows a user to "run 8080, Z-80 and 6100 (PDP-8) software on his 400 system without modifying the software." Inserted in the 400 bus between a 6502-based 400 board and the rest of the 400 system, the 460Z contains both a Z-80 and Intersil 6100 MPU, with room for a third MPU. The "executive" 6502 controls each line of the Z-80 and 6100, monitors system signals, and permits multiprocessing.

Cheiky said that the reason to go to multiprocessing is to protect against obsolescence, since "any processors you use today and in the future can be run under the executive of the extremely fast 6502." The 6502, which is the fastest MPU available, due to its pipeline processing, which increases speed by overlapping operations, will be superseded by an even faster MPU, the 6502C.

Talking Computers

Both Votrax and Computalker exhibited computer-controlled speech synthesizers. The Votrax takes 8 bits to select one of 61 phonemes, which are the individual sounds that make up words. The word "and" takes six bytes, and is coded as 2/PA1, 1/AE1, 1/EN3, 1/I3, 1/N, 1/D. The first byte is a pause; the numbers before the remaining slashes are stress levels, with the highest number indicating the principal stress in the word. Votrax has a "dictionary" of words with their codings, which would have to be stored in a table.

The Hobbyist Standard

Some manufacturers decided to find a short name for the 100-pin bus that has become known as the "Altair/Imsai/PolyMorphic/Sol bus." They picked "S-100," meaning the Standard 100-pin bus. However, MITS says they have that bus patented, and will not advertise in any magazine that uses "S-100" instead of just plain "Altair bus," which is what

MITS insists on. Well, it's short.

Me-Too Boards for the SwTP 6800

Until recently, anybody who was making only the boards for a hobby computer, would make them for the Altair 8800 bus; an example is the Vector prototype board. But now you can get prototype boards for the Southwest 6800 system, in CPU/memory size at $19.95 and I/O size at $9.95, from Personal Computing Co., 3321 Towerwood Dr.,Suite 107, Dallas, Texas 75234.

Case for the CT-1024

If you need a case for your Southwest CT-1024 terminal (or for any similar keyboard terminal), a fine metal one, with welded joints, is available from E,S, & L Industries, Inc. (867 Rose Place, Anaheim, CA 92805). There are 8 models, from $45 to $55; you choose the one that fits your particular keyboard and which has, if you need it, a cutout for a 5-key or 12-key pad for cursor control or numerics. Send for the info sheet, which also shows line drawings of their computer stands and the console.

Expansion for All-On-One Board

Several of the companies that make "computer-on-a-board" machines, with keyboard and display on the PC board, are now offering expansion units.

MOS Technology has, to expand the KIM-1 computer, a KIM-2 4k static RAM memory board ($170), KIM-3 8k static RAM memory board ($298). In the works are a resident assembler, full BASIC, 2k EROM board.

EBKA will soon have an expander board for its 6502 Familiarizor, or for any 6502 or 6800-based micro, with all sorts of options: EPROM programmer, 4k RAM, parallel interface, baud-rate clock, serial interface, dual cassette interface, plus connecting cables. The whole works, complete, is $495 kit, $575 assembled. Up to eight of these boards may be daisy-chained together, for a total of 33k of RAM.

The E&L Mini-Micro Designer (same as the Radio-Electronics Dyna-Micro) now has a plug-in accessory board, with extra RAM (1k supplied, 2k capacity), Teletype and audio-cassette interfaces, paper-tape controller, room for more PROM or ROM (none supplied). $175 kit; $225 assembled and tested.

Digital Group Case

A case will soon be available for all those Digital Group boards; a prototype was shown, with space for a dozen cards or so, no front-panel switches or lights other than for power and reset. CPU boards now available include Z-80, 8080A/9080A, 6800, and 6502. A complete four-board Z-80 system, with 10k memory, power supply, motherboard and cabinet, is $895 kit, $1295 wired; same with 18k, $1095 kit, $1545 wired. Similar 8080 or 6800 systems are $50 cheaper; the 6502 system is $100 cheaper.

Altair Kit-A-Month

First I'd seen of an easy-payment plan, offering the 8800b at $107 per month for 8 months, 8800a at $79 a month for 7 months, 680b at $95.20 per month for 5 months.

