ACS NEWSLETTER

Volume II, Number 7
(Serial issue 18)
August 1970

a publication of the
AMATEUR COMPUTER SOCIETY

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-

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

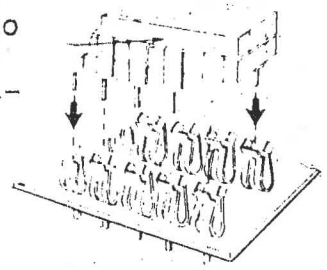
Cambion has some "manufacturer's seconds" of 14-pin sockets for DIP ICs, with Wire-Wrap terminals, style 703-3897-01-03-16, at 25¢ each for 100 to 499, 20¢ each for 500-999. If interested, write to vice-

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

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 Ave.
Darien, Conn. 06820

The Newsletter will appear about every two months.

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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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
1101l- 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 Vcc, ground, or logic signal (high or low), and automatically connect the clip's Vcc 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 SN74C0 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 pushbuttons, 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.

ACS NEWSLETTER

Volume II, Number 9
(Serial Issue 20)
March 1971

a publication of the
AMATEUR COMPUTER SOCIETY

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 Menzel 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 (2154 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."

ACS NEWSLETTER

Volume II, Number 10
(Serial Issue 21)
June 1971

a publication of the
AMATEUR COMPUTER SOCIETY

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.

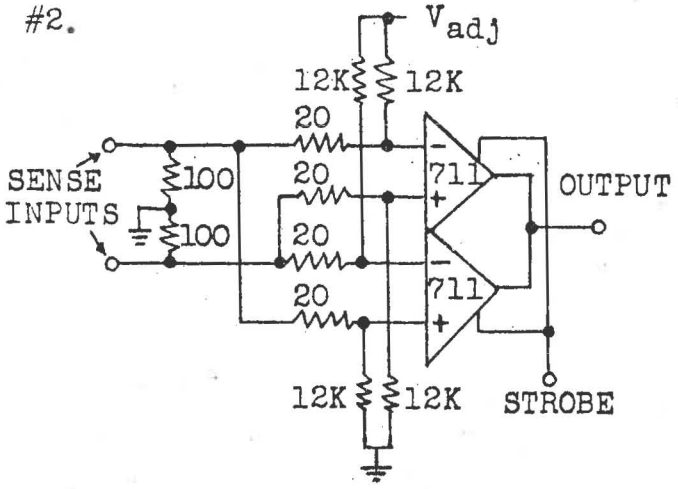
"I've been experimenting with using some of the small epoxy rectifiers that many places sell for 5¢ as selection diodes for a core stack. I haven't run all the tests I should yet (translated: I haven't gotten around to building a complete pair of line drivers), but it looks like they may be OK at least 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

Volume II, Number 11
(Serial Issue 22)
November 1971

a publication of the
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, indir 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.

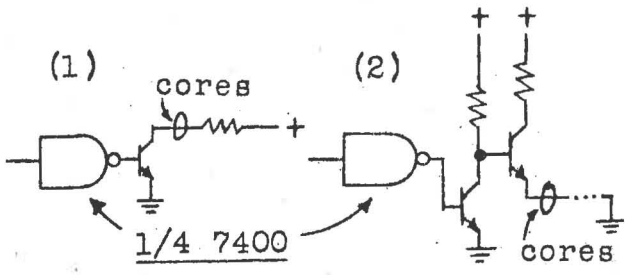
"On memories: I haven't gotten around to testing the rectifiers yet, but it has occured to me that part of the advantage of 3-to-1 selection ratio in a core stack can be had without the need for separate drivers for the X direction on each plane. (Three-to-one selection ratios are usually achieved by 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

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 Norotон 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 ½ 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.

Volume II, Number 12
(Serial Issue 23)
March 1972

ACS NEWSLETTER
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 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) How to get the IBM 1620 memory to work: 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 unidirectional 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-

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 Norotcn Avenue
Darien, Conn. 06820

The Newsletter will appear about every two months or so.

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.