KIM-1 Power Supply

For those who don't have a ready source of +5 and +12 volts, a power supply is available at $50 (plus $2.50 handling and shipping; NJ residents add 5% sales tax) from Scarpa Laboratories, Inc., 46 Liberty St., Brainy Boro Station, Metuchen, New Jersey 08840.

BASIC Tutorial

The Amateur Computer Society is open to all who are interested in building and operating a digital computer.

For membership in the ACS, and a subscription of at least eight issues of the Newsletter, send $5 (or a check) to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.
Darien, Conn. 06820

The Newsletter will appear about every two or three months.

Wave Mate, manufacturers of the Jupiter II and IIC computers, are planning to offer a BASIC tutorial on cassette.

COMING COMPUTER SYSTEM

Godbout may be on the way toward the computer he's been talking about for some time. He's now advertising a 16-bit PACE CPU board, although "not soliciting orders (yet), so please don't write us just now. When we have a complete system, available off-the-shelf, you'll see it in our ads. Hang in..." They do have a Naked RAM board, 4k, with 40-pin connector; $88. And Econoram, 4k Altair-compatible, $99.95.

VECTOR 8800V BOARD

Vector's 8800V universal microprocessor board is the same size as Altair and Imsai boards, prepunched for DIP ICs. Power and ground planes are on opposite sides of the board. Two heat-sink positions; one heat-sink supplied; $19.95 each.

IN PRINT

A unique publication is the 1½-inch thick "Bug Book III, Micro Computer Interfacing: Experiments using the Mark 80 Microcomputer, an 8080 System," $14.95 from E&L Instruments (61 First St., Derby, Conn. 06418). The Mark 80, also known as the Micro-Designer System (Nov. 1975 NL), has two SK-10 breadboard sockets, permitting the use of a wide variety of "LR Outboards," modular electronic circuits that "each perform a single digital function," such as LED display, pulser, timer, clock, line driver/receiver, UART, etc.

After a long section on the 8080, there are dozens of experiments, some involving running simple programs, others that use outboards and simple programs.

Sylvania Technical School Manuals

One of the ACS members says he learned everything he knows about computers from the Computer Lab Books published by the Sylvania Technical School (63 Second Ave., Waltham, Mass. 02154).

The Computer Phase III Student Handout/Lab Book ($3.23) is a 212-page primer that examines the basics of Boolean algebra, truth tables and logic circuits, combinational logic, timing diagrams, numbering systems and conversion, binary arithmetic, and logic families, and is a workbook with many blanks for the student to fill in.

The Computer Phase IV Integrated Circuit Handout/Lab Book (not seen) is $4.36. The Computer Phase V PLC-1 Computer Operations Lab Book ($4.50) is a manual for a pre-MPU teaching computer, an 8-bit, single-address, bus-transfer-organized, parallel processor with ROM control.

The books "may be bought on the premises through the School Book Store, if someone lived nearby. Other arrangements might possible be made." If you don't live nearby, you might write to the Book Store....

KIT ROSTER
PART V

ACS NEWSLETTER
a publication of the
AMATEUR COMPUTER SOCIETY

Volume IV, Number 2
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December 1976

KIT ROSTER (PART V)

There's just no end to the procession of microprocessor kits (and wired units): 18 were listed in the Nov. 1975 Newsletter, 16 in Feb. 1976, 8 in June 1976, 16 in Aug. 1976, and here we go again:

59. The Iasis 7301, from Iasis, Inc. (815 W. Maude Ave., Suite 13, Sunnyvale, Calif. 94086), is an all-on-one-board computer, wired only, with 8080 MPU, 1k RAM, 2k PROM, 24-key keyboard, eight 7-segment readouts, Iasis-developed monitor in 1k of the PROM; $450. Accompanying the "ia7301" is a 250-page programming course. Both computer and course are contained in a three-ring binder. Iasis also has a $7.95 Microcomputer Applications Handbook.

60. The COMPAL-80 computer, from Computer Power & Light (12321 Ventura Blvd., Studio City, Calif. 91604) is an assembled system "for homes and small businesses for only $1863." The system includes a computer with only two front-panel switches, separate keyboard, and 9-inch TV monitor. Uses 8080A MPU, two serial I/O ports, 12k words of RAM, 16-line by 64-character video display, and extended BASIC residing in 10k, including formatted PRINT, double precision, etc. Options include additional memory up to 32k, dual floppy-disk drive, hard-copy devices, disk BASIC, applications programs in BASIC (payroll, inventory control, general ledger, etc.). The typical business system, including disk and printer, is under $9000. In a letter, CP&L said, "We use modified versions of boards manufactured by PolyMorphic Systems and by Processor Technology. Our CPU board is essentially that provided by PolyMorphic in their Poly 88, with the exception that the resident monitor on PROM is addressed at E000 hex, and that we perform a hardware jump to this address upon reset. Also, our monitor includes some features not found in other microcomputers...."

61. The Motorola MEK6800D2 Evaluation Kit has everything on one board, except power supply. The $235 kit features 16 hex keys, 8 function keys, 6 hex LED displays, 256 bytes of RAM, room for more RAM (or ROM or PROM), wire-wrap area for up to 20 16-pin ICs, ACIA for cassette interface, PIA for keyboard and display, second PIA for user, J-BUG monitor in ROM (examine and change memory & registers, set up to five breakpoints, trace one instruction, etc.), crystal-controlled clock. Motorola started shipping the D2 this month.

62. First offered about a year ago, the Motorola MEK6800D1 design evaluation kit consists of PC board, 6800 MPU, PIA, ACIA, two 128-byte RAMs (room for 4 more on board), 1k ROM with Mikbug monitor, $149. The additional required ICs, sockets, resistors, etc., cost around $75 more (not available from Motorola).

The J-BUG in the D2 is like the KIM (Keyboard Input Monitor) in the KIM-1; the Mikbug in the D1 is for use with Teletype or RS-232 interface; these are two incompatible systems.

63. The Microkit-8/16 MOD 8080 and MOD 6800 are from Microkit Inc. (2180 Colorado Ave., Santa Monica, Calif. 90404), which says "Don't be

misled by our name, our system comes fully assembled, fully tested...." The two "Microcomputer Development Systems" are identical except for the MPU. Each includes a black-box computer (with only a power switch), keyboard, TV monitor, and two cassette-tape units, at $3850 each. Other features include an interactive debugger, editor, and resident assembler. Options include 8080 and 6800 in-circuit emulators ($1250 each), conversion packages for adding a 6800 to the 8080 system and vice versa ($950 each). printers and floppy disk, additional 8k dynamic RAM memory ($800), prototype board, PROM/RAM board, PROM programmer, BASIC interpreter ($900), word processor for text editing ($100), and terminal simulator and PL/M loader. This isn't really a hobby item, but it's interesting....

64. MicroMind, from ECD Corp. (196 Broadway, Cambridge, Mass. 02139) is based on the 6512A MPU (second-generation 6502), with character and graphics generator, I/O interface, rf modulator, power supply, 80-key keyboard. Software includes interactive editor, assembler, monitor, cassette-based file system, an extended form of BASIC called notsoBASIC, and "many games and utilities." Has sockets for 16k of memory, with 8k supplied. A memory-mapping option allows addressable memory space to be extended to 64 megabytes; 32k-byte memory expansion boards are available. Each of the 128 possible characters is software-defined, can be changed in real time, for detailed graphics. The cassette interface operates at a transfer rate of 400 8-bit bytes a second. Assembled only, $987.54. The notsoBASIC seems to be a version of Tiny BASIC, as floating-point is an option. Black-and-white graphics is included; 16-color graphics is optional.

65. The Gemini-68 from M&R Enterprises (P.O. Box 61011, Sunnyvale, Calif. 94088) consists of several assembled boards. The $279.95 stand-alone CPU board, with 6800 MPU, 384 RAM bytes, serial I/O, DMA, dual 22-pin edge connector, is about the same as the M&R Astral 2000 CPU board, except that Gemini uses the Mikbug monitor while Astral uses a 2k custom monitor; the PROM and ROM boards are the same. An 8k RAM board, $269.95; 8k EPROM board, with all ICs except the 5204 EPROMs, $89.95. There's also a CPU board with only 128 RAM bytes for $259.95. World-wide distribution rights have been assigned to James Electronics (1021-A Howard Ave., San Carlos, Calif. 94070); M&R will handle only OEM orders for 100 or more. The Gemini boards fit one of the Vector cabinets; if the volume of orders warrants it, M&R may provide a backplane. M&R advertising emphasis is now on the Gemini-68; presumably M&R has had the same trouble with the Astral 2000 that most other computer-kit manufacturers are having: many phone calls requesting assistance, and many PC boards sent in "all screwed up," as one company puts it.

66. In addition to the 1801-based Microtutor (#34, Feb. 1976), RCA now has the CDP18S020 Evaluation Kit with 1802 MPU, PC board, byte input and byte output ports, terminal interface, 512-byte ROM with "utility programs of commonly required functions," 256-byte RAM (room on-board for 4k max.), LED display, $249.

67. Cromemco (One First St., Los Altos, Calif. 94022), famous for the "TV Dazzler," has an assembled-only system using the Zilog Z-80 MPU, along with 8k RAM, PROM programmer, monitor in PROM, RS-232 interface, and mainframe with 22 slots. Actually, the mainframe is an Imsai. The price is a little beyond the usual hobby range: $2495.

This is justified by calling the Z-1 a "microprocessor development system."

HOBBY COMPUTERS: TWO DIRECTIONS

Two trends dominate hobby computers today. One is for computer freaks, and involves advanced hardware. Such as an Altair-compatible board that will store digitized versions of your voice in "training" mode, and then, in speech mode, when it recognizes your voice speaking one of the previously recorded words, will cause that word to be printed. (this is coming up in 1977). There are already computer boards that synthesize speech from stored vocabularies (August 1976 Newsletter, p 4). So it won't be long before computer freaks will be trying to get one computer to talk to another, not through wire, but by voice!

Other computer-freak areas involve advanced graphics, computer music, interfacing to a breadboard, digitizing the output of a TV camera, etc. So much time is spent on getting these devices to work, that very little time is actually spent by these hobbyists on computing. The emphasis here is on gadgeteering, on a constant search for the far-out and complex.

The other trend is more and more toward the average consumer's use of hobby computers. This means a certain amount of using all-on-one-board machines such as the KIM-1, EBKA 6502 Familiarizor, and EPA-68, programmed in assembly language. There are more of these all-on-one-board type of hobby computer than any other, one reason being that it's the simplest complete computer in a single package, with a minimum of parts, and is thus much easier for a manufacturer to design and produce than the more complex multi-board machines such as the Imsai 8080 or Digital Group system. For the manufacturer, there's very little labor involved, no sheet-metal work, no point-to-point wiring, and no construction manual to have to supply. A KIM-1 offers the hobbyist the cheapest way to get his feet wet, to learn the basics of computing at minimum cost, without the need for an external keyboard, or connection to a TV set or printer.

Some of these all-on-one-board computers are so simple and cheap that they'd be hard to expand, and are fine for the person who's quite sure all he wants is to learn the elements of computing without havint to put too much money into a machine he might not use much after he figures out how it works.

For those who think they may want to expand their computer so as to be able to write longer programs, or to hook on an alphanumeric keyboard or cassette memory system, etc., several of these "compacts" have add-on boards. KIM-1 owners can buy the KIM-2 4k RAM memory board, or KIM-3 8k memory. KIM-4 is a 6-slot motherboard with all connectors and a regulator. And further KIMs are in the works. The EBKA expander board, which will "expand any 6502 or 6800-based microcomputer," can be bought as an empty board, or with any or all of seven options, including kits for a PROM programmer, 4k RAM, 2k PROM, baud-rate clock, and interfaces for serial, parallel and dual-cassette operation.

But a much more important trend is to the wired-only computer that can be programmed in BASIC. As the hobby market appeals to more and more non-technical people, it will have to provide this high-level language, since such people will be interested in programming, and not at all in assembly language, which is too tedious and time-consuming

for all but the computer freak. As it turns out, incidentally, there are very few hobbyists who are really into heavy assembly-language programming; most of them use BASIC.

Aimed directly at the mass computer-hobby market is a $495 BASIC computer, with CRT and keyboard, scheduled to be shown in prototype at the January 1977 Consumer Electronics Show in Chicago, and made by a calculator manufacturer that recently bought an IC manufacturing company. Another calculator manufacturer is said to be working on a similar home computer, although more expensive: with 32k, $2,000.

This is where the major hobby-computer market of the future lies, not in the far-out hardware, but in an all-in-one-box computer that sells for less than $1000. The user won't care if the MPU is a Zilog Z-80 or an Intel 4004. He wants to program, and he needs to be supplied with plenty of software and with plenty of tutorial material to teach him how to use the software and to write his own programs. A couple of the larger hobby-computer manufacturers are already considering hard-wired BASIC computers. This means a BASIC interpreter in some form of read-only memory. A couple of hobby-computer manufacturers have BASIC in ROM now; one has 4k, 8k and 12k BASIC in firmware, but at prices that make his complete BASIC machine too expensive for the mass market. However, 1977 should see several new BASIC machines, assembled only, ready to run, for less than $500.

MICROPROCESSOR IN AN FM TUNER

The first use of a microprocessor in hi-fi tuners is in the Sherwood Micro/CPU 100, a synthesized digital FM tuner. The entire tuner is said to be "controlled by a mini computer circuit, which all but eliminates tuning errors (accurate to .0024%), stringing dial cords and all mechanical functions." The tuner reads out the tuned-station call letters on a separate display, which can be programmed to display any four alphanumeric characters in place of the call letters. And there's also a display of the frequency tuned. Four stations can be called up from memory by simply toucing one of four pairs of electronic touch-switches. There is no dial pointer; LEDs indicate the relative position on a standard linear scale, in analog fashion. Other touch-switch controls allow scanning up or down the FM band. The memory is "non-volatile." And the price is about $2,000.

PUBLICATIONS

End of "Microtrek"

One of the half-dozen hobby-computer magazines has already ceased publication. The first issue of Microtrek was published in August 1976, and the second in December. It has since merged with Personal Computing, and will become a "special section" in that magazine.

Computer Music Journal

The People's Computer Company (PCC), which publishes Dr. Dobb's Journal, has announced a "Computer Music Journal," which "will be devoted to the development of computer systems which are capable of producing high-quality music." Topics to be covered include synthesis of tones, design of real-time playing instruments, real-time controllers, reviews of hardware components, composition of music using a computer, digital filtering, envelope generation, etc. A one-year subscription (6 issues) is $14 (first issue due Jan. 1977), from PCC, Box E, Menlo Park, Calif. 94025.

More Magazines on the Way

In addition to Byte, Personal Computing, Kilobaud, Interface Age, SCCS Interface, Creative Computing, Dr. Dobb's Journal, and People's Computer Company, two more hobby-computer magazines are said to be in the works for 1977: ROM, originally planned by New York magazine, and due in June 1977; and a Hearst magazine, as yet unnamed.

HARDWARE

Zilog Boards

The Z-80 company, Zilog, has introduced a set of three boards. The MCB is a CPU board using the Z-80, with 4k bytes of RAM, sockets for up to 4k bytes of ROM, PROM or EROM, -5 volts power, four programmable counter-timer circuits; $415 kit, $475 assembled.

The Disk Controller board, MDC, permits storing and retrieving data from up to four floppy disks, and contains 12k bytes of RAM; $745 assembled.

Third is the RMB memory board, for expanding memory up to 65k in 16k increments of RAM; $750 assembled. As an option, Zilog offers a system including card cage, chassis, power supply, two floppy disks and a front panel, at $6990.

Imsai Terminal and Printer

Imsai now offers a keyboard terminal and a printer. The ASCII-encoded 53-key keyboard terminal has two-key rollover with audio feedback, and a display panel with indicator LEDs for the shift and control key as well as the ASCII bit pattern. Assembled only, $199.

The 44-column dot-matrix printer interfaces to an 8-bit parallel-output port with handshaking, and offers multiple-copy printing by using carbon or NCR paper. Kit $399, assembled $549.

FROM OUR READERS

Need Help on the Mark-8?

From Ron Carlson: "I got my MARK-8 running last year and have been rapidly developing a system around it. In addition to advancing my own computer, I have helped several other local MARK-8 users get their machines debugged and up. From my experiences I have been asked to be the "MARK-8 Coordinator" for SCCS (Southern Calif. Computer Society) and I have accepted. I have several things to offer to MARK-8 users at this time: Some rather simple programs to play music and some very nice test programs, maybe my operating system in the near future (inquire with a SASE); and a MARK-8 corrections/mods package.

The MARK-8 package is the culmination of a lot of work and finishes up the design of the system. It fixes over 50 errors in the schematics, the interrupt structure, clock phases, buffered CPU, open inputs, LED drivers, etc. There is a complete set of redrawn, corrected schematics and an instruction booklet of 10 pages. A parts kit is also included, with even a drill-bit to allow one to make the mods or corrections as neatly as they wish. The price is $10 to cover costs and postage, from

Ronald E. Carlson
14014 Panay Way #255
Marina del Rey, Calif. 90291

Any questions or troubleshooting inquiries are welcome."

Printers

R. David Vednor (RDV Engineering, 14914-D Newport Ave., Tustin, CA 92680) writes: "I have three Centronics 306C printers for $2000

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The Newsletter will appear about every two or three months.

each. These are new and have never been installed. Also, I am in the business of manufacturing Interdata-compatible interfaces. I have some used items, and know of several used system components available for someone with the money."

COMPUTER-STORE ROBBERY

The Computer Store at 55 West 39 St. in New York City was robbed over a weekend several months ago, by burglars who knew exactly what they were after. As the store manager put it, "They took two of everything that was useful and not tied down," including a color TV set, two Altair 8800a computers, an Altair 680 computer, oscilloscope, two disk drives, at least three Design Mates, two 16k memory-board kits for 8800, several 4k memory, two CRTs, four Superscope cassette recorders, and a few assorted odds and ends.

PROBE AND MONITOR

Speaking of Design Mates (made by Continental Specialties Corp., 44 Kendall St., P.O. Box 1942, New Haven, Conn. 06509), the same manufacturer makes a couple of interesting and very useful test instruments.

The LP-1 logic probe ($44.95) is five inches long and an inch wide, with three LEDs and two switches. One switch is set for the type of logic being checked out, TTL/DTL or CMOS. The other switch has PULSE and MEMORY positions. When the switch is set to PULSE, frequencies up to 10 MHz will cause the PULSE LED to blink on and off at a 3-Hz rate, due to a pulse-stretcher in the probe. If a single pulse is to be detected, the MEMORY position permits the event to be stored indefinitely. The HI and LO LEDs blink on and off, tracking the one and zero states at square-wave frequencies up to 100 KHz. Clip leads connect to the circuit's power supply.

The logic probe is fine for tracing signals through one IC pin at a time. But if you need to check out an entire IC all at once, just clip on the LM-1 logic monitor. Hinged something like a clothespin, it clips over any DIP IC up to 16 pins, automatically locates the power leads and feeds them to the LM-1's internal circuitry. Each of the 16 contacts connects to a level detector that drives a numbered high-intensity LED, so you know right away which pins are high and which are low. The LM-1 is $84.95.

ARE YOU A SOFTWARE WRITER?

Is anybody out there good at writing about hobby-computer software, such as an article on how to set up a hifi-LP inventory system, going into flowchart, record format, and a program in BASIC? (This is for a hobby-computer magazine that pays for contributed articles, and which has asked me to help look for such a writer.)

If you've assembled anything other than an Altair 8080, please write in about your comments and opinions.

February 1977

Amateur Computer Society
Newsletter
To Cease Publication

After two issues of Volume IV, the Newsletter of the Amateur Computer Society is ceasing publication. Published regularly since August 1966, the ACS Newsletter was the first hobby-computer publication in the world.

Times have changed, and now that kits are so prevalent, there are other publications that serve the readers' interests better than the ACS Newsletter. Also, the ACS Newsletter always depended heavily upon reader input, and this input has dwindled.

A few sets of back issues are still available:

	USA & Canada	Overseas
Volume I (11 issues)	$3.00	$3.50
Volume II (12 issues)	$3.00	$3.50
Volume III (15 issues)	$5.00	$6.00

There are only a few left of the two issues in Volume IV, at $2.00 for both, in the USA, Canada, or overseas.

A refund check is enclosed for the unused portion of your subscription. If there was anything extra in your account beyond what you sent in for Volume IV, that amount is also herewith refunded.

Thank you all for your support over these last 10½ years. It was fun while it lasted.

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.
Darien, Conn. 06820

So long to one of the "old-timers," dating back to early 1967. Sorry I couldn't keep it up, but am quite busy in a new job, as editor-in-chief of Creative Computing.

Steve Gray